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TURKISH JOURNAL of ORTHODONTICS

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Turkish Journal of Orthodontics (Turk J Orthod) is an international, scientific, open access periodical published in accordance with independent, unbiased, and double-blinded peer-review principles. The journal is the official publication of Turkish Orthodontic Society and it is published quarterly on March, June, September and December.

Turkish Journal of Orthodontics publishes clinical and experimental studies on on all aspects of orthodontics including craniofacial development and growth, reviews on current topics, case reports, editorial comments and letters to the editor that are prepared in accordance with the ethical guidelines. The journal's publication language is English and the Editorial Board encourages submissions from international authors.

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Table 1. Limitations for each manuscript type

TYPE OF MANUSCRIPT	WORD LIMIT	ABSTRACT WORD LIMIT	REFERENCE LIMIT	TABLE LIMIT	FIGURE LIMIT
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REVIEW ARTICLE	5000	250	50	6	10 or total of 20 images
CASE REPORT	1000	200	15	No tables	10 or total of 20 images
LETTER TO THE EDITOR	500	No abstract	5	No tables	No media

Tables

Tables should be included in the main document, presented after the reference list, and they should be numbered consecutively in the order they are referred to within the main text. A descriptive title must be placed above the tables. Abbreviations used in the tables should be defined below the tables by footnotes (even if they are defined within the main text). Tables should be created using the "insert table" command of the word processing software and they should be arranged clearly to provide easy reading. Data presented in the tables should not be a repetition of the data presented within the main text but should be supporting the main text.

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Figures, graphics, and photographs should be submitted as separate files (in TIFF or JPEG format) through the submission system. The files should not be embedded in a Word document or the main document. When there are figure subunits, the subunits should not be merged to form a single image. Each subunit should be submitted separately through the submission system. Images should not be labeled (a, b, c, etc.) to indicate figure subunits. Thick and thin arrows, arrowheads, stars, asterisks, and similar marks can be used on the images to support figure legends. Like the rest of the submission, the figures too should be blind. Any information within the images that may indicate an individual or institution should be blinded. The minimum resolution of each submitted figure should be 300 DPI. To prevent delays in the evaluation process, all submitted figures should be clear in resolution and large in size (minimum dimensions: 100 × 100 mm). Figure legends should be listed at the end of the main document.

Where necessary, authors should Identify teeth using the full name of the tooth or the FDI annotation.

All acronyms and abbreviations used in the manuscript should be defined at first use, both in the abstract and in the main text. The abbreviation should be provided in parentheses following the definition.

When a drug, product, hardware, or software program is mentioned within the main text, product information, including the name of the product, the producer of the product, and city and the country of the company (including the state if in USA), should be provided in parentheses in the following format: "Discovery St PET/CT scanner (General Electric, Milwaukee, WI, USA)"

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Books with a Single Author: Sweetman SC. Martindale the Complete Drug Reference. 34th ed. London: Pharmaceutical Press; 2005.

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Conference Proceedings: Bengisson S. Sothemin BG. Enforcement of data protection, privacy and security in medical informatics. In: Lun KC, Degoulet P, Piemme TE, Rienhoff O, editors. MEDINFO 92. Proceedings of the 7th World Congress on Medical Informatics; 1992 Sept 6-10; Geneva, Switzerland. Amsterdam: North-Holland; 1992. pp.1561-5.

Scientific or Technical Report: Cusick M, Chew EY, Hoogwerf B, Agrón E, Wu L, Lindley A, et al. Early Treatment Diabetic Retinopathy Study Research Group. Risk factors for renal replacement therapy in the Early Treatment Diabetic Retinopathy Study (ETDRS), Early Treatment Diabetic Retinopathy Study Kidney Int: 2004. Report No: 26.

Thesis: Yılmaz B. Ankara Üniversitesindeki Öğrencilerin Beslenme Durumları, Fiziksel Aktiviteleri ve Beden Kitle İndeksleri Kan Lipidleri Arasındaki Ilişkiler. H.Ü. Sağlık Bilimleri Enstitüsü, Doktora Tezi. 2007.

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Original Article

Impact of Orthodontic Treatment Complexity on Oral Health-Related Quality of Life in Turkish Patients: A Prospective Clinical Study

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ABSTRACT

Objective: The study aimed to evaluate the relationship between orthodontic treatment complexity and oral health-related quality of life (OHRQoL) and to assess the impact of malocclusion and orthodontic treatment on OHRQoL in orthodontic patients with regard to gender and age.

Methods: This prospective clinical study included 102 patients aged 13-35 years who were referred to the orthodontic department. The impact of orthodontic treatment complexity was assessed using the Index of Complexity, Outcome and Need (ICON). The Turkish version of the Oral Health Impact Profile (OHIP-14) was used to examine the subjects for OHRQoL before and after treatment. The before and after treatment data (T1 and T2, respectively) were tested using a paired t-test, and one-way analysis of variance (ANOVA) with the Bonferroni test was used to assess the differences in OHIP-14 across groups, as defined by the ICON. The cross-sectional comparisons between genders and age groups before and after treatment were tested using the Student's t-test. The level of significance was set to a p value of 0.05.

Results: Patients with moderate treatment complexity reported a significantly negative impact on the psychological disability domain compared to the difficult treatment complexity. OHRQoL improved after treatment. Females showed statistically significant and highest scores on the physical pain domain compared to males. Adults showed a statistically significant negative impact on the psychological domains before treatment as well as a statistically significant positive impact on the psychological disability domain after treatment compared to adolescents ($p<0.05$).

Conclusion: Orthodontic treatment improves OHRQoL, and orthodontic treatment complexity does not seem to have an impact on OHRQoL.

Keywords: Oral health-related quality of life, treatment complexity, ICON, OHIP-14, orthodontic treatment, malocclusion

INTRODUCTION

Oral Health-Related Quality of Life (OHRQoL) is defined as "a multi-dimensional construct that reflects people's comfort when eating, sleeping, and social interaction; their self-esteem; and their satisfaction with respect to their oral health" (1). A variety of OHRQoL instruments have been developed (2), of which multiple-item questionnaires are the most widely used methods to evaluate the functional and psychosocial impacts of oral diseases (3). Several instruments that have been thoroughly tested to assess their psychometric properties, such as reliability, validity, and responsiveness, are widely used for measuring oral health (4).

Currently, the Oral Health Impact Profile (OHIP) is the most comprehensive and widely used instrument to measure OHRQoL. It was developed by Slade in 1994 and has been validated in cross-sectional population studies of the elderly (5).

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The Index of Complexity, Outcome, and Need (ICON) has been used in literature to evaluate orthodontic treatment need, complexity, and outcome. Although the term treatment complexity is a separate parameter from the malocclusion severity, both measure the same latent trait; hence, they are related to each other (6). Many researchers have found that complex cases are more severe and require more effort associated with more extraction, treatment plan changes, more appointments, longer treatment duration, and cooperation problems (7, 8). Patients with complex treatment or severe malocclusion may report various oral health impacts that affect their well-being in many ways. Previous research findings indicate that the perception of malocclusion varies across specialists and patients and that the severity of malocclusion does not always reflect OHRQoL (9, 10).

The impact of malocclusion differs between genders and age groups. Most of the studies have indicated that females experience poorer OHRQoL than males. This gender difference in malocclusion perception could be because females pay more attention to their appearance and therefore refer to orthodontic clinics more often than males. There has been an increasing demand for orthodontic treatment by adults, and the key motivations for them are mostly the social and psychological effects of orthodontic treatment. Previous researches have revealed that the relation between gender, age, and the satisfaction of dental appearance is still controversial (11-16).

It is hypothesized that malocclusion and orthodontic treatment would not have an adverse effect on the oral health status and a negative impact on the quality of life as a whole. Although there have been studies on the impact of orthodontic treatment need on OHRQoL, to the authors' knowledge, there is no published research using ICON and OHIP-14 on Turkish patients and studying no treatment need but treatment complexity. This has encouraged us to carry out this study to obtain the baseline information for Turkey. Therefore, this study was conducted to assess (a) the impact of malocclusion and orthodontic treatment on OHRQoL with regard to gender and age and (b) the impact of orthodontic treatment complexity on OHRQoL.

METHODS

The present prospective research study was approved by the ethics research committee of Medipol University. The participants or where appropriate their parents were informed about the purpose and procedure of the study, and written informed consent was obtained.

Participants

A total of 102 (65 females and 37 males) patients were included in this study. All participants selected from patients who had undergone orthodontic treatment for the period 2013-2016 at the Department of Orthodontics, Medipol University Hospital were assessed. The overall response rate was 100%. Table 1 shows the demographic characteristics and ICON complexity scores. The mean age of all participants was 19.6±5.1 years (range: 13-35), they were stratified into two age groups: 55.9% were adolescents (range: 13-17 years) and 44.1% were adults (range: 18-35 years).

Inclusion Criteria

The inclusion criteria were as follows: (1) 13-35 years of age (2) planned for comprehensive fixed orthodontic treatment; (3) no missing teeth with the exception of third molars; (4) no dental caries or periodontal problems; (5) no craniofacial anomalies or chronic medical problems; and (6) no previous orthodontic treatment of any type.

Interview and Questionnaire

All recruited patients were subjected to a face-to-face interview. They were asked to provide information concerning their demographic data, including age, gender, and medical status; they were also questioned whether they had previously received any type of orthodontic treatment. In addition, they were required to complete the shortened version of the OHIP-14 instrument to measure the OHRQoL.

The OHIP-14 questionnaire, which has been validated in Turkey (17) and has shown good psychometric properties, was used to assess OHRQoL. The OHIP questionnaire evaluated dysfunction, discomfort, and disability caused by oral disorders. Basically, the original OHIP is a 49-item measure, with statements divided into seven dimensions, namely functional limitation, pain, psychological discomfort, physical disability, psychological disability, social disability, and handicap.

The OHIP-14 is a self-administered, short-version of the original questionnaire and includes 14 questions with seven domains that are used to measure the impact of orthodontic treatment on OHRQoL. The domains are functional limitation (Q1 and Q2), physical pain (Q3 and Q4), psychological discomfort (Q5 and Q6), physical disability (Q7 and Q8), psychological disability (Q9 and Q10), social disability (Q11 and Q12), and handicap (Q13 and Q14). Subjects were asked how they had experienced negative impacts in these dimensions, and their responses to the items were recorded using a five-point Likert scale (0=never, 1=hardly ever, 2=occasionally, 3=fairly often, 4=very often). The total OHIP score was computed by adding the ratings of all questionnaire items (additive count method). The total OHIP-14 score ranged from 0 to 56, and the domain scores ranged from 0 to 8. This questionnaire was administered before bonding (T1) and after

Table 1. Demographic characteristics and ICON

Variable	n	%
Gender		
Female	65	63.7
Male	37	36.3
Age, years		
13-17	57	55.9
18-35	45	44.1
ICON complexity scores		
Easy	11	10.8
Mild	38	37.3
Moderate	15	14.7
Difficult	12	11.8
Very difficult	26	25.5

de-bonding (T2). The OHIP-14 scores were calculated using the mean values. Higher OHIP-14 scores indicated poorer OHRQoL.

Each patient was examined for orthodontic treatment complexity using the ICON before starting fixed orthodontic treatment. The ICON was developed by Daniels and Richmond (18) in 2000 as an international index based on the consensus of 97 specialist orthodontists from 9 countries, including America and 8 European countries. This index consists of 5 components: (1) Aesthetic Component of Index of Orthodontic Treatment Need, (2) Upper arch crowding/spacing, (3) Cross-bite, (4) Incisor open-bite/overbite, and (5) Buccal segment anterior–posterior relation of Peer Assessment Rating. Each component has a weight coefficient and these components are scored according to the ICON protocol; the sum was then calculated to obtain a total score. The total score was evaluated as easy if it was <29, as mild if between 29 and 50, as moderate if between 51 and 63, as difficult if between 64 and 77, and as very difficult if greater than 77. According to the ICON, a vast majority of subjects were mild followed by very difficult group; however, the least was the easy group.

Table 2. Gender and age distribution by groups

	Very Difficult	Difficult	Moderate	Mild	
Easy Gender					
Female	11	8	13	27	6
Male	15	4	2	11	5
Age, years					
13-17	18	8	6	18	7
18-35	8	4	9	20	4

Method Error

Both OHIP-14 and ICON assessment was performed by only one investigator (H.K.O.) who was trained to use the ICON. The reliability and validity were assessed by examining internal consistency and reproducibility. The kappa value was used to measure inter-item and itemscore correlations by repeating the administration of the OHIP to 10 (10%) of the subjects after 2 weeks (test-retest correlation). The kappa values of the re-examined questionnaire were 0.86 for OHIP-14 and 0.99 for ICON. As a very strong correlation and insignificant differences were noted, it was assumed that the results would be reliable.

Statistical Analysis

The Statistical Package for Social Sciences software version 18.0 (IBM Corp.; Armonk, NY, USA) was used to perform the statistical analysis. According to Shapiro Wilk-W test, data distributed normal. The mean differences between before- and after-treatment data (T1 and T2, respectively) were tested using a paired t-test.

Table 3. OHIP-14 overall scores and domain scores among treatment complexity groups before treatment (T1) and after treatment (T2)

		Total		Easy		Mild		Moderate		Difficult		Very Difficult	
		T1	T2	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2
Overall OHIP-14	Mean	0.99	0.1	0.66	0.14	1.03	0.09	1.12	0.18	0.79	0.07	1.1	0.07
	SD	0.63	0.19	0.34	0.22	0.73	0.2	0.55	0.23	0.57	0.13	0.61	0.14
	p	0.000*		0.005*		0.000*		0.000*		0.020*		0.000*	
Functional Limitation	Mean	0.67	0.13	0.18	0.09	0.6	0.13	0.86	0.3	0.5	0.08	0.96	0.07
	SD	0.84	0.34	0.46	0.2	0.82	0.43	0.78	0.45	0.85	0.19	0.93	0.18
	p	0.000*		0.441		0.005*		0.018*		0.147		0.000*	
Physical Pain	Mean	1.08	0.19	0.27	0.54	1.09	0.17	1.33	0.26	1.2	0.000	1.23	0.13
	SD	1.17	0.49	0.51	1.03	1.3	0.4	1.19	0.56	1.09	0.000	1.11	0.26
	p	0.000*		0.258		0.000*		0.002*		0.003*		0.000*	
Psychological Discomfort	Mean	1.65	0.13	1.59	0.13	1.82	0.07	1.73	0.16	1	0.2	1.69	0.15
	SD	1.25	0.35	1.42	0.32	1.3	0.24	1.16	0.36	0.97	0.39	1.24	0.48
	p	0.000*		0.009*		0.000*		0.000*		0.022*		0.000*	
Physical Disability	Mean	0.5	0.04	0.22	0.18	0.48	0.01	0.53	0.06	0.83	0.04	0.48	0.01
	SD	0.85	0.17	0.51	0.33	0.71	0.08	0.83	0.25	1.54	0.14	0.76	0.09
	p	0.000*		0.779		0.000*		0.021*		0.1		0.040*	
Psychological Disability	Mean	1.62	0.09	1.27	0.000	1.69	0.09	2.2	0.16	0.79	0.08	1.71	0.11
	SD	1.26	0.29	1.14	0.000	1.36	0.3	0.95	0.4	1.21	0.19	1.17	0.32
	p	0.000*		0.004*		0.000*		0.000*		0.068		0.000*	
Social Disability	Mean	0.72	0.1	0.36	0.09	0.77	0.11	0.53	0.2	0.66	0.12	0.94	0.01
	SD	0.85	0.33	0.39	0.2	0.99	0.37	0.83	0.56	0.77	0.31	0.77	0.09
	p	0.000*		0.006*		0.000*		0.207		0.035*		0.000*	
Handicap	Mean	0.7	0.04	0.72	0.000	0.73	0.07	0.7	0.13	0.58	0.000	0.71	0.000
	SD	0.66	0.25	0.56	0.000	0.75	0.35	0.52	0.35	0.66	0.000	0.65	0.000
	p	0.000*		0.002*		0.000*		0.006*		0.012*		0.000*	

Means and Standard Deviations of T1 and T2 values of the total sample and for each treatment complexity group. Paired samples t-test; p value*<0.05

The mean differences between ICON groups (complexity) were tested using the one-way analysis of variance (ANOVA) with the Bonferroni test as a post-hoc. The cross-sectional comparisons between gender groups and age groups before and after treatment were performed using Student's t-test. The level of significance was set at a p value of 0.05.

RESULTS

Table 2 shows the gender and age distribution according to treatment complexity groups. In the moderate group, a vast majority of subjects were females (86%).

Table 3 shows the mean scores in the overall and domain items of OHIP-14 among treatment complexity groups before (T1) and after treatment (T2). The mean overall score for OHIP-14 for T1 was significantly higher compared to T2 (0.99 and 0.1, respectively, p<0.05). The psychological discomfort domain had the highest reported impact with a mean score of 1.65, whereas the mean score of the physical disability domain was 0.5 of the OHIP-14, indicating the lowest impact due to malocclusion in patients. The paired sample t-test analysis showed that OHRQoL improved for T2 regardless of the type of treatment complexity. Table 4 shows the OHIP-14 domain scores among treatment complexity groups before treatment. The one-way ANOVA and Bonferroni test were used to compare results between groups defined by the ICON. A significant difference in the psychological disability domain was obvious with respect to orthodontic treatment complexity (p<0.05). Participants with moderate treatment complexity reported a significantly negative impact on the

Table 4. OHIP-14 domain scores among treatment complexity groups before treatment (T1)

	Easy (a) T1 Mean±SD	Mild (b) T1 Mean±SD	Moderate (c) T1 Mean±SD	Difficult (d) T1 Mean±SD	Very Difficult (e) T1 Mean±SD	ANOVA p	Bonferroni p
Functional Limitation	0.18±0.46	0.60±0.82	0.86±0.78	0.50±0.85	0.96±0.93	0.077	
Physical Pain	0.27±0.51	1.09±1.30	1.33±1.19	1.20±1.09	1.23±1.11	0.166	
Psychological Discomfort	1.59±1.42	1.82±1.30	1.73±1.16	1±0.97	1.69±1.24	0.395	
Physical Disability	0.22±0.51	0.48±0.71	0.53±0.83	0.83±1.54	0.48±0.76	0.571	
Psychological Disability	1.27±1.14	1.69±1.36	2.20±0.95	0.79±1.21	1.71±1.17	0.048*	0.038* c>d
Social Disability	0.36±0.39	0.77±0.99	0.53±0.83	0.66±0.77	0.94±0.77	0.332	
Handicap	0.72±0.56	0.73±0.75	0.70±0.52	0.58±0.66	0.71±0.65	0.974	

Means and Standard Deviations of T1 values for each treatment complexity group. p value*<0.05

Table 5. OHIP-14 overall scores and domain scores among gender groups, cross-sectional comparisons for before treatment (T1) and after treatment (T2)

	Female T1	Male T1	p	Female T2	Male T2	p
Overall OHIP-14	1.07±0.69	0.86±0.51	0.097	0.12±0.18	0.79±0.20	0.256
Functional Limitation	0.65±0.88	0.71±0.77	0.721	0.16±0.34	0.81±0.34	0.258
Physical Pain	1.26±1.27	0.78±0.90	0.03*	0.23±0.49	0.13±0.50	0.354
Psychological Discomfort	1.75±1.29	1.48±1.17	0.302	0.16±0.40	0.08±0.25	0.219
Physical Disability	0.58±0.89	0.36±0.77	0.215	0.04±0.17	0.04±0.18	0.876
Psychological Disability	1.72±1.29	1.44±1.20	0.289	0.13±0.35	0.04±0.13	0.073
Social Disability	0.73±0.92	0.70±0.72	0.84	0.09±0.31	0.12±0.38	0.678
Handicap	0.77±0.70	0.58±0.57	0.151	0.46±0.21	0.05±0.32	0.883

Means and Standard Deviations of T1 and T2 values for each gender group. Student's t-test; p value*<0.05

Table 6. OHIP-14 overall scores and domain scores among age groups, cross-sectional comparisons for before treatment (T1) and after treatment (T2)

Age	13-17 T1	18-35 T1	p	13-17 T2	18-35 T2	p
Overall OHIP-14	0.92±0.65	1.08±0.60	0.206	0.13±0.22	0.07±0.12	0.098
Functional Limitation	0.66±0.82	0.68±0.87	0.896	0.14±0.36	0.12±0.32	0.793
Physical Pain	1.15±1.16	1.00±1.18	0.503	0.17±0.52	0.22±0.47	0.64
Psychological Discomfort	1.41±1.13	1.96±1.34	0.026*	0.18±0.40	0.06±0.27	0.086
Physical Disability	0.51±0.77	0.48±0.96	0.868	0.70±0.22	0.001±0.07	0.063
Psychological Disability	1.37±1.17	1.93±1.31	0.027*	0.14±0.37	0.03±0.12	0.034*
Social Disability	0.73±0.83	0.71±0.88	0.881	0.14±0.42	0.04±0.17	0.095
Handicap	0.61±0.69	0.82±0.60	0.115	0.07±0.31	0.02±0.14	0.355

Means and Standard Deviations of T1 and T2 values for each age group. Student's t-test; p value*<0.05

psychological disability domain compared to difficult treatment complexity ($p<0.05$).

Table 5 shows OHIP-14 overall and domain scores among gender groups and cross-sectional comparisons of T1 and T2. Females showed a statistically significant negative impact on the physical pain domain compared to males for T1 ($p<0.05$).

Table 6 shows the OHIP-14 overall and domain scores among age groups and cross-sectional comparisons for T1 and T2. Adults showed a statistically significant negative impact on the psychological discomfort and psychological disability domains compared to adolescents for T1 and showed a statistically significant positive impact on the psychological disability domain for T2 ($p<0.05$).

DISCUSSION

The present study aimed to evaluate the impact of orthodontic treatment with regard to gender and age, as it is challenging to understand the impact of orthodontic treatment complexity without understanding the independent effect of malocclusion severity and vice versa. To evaluate the effect of orthodontic treatment on oral health, the subjects were stratified according to two age groups and gender. The incorporation of these multi-variables against the responses of subjects to the questionnaire used to evaluate their oral health status renders a more comprehensive study.

Many studies have been conducted on the effect of malocclusion and orthodontic treatment on the QoL (12, 14-16). In our study, the effect of malocclusion on the QoL was measured using the OHIP-14 questionnaire. Although OHIP-14 is a widely used questionnaire, cultural differences might have an impact on the results. Therefore, the second aim was to produce baseline records for Turkish patients and to compare the results with other ethnicitybased studies. Similar to other studies, the results of the present investigation showed that malocclusion has a negative effect on the QoL of individuals (12, 19-25). However, the patient groups, questionnaires, indices, study design, and statistical methods used in those studies differ. This difference has made it difficult to compare the results of this study with the results of other studies.

The present study showed that orthodontic treatment complexity does not seem to have an impact on OHRQoL. Only pretreatment psychological disability scores of the moderate group were significantly higher than those of the difficult group, which appears unreasonable from a clinical perspective. Also, the p value of the ANOVA test is very close to non-significance ($p=0.048$). The only explanation could perhaps be the larger number of females in the moderate group. As reported in previous researches, women are more uncomfortable with their dental appearance than are men (8, 26).

To the authors' knowledge, only one study has evaluated the impact of orthodontic treatment complexity on OHRQoL. Onyeaso et al. (21) conducted a study including 12 to 17year-old Nigerian adolescents without previous orthodontic treatments and used the same measurement methods (OHIP-14 and ICON). They concluded that there is no relationship between orthodontic treatment complexity and OHRQoL, which is similar to the current study. The difference was that they found the highest scores in physical pain besides psychological discomfort and psychological disability. They discussed that the highest scores of physical pain may be due to tooth decay or periodontal problems. To eliminate this confusion, individuals with periodontal problems, tooth decay, chronic medical disorders, and craniofacial anomalies were excluded from this study. In this study, the highest scores were seen in the psychological discomfort and psychological disability domains before orthodontic treatment for all participants, which is similar to the study by Chen et al. (22).

The sample of this study consisted of patients who had undergone comprehensive fixed orthodontic treatment, thus representing a specific group of patients. Most of the studies showed that orthodontic treatment has a positive impact on OHRQoL (23-25). Chen et al. (23) performed a study including Chinese patients, and they concluded that after orthodontic treatment, both the scores of domain and total OHIP-14 were better than before treatment. In this study, a statistically significant difference was reported in total OHIP-14 and domain scores between pre- and post-treatment comparisons in all groups.

The associations between facial pain and various forms of malocclusion have been reported in epidemiological studies (27, 28). Although pain is thought to be a biological response to tissue damage, according to the cognitive-behavioral model, age, education level, sociocultural, and economic factors are also influential in interpreting the pain experienced by individuals. According to previous studies, females experience chronic orofacial pain more often as well as report severe oral impacts more often than males. In this study, while comparing gender, only pretreatment physical pain scores of females were significantly higher than males (29-31). The reason that females appear to suffer more pain has been an important topic of discussion and evaluation in literature.

According to the previous studies, younger individuals with malocclusion had higher scores for handicap, social disability, psychological disability, psychological discomfort, physical disability, and total OHIP-14 (14, 32). In this study, the pretreatment psychological discomfort and psychological disability scores for adults were statistically higher than those of adolescents; in addition, the post-treatment psychological disability scores of adults were statistically lower than those of adolescents. It can be explained that feeling psychological discomfort of their appearance is more likely to be the main factor in seeking orthodontic treatment in adults, and they are also psychologically more benefited than adolescents after the orthodontic treatment.

The QoL is increasingly acknowledged as a valid, appropriate, and significant indicator of service need and intervention outcome in contemporary public health research and practice (33).

The present study provides information concerning the impact of orthodontic treatment among two different age groups in both genders and demonstrates a baseline knowledge of oral health and refutes the null hypothesis. Although many researches have studied the effect of orthodontic treatment on OHRQoL, it was difficult to compare their results with the outcome of this study due to variations in the variables incorporated.

Further research is still needed to overcome the limitations of this study, which include lack of information of socio-economic status, educational level of participants, types of malocclusions in terms of classification and severity, and the relation of oral status with general health. In addition, further evolution of the concept of an orthodontic treatment index to include psychosocial criteria is still required. The ICON relates only to the functional measurement for orthodontic treatment and should be used in combination with appropriate psychological indicators such as OHIP-14.

The other limitations in this study must be taken into consideration. The use of the OHIP-14 questionnaire in adolescents is also a major limitation. The OHIP-14 is only validated for Turkish adults and not for adolescents. Although this index was administered through face-to-face interviews, and patients were able to ask questions when they did not understand something, the results should be interpreted with caution.

The usefulness of the findings from this study is limited as the sample is not necessarily representative of all members of the general population. The determination of sample size was based on the data from a previous study (16), by setting type I error at 0.05 and type II error at 0.20 (80% power). A sample size of minimum 97 subjects would be needed to demonstrate a significant change in OHRQoL from T1 to T2. To account for possible dropouts during the study, 102 participants were included in this study. Another potential limitation was the size differences of the complexity groups, age groups and gender groups, which may cause bias and should be considered when interpreting results. A larger sample size would increase the sensitivity of the impact of malocclusion on the OHRQoL, which could be explored completely among gender and various age groups to a greater extent.

CONCLUSION

- Within the limitations of this study, it was observed that orthodontic treatment improves OHRQoL, and orthodontic treatment complexity does not seem to have an impact on OHRQoL.
- This study provides fairly strong evidence that adult subjects are more likely to report "psychological discomfort" of their appearance, which is associated with the impairment in OHRQoL. They reported positive oral health status from a psychological perspective compared to adolescents as a result of orthodontic treatment. In addition, female subjects appear to experience more physical pain than males during orthodontic treatment.
- Given the negative consequences of orthodontic treatment on OHRQoL, it is important that disease prevention measures are promoted when formulating a health policy. It is likely that there will be greater demand from patients for treatment aimed at reducing the severity of the disease.

Ethics Committee Approval: Ethics committee approval was received for this study from the Ethics Committee of İstanbul Medipol University.

Informed Consent: Written informed consent was obtained from the patients who participated in this study.

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REFERENCES

1. DeGuzman L, Baniraei D, Vig KWL, Vig PS, Weyant RJ, O'Brien KD. The validation of the peer assessment rating index for malocclusion severity and treatment difficulty. Am J Orthodont Dentofac Orthoped 1995; 107: 72-6. [CrossRef]
2. Marya CM, Baiju CS, Nagpal R, Rekhi A. Oral Health Related Quality of Life and it's impact on elderly people. Ind J Dent Sci 2012; 4s: 127-32 (Supplementary Issue).
3. Naito M, Yuasa H, Nomura Y, Nakayama T, Hamajima N, Hanada N. Oral health status and health-related quality of life: a systematic review. J Oral Sci 2006; 48: 1-7. [CrossRef]
4. El Osta N, Tubert-Jeannin S, Hennequin M, Naaman NBA, El Osta L, Geahchan N. Comparison of the OHIP-14 and GOHAI as measures of oral health among elderly in Lebanon. Health Qual Life Outcomes 2012; 10: 131-40. [CrossRef]
5. Slade GD. Measuring oral health and quality of life. Chapel Hill: Dental Ecology, University of North Carolina, North Carolina, USA: 1997.
6. Pommer B. Use of the Oral Health Impact Profile (OHIP) in clinical oral implant research. J Dent Oral Craniofac Epidem 2013; 1: 3-10.
7. Richmond S, Daniels CP, Fox N, Wright J. The professional perception of orthodontic treatment complexity. Br Dent J 1997; 183: 371-5. [CrossRef]
8. Stephens CD, Harradine NW. Changes in the complexity of orthodontic treatment for patients referred to a teaching hospital. Br J Orthodont 1988; 15: 27-32. [CrossRef]
9. Rowe TK, Weintraub JA, Vig PS, Kowalski C J, Vig KWL. The influence of malocclusion components on perceived severity and treatment difficulty. J Dent Res 1990; 69: 260.
10. Hunt O, Hepper P, Johnston C, Stevenson M, Burden D. Professional perceptions of the benefits of orthodontic treatment. Eur J Orthod 2001; 23: 315-23. [CrossRef]
11. Shaw WC, Richmond S, O'Brien KD, Brook P, Stephens CD: Quality control in orthodontics: indices of treatment need and treatment standards. Br Dent J 1991; 170: 107-12. [CrossRef]

12. Marques LS, Ramos-Jorge ML, Paiva SM, Pordeus IA. Malocclusion: esthetic impact and quality of life among Brazilian schoolchildren. Am J Orthod Dentofacial Orthop 2006; 129: 424-7. [CrossRef]
13. Shaw WC. Factors influencing the desire for orthodontic treatment. Eur J Orthod 1981; 3: 151-16. [CrossRef]
14. Ashari A, Mohamed AM. Relationship of the Dental Aesthetic Index to the oral health-related quality of life. Angle Orthod 2016; 86: 337-42. [CrossRef]
15. Clijmans M, Lemiere J, Fieuws S, Willems G. Impact of self-esteem and personality traits on the association between orthodontic treatment need and oral health-related quality of life in adults seeking orthodontic treatment. Eur J Orthod 2015; 37: 643-50. [CrossRef]
16. de Couto Nascimento V, de Castro Ferreira Conti AC, de Almeida Cardoso M, Valarelli DP, de Almeida-Pedrin RR. Impact of orthodontic treatment on self-esteem and quality of life of adult patients requiring oral rehabilitation. Angle Orthod 2016; 88: 1-7. [CrossRef]
17. Mumcu G, Inanç N, Ergun T, Ikiz K, Gunes M, Islek U, et al. Oral health related quality of life is affected by disease activity in Behçet's disease. Oral Disease 2006; 12: 145-51. [CrossRef]
18. Daniels C, Richmond S. The development of the index of complexity, outcome and need (ICON). J Orthod 2000; 27: 149-62. [CrossRef]
19. Choi SH, Kim JS, Cha JY, Hwang CJ. Effect of malocclusion severity on oral health-related quality of life and food intake ability in a Korean population. Am J Orthod Dentofacial Orthop 2016; 149; 384-90. [CrossRef]
20. Badran SA. The effect of malocclusion and self-perceived aesthetics on the self-esteem of a sample of Jordanian adolescents. Eur J Orthod 2010; 32: 638-44. [CrossRef]
21. Onyeaso CO. Orthodontic treatment complexity and need with associated oral health-related quality of life in Nigerian adolescents. Oral Health Prev Dent 2009; 7: 235-41.
22. Chen M, Feng ZC, Liu X, Li ZM, Cai B, Wang DW. Impact of malocclusion on oral health-related quality of life in young adults. Angle Orthod 2015; 85: 986-91. [CrossRef]
23. Chen M, Wang DW, Wu LP. Fixed orthodontic appliance therapy and its impact on oral health-related quality of life in Chinese patients. Angle Orthod 2010; 80: 49-5. [CrossRef]
24. de Oliveira CM, Sheiham A. Orthodontic treatment and its impact on oral health-related quality of life in Brazilian adolescents. J Orthod 2004; 31: 20-7. [CrossRef]
25. Feu D, Miguel JA, Celeste RK, Oliveira BH. Effect of orthodontic treatment on oral health-related quality of life. Angle Orthod 2013; 83: 892-8. [CrossRef]
26. Sheats RD, McGorray SP, Keeling SD, Wheeler TT, King GJ. Occlusal traits and perception of orthodontic need in eighth grade students. Angle Orthod 1998; 68: 107-14.
27. Sipilä K, Ensio K, Hanhela H, Zitting P, Pirttiniemi P, Raustia A. Occlusal characteristics in subjects with facial pain compared to a pain-free control group. Cranio 2006; 24: 245-51. [CrossRef]
28. Schmitter M, Balke Z, Hassel A, Ohlmann B, Rammelsberg P. The prevalence of myofacial pain and its associations with occlusal factors in a threshold country non-patient population. Clin Oral Investig 2007; 11: 277-81. [CrossRef]
29. Robinson ME, Gagnon CM, Riley JL III, Price DD. Altering gender role expectations: effects on pain tolerance, pain threshold, and pain ratings. J Pain 2003; 4: 284-8. [CrossRef]
30. Fillingim RB, King CD, Ribeiro-Dasilva MC, Rahim-Williams B, Riley JL 3rd. Sex, gender, and pain: a review of recent clinical and experimental findings. J Pain 2009; 10: 447-85. [CrossRef]
31. Edwards CL, Fillingim RB, Keefe F. Race, ethnicity and pain. J Pain 2001; 94: 133-7. [CrossRef]
32. Clijmans M, Lemiere J, Fieuws S, Willems G: Impact of self-esteem and personality traits on the association between orthodontic treatment need and oral health-related quality of life in adults seeking orthodontic treatment. Eur J Orthod 2015; 37: 643-50. [CrossRef]
33. Mack F, Schwahn C, Feine JS, Mundt T, Bernhardt O, John U, et al. The impact of tooth loss on general health related to quality of life among elderly Pomeranians: Results from the Study of Health in Pomerania (SHIP-0). Int J Prosthodont 2005; 18: 414-9.

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Original Article

Comparison of the Effects of Various Methods Used to Remove Adhesive from Tooth Surfaces on Surface Roughness and Temperature Changes in the Pulp Chamber

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ABSTRACT

Objective: The purpose of the present study was to compare the effects of three methods of removing adhesive on enamel surface roughness and dental pulp temperature.

Methods: Ninety human maxillary premolars were randomly divided into three groups (n=30) according to the type of adhesive clean-up procedure: aluminum oxide-based burs, erbium-doped yttrium aluminum garnet (Er:YAG) laser, and tungsten carbide bur. The surface roughness of enamel was measured using a non-contact optical profilometer. After the first readings of surface roughness were measured (T1), orthodontic brackets were attached to the enamel surface with composite. The brackets on the teeth were debonded using bracket removal pliers. The residue of adhesive was eliminated from the enamel surface of the teeth by different procedures in each group. While removing adhesive from the tooth surface, the intrapulpal temperature rise was simultaneously measured using a thermocouple. One-way ANOVA and post-hoc Tukey HSD tests were used to analyze data with a significance level set at 0.05.

Results: The highest roughness average (Ra) values were observed for the Er:YAG laser group, with a significant difference with the aluminum oxide bur group and tungsten carbide bur group ($p<0.001$). Ra values for the aluminum oxide bur group were significantly lower than those for the other groups ($p<0.001$). Comparing the thermal changes in each group showed a significant decrease in the Er:YAG laser group, but a significant increase in two other groups.

Conclusion: Within the limitations of the present study, one-step finisher and polisher bur created the smoothest enamel surface, whereas Er:YAG laser the roughest. Tungsten carbide and aluminum oxide-based burs generated more heat than Er:YAG laser.

Keywords: Pulp chamber, temperature, remove adhesive

INTRODUCTION

Following the completion of orthodontic therapy and removal of the brackets, removal of the remaining adhesive on the tooth surface must be performed to preserve enamel tissue and to minimize enamel contact as far as possible (1). During this procedure, removal of the superficial enamel layer that has the highest fluoride and mineral content, exposure of enamel prisms to the environment within the mouth, and attack by organic acids in the bacterial plaque predispose the affected tooth to decalcification lesions (2). Another main problem during adhesive removal is the transfer of heat produced by friction to the pulp chamber. Histopathological studies have shown that elevated temperature may cause a wide range of changes from impairment of microvascular circulation of the pulp to necrosis, increased flow of fluid within the tubules toward the pulp, expansion of fluid

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within the dentinal tubules and pulp, aspiration of odontoblasts into the tubule and destruction of odontoblasts, and vesicle and papule formation in the periphery of the pulp (3).

Various methods can be used to remove adhesive remnants on the enamel surface, including sandpaper discs, tungsten carbide bur, composite bur, and air abrasion. Tungsten carbide bur has been successfully used for years to remove the remnants of adhesive as a block. Previous studies have investigated temperature increase in the pulp chamber during removal with tungsten carbide bur and roughness of the enamel surface after the procedure, and many have reported a significant increase in surface roughness with 100 µm tissue loss on the enamel surface and 10-20 µm deep gouges (4). Different laser types have been investigated in addition to traditional methods in recent years. These studies have reported that erbium-doped yttrium aluminum garnet (Er:YAG) laser does not cause a significant increase in the temperature of the pulp chamber but removes more enamel tissue than tungsten carbide bur and produces more irregular surfaces. Er:YAG laser specifically exerts its effects on water-containing hard tissues, and it is absorbed directly by resin cement that can contain remnant monomers without excessive heat transmission (5, 6). There is still ongoing research on safer methods as carbide bur generates heat due to friction and affects enamel roughness, and Er:YAG laser produces irregular surfaces although it does not generate heat. Microgrit aluminum oxide-based finishing and polishing burs have become popular in recent years. However, there are a limited number of studies on the effects of these burs on temperature changes in the pulp chamber and enamel surface. The aim of the present study was to measure temperature changes during the orthodontic debonding procedure using various methods and to evaluate enamel surface roughness in the in vitro setting.

METHODS

The study was approved by the Clinical Research Ethics Committee of Ministry of Health's Kecioren Training and Research Hospital (B.13.4.ISM.4.06.68.43/557) in Ankara. Informed consent was obtained from all individual participants included in the study. A total of 90 recently extracted maxillary premolar teeth without caries, cracks, erosion-abrasion, or restoration of any type were used in the present study. The teeth were stored in 0.1% thymol solution at 4 °C until the day of use after extraction. Teeth with homogeneous shapes and sizes were selected to obtain standard teeth with regard to the distance from the pulp chamber to the tooth surface and thickness of the hard crown tissue.

Periapical radiographies were obtained before the study to standardize these parameters. The distance between the pulp horn and the tooth surface was measured using a digital compass. Teeth with excessively enlarged pulp chambers or teeth with calcified and narrow pulp chambers were excluded from the study. Teeth were divided into three groups with each comprising 30 teeth: aluminum oxide-based burs (Onegloss; Shofu Dental, Kyoto, Japan), Er:YAG laser (Fidelis Plus II; Fotona, Slovenia), and tungsten carbide burs (12-fluted tungsten carbide bur; Dentaurum no. 123-604, Ispringen, Germany).

After preparation, the root of each tooth was cut apically at approximately 2-3 mm to the enamel-cement junction and perpendicular to the long axis, and the root channel was widened toward the pulp chamber (Figure 1a). The remaining pulp tissue in the pulp chamber was removed using an excavator and irrigated with NaOCl for 1 min. Then, the pulp chamber was irrigated with physiological saline. Teeth were kept in distilled water to avoid dehydration until the testing step (<1 month). Crowns were placed on their palatinal surfaces in molds containing silicone impression material (Siloflex® Putty; SpofaDental, Moscow) with the vestibular surface being exposed and facing upwards for measurement of microroughness. A 4×6 mm acrylic resin molding was made in the same diameter with the bracket to restrict the surface roughness measurement area to the bracket area in contact with the enamel. While the molding was on the tooth surface, surface roughness of the intact enamel on which a bracket has not yet been placed was

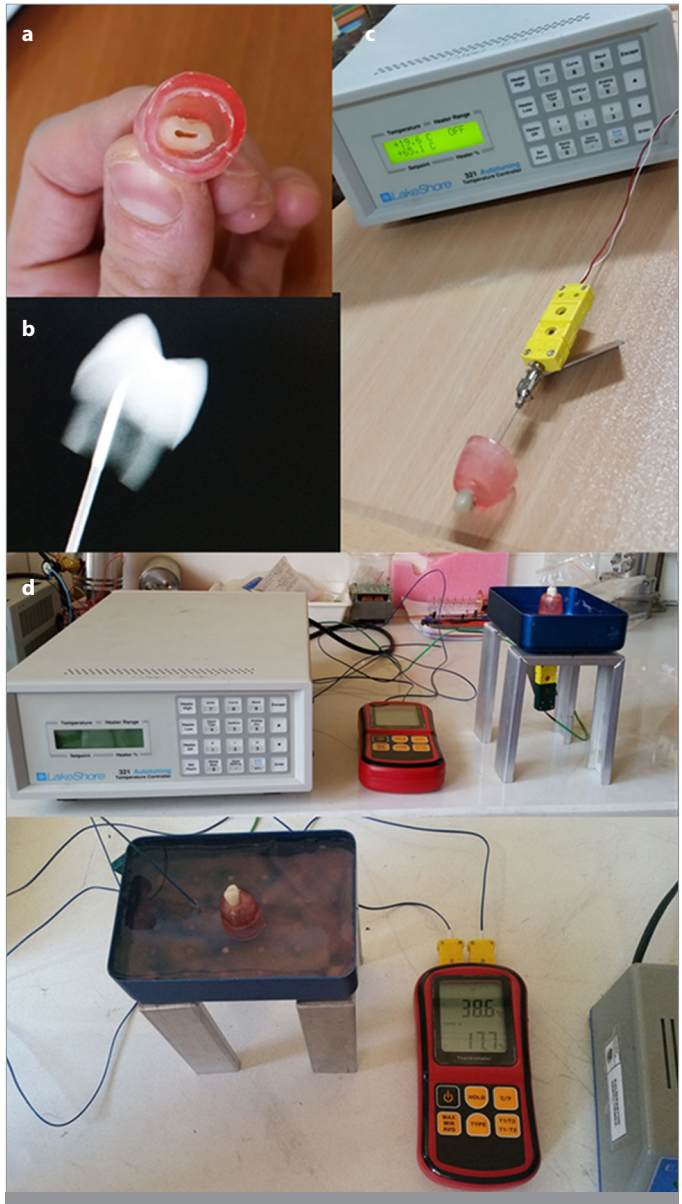

Figure 1. a-d. (a) Preparation of each tooth for the experiment. (b) Radiographical confirmation of the position of the thermocouple. (c, d) An in vitro experimental model for pulp temperature measurement

measured using an optical profilometer (Contour Elite; Bruker Nano Surfaces Division, Tucson, AZ, USA) not in contact with the enamel surface (T1). Two measurements were obtained from each sample: one before attaching brackets (T1) and the other after removing adhesive (T2). The measurement of baseline surface roughness (T1) was followed by the attachment of orthodontic brackets to the enamel surface with a composite. While one physician was holding the acrylic molding on the tooth surface, the other physician was treating the enamel with 37% orthophosphoric acid (Ormco, Orange, CA, USA) for 30 s and placed a stainless steel bracket (Rocky Mountain, Denver, CO, USA) of the same diameter with the molding on the tooth surface using adhesive resin (Enlight light cure adhesive, Ormco) as per the manufacturer's instructions. Excess adhesive around the brackets was removed with a sharp scaler and cured with light for 40 s. The samples were kept in water at 37 °C for 24 h and then detached with special pliers (Ormco). Teeth were removed from the molds containing silicone impression material for measurement of enamel roughness and fixed on the acrylic molding from the apical surfaces as to expose the crown and pulp chamber for temperature measurement. The pulp chamber was accessed through the crown pulp immediately beneath the pulp chamber (Figure 1a).

During temperature measurement, a thermocouple was placed from the canal space toward the vestibule pulp horn and mounted with silicone, and the final position was controlled with radiography (Figure 1b). The other end of the thermocouple was connected to a digital data collector (XR 440 M Pocket Logger Pace Scientific, Mooresville, NC, USA), and data were simultaneously transferred to a computer (Figure 1c). The brackets were debonded using a posterior debonding plier. Resin removal was done using three different methods. In the aluminum oxide bur and tungsten carbide bur groups, resin removal was done with these burs in a low-speed handpiece without water cooling. A new bur was used for each tooth. In the Er:YAG laser group, laser energy was used with a wavelength of 2940 nm at a pulse repetition rate of 4 Hz, pulse energy of 250 mJ, and pulse duration of 350 µs (long pulse), and the level of air/fluid was set at 3 mL/s. Laser energy was applied at a distance of 1 mm from the bracket. Complete removal of the resin adhesive was verified by visual inspection under a dental operating light under dry conditions. The time required for resin removal was recorded electronically. For measurement of temperature increases to mimic in vivo environment, teeth were kept in a water bath at body temperature during the testing procedure, and the temperature in the pulp chamber was increased to body temperature (37±1 °C; Figure 1c). Starting from 37.1 °C, temperature changes in each group were recorded with 2 s apart until the temperature in the pulp chamber has returned to body temperature (Figure 2). After the completion of measurement, the bath temperature was controlled for each tooth. The test procedure was repeated when a change was noted in the bath temperature. Finally, surface roughness of the enamel was recorded using an optical profilometer (T2). Although it was impossible to locate the acrylic window at the same position at the micron level, it was positioned roughly in the same area for second measurement. Roughness average (Ra) is the arithmetic average of the individual heights and depths over the evaluation length. Data were analyzed using a commercially available software program (MedCalc Software bvba, Ostend, Belgium; http://www.medcalc.org; 2013) for statistical analysis. The Shapiro–Wilk test was used to evaluate all data before analysis whether they were normally distributed. In the analysis of surface roughness, one-way ANOVA and post-hoc Tukey HSD tests were used to analyze all data, whereas Mann–Whitney U test was used to analyze T2 data in the aluminum oxide bur group for non-normally distributed data. Temperature changes during adhesive removal were analyzed using t-test and ANOVA test. A p value of <0.05 was considered statistically significant.

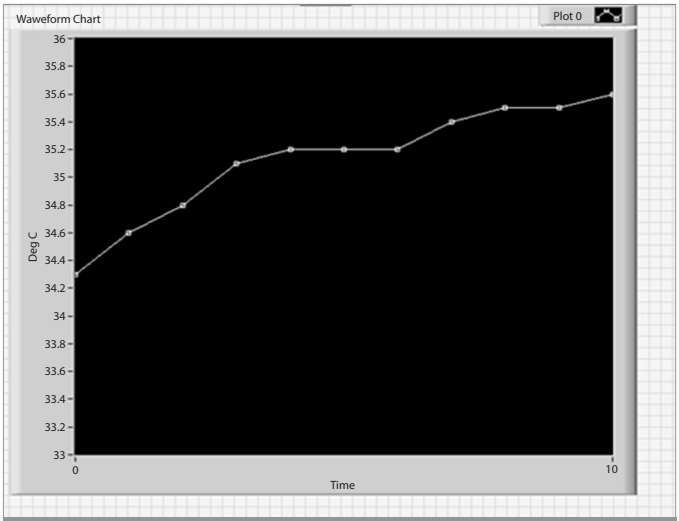

Figure 2. Chart of intrapulpal temperature changes

RESULTS

The mean Ra values are shown in Table 1. The mean Ra values at T1 did not show a significant difference between the groups (ANOVA, p=0.970); however, the mean Ra values at T2 in all experimental groups were found to be significantly higher than those at T1 (p<0.001). The mean Ra values of the study groups at T2 also showed significant differences. In the Mann–Whitney *U* test, the mean Ra values were significantly higher in the Er:YAG laser group than in the other groups, and the mean Ra values were also significantly higher in the tungsten carbide bur group than in the aluminum oxide bur group (p<0.001). Enamel surfaces in the laser group showed higher roughness than those in the other groups in three-dimensional profilometric enamel surface imaging (Figure 3). The pulp chamber temperature in the Er:YAG laser group was significantly lower, where temperature changes were significantly higher in the other groups (p<0.001). Temperature changes in the groups are shown in Table 2. ANOVA showed significant temperature changes in all groups (Table 2, 3). Furthermore, the time spent for removing adhesive from the enamel surface was the longest in the Er:YAG laser group (3.69±1.19 min) and shortest in the tungsten carbide bur group (2.99±1.11 min); however, there was no significant difference between the three groups (p<0.05).

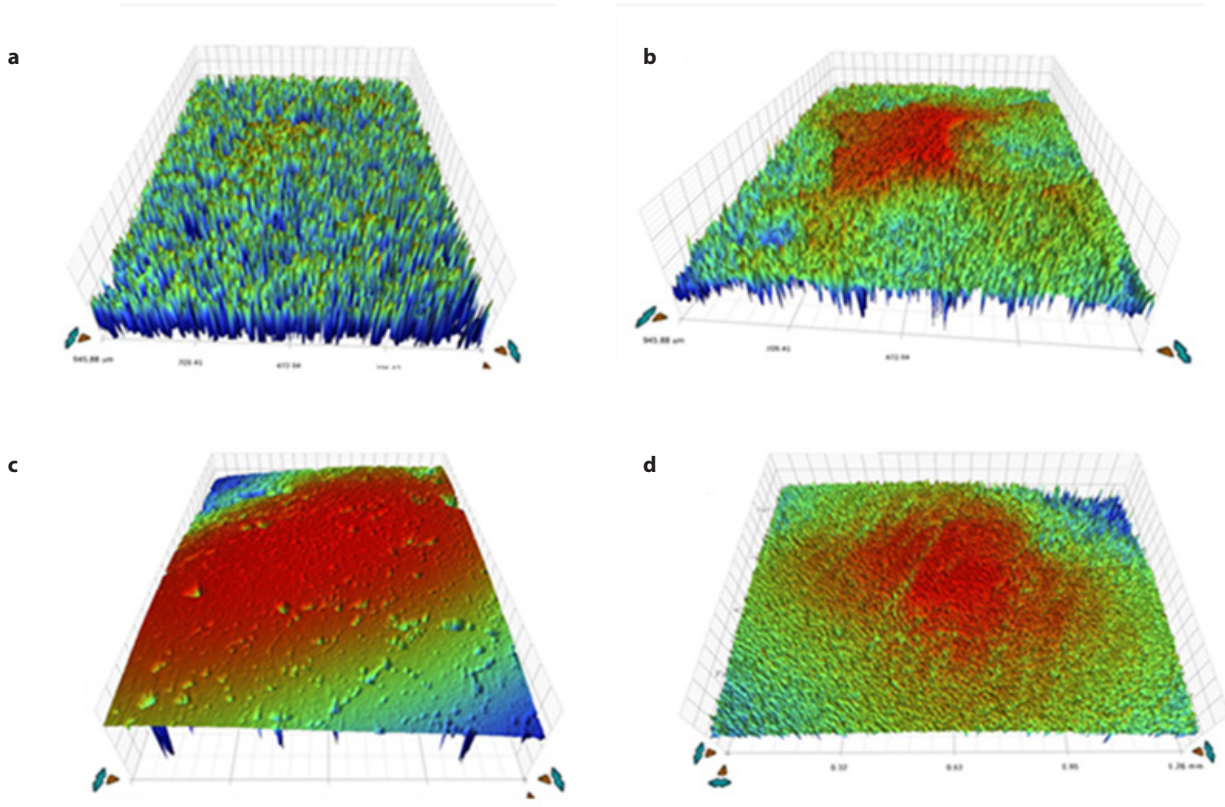

Figure 3. a-d. Profilometric images of all groups. (a) Profilometric image of an intact enamel surface. (b) Profilometric image of an enamel surface treated with aluminum oxide-based bur. (c) Profilometric image of an enamel surface from which adhesive was removed by Er:YAG laser. (d) Profilometric image of an enamel surface from which adhesive was removed by tungsten carbide bur

DISCUSSION

Orthodontic treatment indisputably results in various changes in the enamel surface. Surface irregularities and indentations occur independently from the methods used in debonding and removal of adhesive. Surface changes following removal of the brackets are of utmost importance as the external surface of the enamel contains higher amounts of minerals and fluoride than the inner layers. The procedure causes plaque formation and predisposition to decalcification on the surface. On the other hand, although successful adhesion of orthodontic attachments brings advantages, the enamel surface must be left intact following removal of excess resin. Therefore, the adhesives must be removed using methods causing minimal damage to the enamel and minimal loss of intact enamel tissue, and the vitality of the tooth must be preserved against temperature changes that could occur during the procedure (7, 8). Therefore, the aim of the present study was to measure temperature changes during the orthodontic debonding procedure using various methods and to evaluate enamel surface roughness simultaneously.

Teeth specimens collected as the study materials need to be protected against bacterial infiltration and without compromise in the organic structure. For this purpose, various studies have used different storage conditions for tooth specimens, such as tap water at -24 °C, tap water at −20 °C, distilled ionized water, 70% ethyl alcohol, 4% formalin solution, 0.5% chloramine in the refrigerator, 0.9% NaCl-containing physiological saline, and 4%, 0.1%, and 0.02% thymol solutions (9-12) In the present study, tooth specimens were stored in 0.1% thymol solution at 4 °C until the day of use after extraction (13-15). Williams and Svare (16) evaluated the effects of storage conditions and duration on the bonding strength and reported no change in the bonding strength of teeth that were stored in distilled water and thymol solution for 5 years.

Tungsten carbide burs are the most commonly used method in removing excess composite from the enamel surface following removal of fixed appliances and considered as the gold standard method. Many studies comparing various surface cleaning techniques have reached a consensus that the use of tungsten carbide burs causes the least damage to the enamel surface (17-19). Recently, the use of aluminum oxide-based microgrit burs has been popular for adhesive removal. However, to our knowledge, there is only one study in the literature evaluating enamel surface roughness with the use of aluminum oxide-based microgrit burs, which showed higher surface roughness values using scanning electron microscope (SEM) than tungsten carbide burs (17-19).

Surface roughness values vary depending on the measurement method used. Various methods have been used in the measurement of surface roughness, such as Vicker hardness tester, contact (or optical pens) profilometer, non-contact profilometer, and SEM. Traditional contact profilometers use linear measurement devices to measure roughness; however, these devices can only detect large microfissures on the surface due to the thick-

ness of the device contacting with the enamel surface, and these devices cannot evaluate depths with lower Ra values. The tip of the traditional profilometer can damage the enamel surface during contact with the surface, and this device can only measure roughness of the contacted area. Non-contact profilometer scans the surface with a type of laser to create a surface map and scans a large area without any contact with and damage to the scanned surface. In addition, non-contact profilometer provides three-dimensional surface maps rather than simple striations and allows the analysis of volume loss. Non-contact profilometer does not damage the specimen's surface compared with contact profilometer, and it is considerably safe (17, 20, 21).

Furthermore, electron microscopy is a visual assessment tool and does not provide numeric measurement data; therefore, enamel surface roughness values obtained by SEM are subjective and not reliable. Non-contact profilometer possesses the advantage of providing accurate measurement of the depths of the defects on the enamel surface. Based on these factors, non-contact profilometer was used in the present study that allows reproducible numeric measurement of surface roughness and revealing microscopic details with three-dimensional colored images (22).

Previous studies in the literature that evaluated in vitro temperature changes in the pulp chamber have used various methods, including infrared camera, thermocouple, and calorimeter. The reason for selection of a thermocouple device in the present study is that it is easily applicable and provides accurate results.

The extent of changes in the pulp chamber caused by in vivo procedure and dissipation of heat are affected by various factors, such as blood circulation in the pulp chamber, fluid movement in the dentin tubules, time and intensity of the thermal stimulus, and pulpal blood circulation induced by the pulpal nervous system. A pulpal circulation mechanism was constructed in the present study. Tooth specimens were placed in a thermal water bath at body temperature to mimic in vivo settings.

The present study showed that the enamel surface was affected in the three groups (Figure 3). Aluminum oxide-based microgrit burs provided the lowest surface roughness, whereas laser treatment (pulse energy of 250 mJ, pulse duration of 350 µs (long pulse), and pulse repetition rate of 4 Hz at a distance of 5 mm under air and water cooling) produced the highest surface roughness values. Rougher surface provided by tungsten carbide burs than that by aluminum oxide burs can be explained by the fact that its sharp edges remove more enamel tissue (17). On the other hand, the microgrit structure of aluminum oxide bur is disrupted upon contact with the enamel surface (17), and thus it provides a smoother surface. Higher surface roughness values in the Er:YAG group than those in the tungsten carbide group were in agreement with the findings by Almeida et al. (23) and Burke et al. (24). Increased surface roughness in the Er:YAG laser group can be associated with an ablation mechanism that could cause melting in the inorganic tissues, expansion of the organic matrix, and occlusion in ion diffusion channels. Laser energy absorbed by the tooth surface is converted to heat energy which in turn evaporates water. This produces high-pressure vapor, and previous studies have supported the evidence that water explodes as a result of temperature changes and roughens smooth tooth surface and turns it to an irregular structure with microfissures (20, 25).

The present study showed that both aluminum oxide and tungsten carbide burs caused temperature increases >5.5 °C. Although many studies in the literature have evaluated the effects of temperature changes on the pulp chamber, there is no consensus over the temperature changes that can be tolerated by the pulp chamber. In a study on Rhesus monkeys, Zach and Cohen (26) associated intrapulpal temperature elevations with histologically observable pulpal damage. In their study, a 2.3 °C temperature increase caused minimal change in the dental pulp tissue, whereas an increase >5.6 °C caused irreversible inflammation in the pulp tissues in 40% of the animals in the test group. Furthermore, they reported pulpal necrosis in all animals in the test group when the temperature increase was ≥11 °C (19). Eriksson et al. (27) reported that pulpal temperature must exceed 42 °C, and that the pulp tissue must be exposed to this temperature for 1 min for histological changes to occur in the pulp tissue. Baldissara et al. (28) reported that temperature increases up to 8.9 °C–14.7 °C do not cause pathological changes in the pulp tissue. Based on these findings, although previous studies used different designs, considering a cut-off level of 5.6 °C for temperature elevations appears to be reasonable to maintain pulpal health. According to our study results, temperature increases when using aluminum oxide and tungsten carbide burs were somewhat above the critical level of 5.5 °C (approximately 8 °C), and it is considered that the use of water or air cooling in both methods would decrease temperature changes below the critical level. However, there was no temperature increase, but the temperature decreased by −2 °C in the Er:YAG laser group. Decreased temperature in the laser group can be explained by the use of water and air cooling. These findings are also consistent with the results of previous studies (20, 25, 26). Although it may appear advantageous that the use of Er:YAG laser does not increase the pulp temperature during debonding, the laser method still does not provide a good alternative to other methods as it causes a significant increase in surface roughness of the buccal enamel compared with other methods.

Although high surface roughness values of Er:YAG laser were confirmed by previous studies (15, 29, 30), we want to evaluate the effect of Er:YAG laser with different parameters on both surface roughness and intrapulpal temperature. Pulse repetition rate has been considered as the most important parameter in determining heat accumulation in the tissue during the ablation procedure (29), encouraging the use of low pulse repetition rates to be safe (29). Furthermore, selecting a high repetition rate necessitates the use of high water stream, and this can make observation of the operating field difficult (15). Correa-Afonso et al. (31) found that increasing the pulse repetition rate provides faster and more effective ablation of composite resin, but it causes greater removal of the healthy surrounding tissues and produces more irregularities in cavities prepared by the Er:YAG laser. In the present study, a pulse repetition rate of 4 Hz was used to prevent iatrogenic damage to the tooth tissue. A pulse energy of 250 mJ

provided the minimum energy required for composite resin removal while minimizing the possibility of healthy tissue ablation. Hibst and Keller (32) found that the ablation rate of restorative materials depends on the pulse energy selected, and that suggested energies between 250 mJ and 350 mJ are necessary to achieve successful results. In the present study, a pulse energy of 250 mJ was used.

In addition, previous studies reported controversial results regarding the thermal effects of tungsten carbide bur. Mank et al. (29) found no significant temperature elevation associated with the use of tungsten carbide burs without air and water cooling, whereas Ozturk et al. (33), similar to the present study, reported temperature elevation with the use of tungsten carbide bur without water cooling.

The present study has a number of limitations. Our study limitations include difficulty in simulating the complex nature of the oral environment in the laboratory and a small sample size. Further studies evaluating temperature changes together with histological changes in the pulp tissue and larger sample sizes are required to ascertain the safety of these methods.

CONCLUSION

One-step finisher and polisher bur created the smoothest enamel surface, whereas Er:YAG laser the roughest. Tungsten carbide and aluminum oxide-based burs generated more heat than Er:YAG laser.

Ethics Committee Approval: Ethics committee approval was received for this study from the Clinical Research Ethics Committee of Ministry of Health's Kecioren Training and Research Hospital (B.13.4.ISM.4.06.68.43/557) in Ankara.

Informed Consent: Informed consent was obtained from all individual participants included in the study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - F.A.S., S.E.; Design - F.A.S., S.E.; Supervision - E.A.O., M.A.; Fundings - M.A.; Materials - F.A.S., S.E.; Data Collection and/or Processing – M.A., F.A.S.; Analysis and/or Interpretation - E.A.O.; Writing Manuscript - F.A.S., S.E.; Critical Review - F.A.S., S.E., E.A.O.

Conflict of Interest: The authors have no conflict of interest to declare.

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REFERENCES

1. David VA, Staley RN, Bigelow HF, Jakobsen JR. Remnant Amount and Clean up for 3 Adhesives After Debracketing. Am J Orthod Dentofacial Orthop 2002; 121: 291-6. [CrossRef]
2. Peretz B, Ram D. Restorative material for children's teeth: preferences of parents and children. ASDC J Dent Child 2002; 69: 243-8.
3. Nyborg H, Brannstrom M. Pulp reaction to heat. J Prosthet Dent 1968; 19: 605-12. [CrossRef]
4. Mueller J, Yang F, Neumann K, Kielbassa AM Surface 3D dimensional topography analysis of materials and finishing procedures after resinous infiltration of subsurfacebovineenamellesions. Quintessence Int 2011; 42: 135-47.
5. Kohara EK, Hossain M, Kimura Y, Matsumoto K, Inoue M, Sasa R. Morphological and microleakage studies of the cavities prepared byEr:YAG laser irradiation in primary teeth. J Clin Laser Med Surg 2002; 20: 141-7. [CrossRef]
6. Stabholz A, Sahar-Helft S, Moshonov J. Lasers in endodontics. Dent Clin North Am 2004; 48: 809-32. [CrossRef]
7. Yassaei S, Aghili H, Joshan N. Effects of removing adhesive from tooth surfaces by Er:YAG laser and a composite bur on enamel surface roughness and pulpchamber temperature. Dent Res J (Isfahan) 2015; 12: 254-9.
8. Janiszewska-Olszowska J, Tomkowski R, Tandecka K, Stepien P, Szatkiewicz T, Sporniak-Tutak K, et al. Effect of orthodontic debonding and residual adhesive removal on 3D enamel microroughness. PeerJ 2016;4: e2558. [CrossRef]
9. Eminkahyagil, N, Korkma Y, Gökalp S, Başeren M. Shear Bond Strength of Orthodontic Brackets with Newly Developed Antibacterial Self Etch Adhesive. Angle Orthod 2005; 75: 843-8.
10. Coups-Smith, KS, Rossouw PE, Titley KC. Glass ionomer cements as luting agents for orthodontic brackets. Angle Orthod 2003; 73: 436-44.
11. Büyükyılmaz T, Üşümez, S, Karaman AI. Effect of Self Etching Primers on Bond Strength-Are They Reliable? Angle Orthod 2003; 73: 64-70.
12. Sayınsu K, Işık F, Sezen S, Aydemir B. New Protective Polish Effects on Shear Bond Strength of Brackets. Angle Orthod 2006; 76: 306-9.
13. Çehreli ZC, Keçik D, Kocadereli I. Effect of Self-Etching Primer and Adhesive Formulations on the Shear Bond Strength of Orthodontic Brackets. Am J Orthod Dentofacial Orthop 2005; 127: 573-9. [CrossRef]
14. Zeppieri IL, Chung CH, Mante FK. Effect of saliva on shear bond strength of an orthodontic adhesive used with moisture-insensitive and self-etching primers. Am J Orthod Dentofacial Orthop 2003; 124: 414-419. [CrossRef]
15. Oztürk B, Uşümez A, Oztürk AN, Ozer F. In vitro assessment of temperature change in the pulp chamber during cavity preparation. J Prosthet Dent 2004; 91: 436-40. [CrossRef]
16. Williams VD, Svare CW. The Effect of Five Year Storage Priorto Bonding on Enamel/Composite Bond Strength. J Dent Res 1985; 64: 151-4. [CrossRef]
17. Ireland AJ, Hosein I, Sherriff M. EnamelLoss at Bond-Up, Debondand Clean-Up Following the Use of a Conventional Light-Cured Compositeand a Resin-Modifiedglass Polyalkenoate Cement. Eur J Orthod 2005; 27: 413-9. [CrossRef]
18. Ahrari F, Akbari M, Akbari J, Dabiri G. Enamel surface roughness after debonding of orthodontic brackets and various clean-up techniques. J Dent (Tehran) 2013; 10: 82-93.
19. Fan XC, Chen L, Huang XF. Effects of various debonding and adhesive clearance methods on enamel surface: an in vitro study. BMC Oral Health 2017; 17: 58. [CrossRef]
20. Kim JH, Kwon OW, Kim HI, Kwon YH. Acid resistance of erbium-dopedyttrium aluminum garnet laser-treated and phosphoric acid-etched enamels. Angle Orthod 2006; 76: 1052-6. [CrossRef]
21. Zanet CG, Arana-ChavezVE, Fava M. Scanning electron microscopy evaluation of the effect of etching agents on human enamel surface. J Clin Pediatr Dent 2006; 30: 247-50. [CrossRef]
22. Mhatre AC, Tandur AP, Reddy SS, Karunakara BC, Baswaraj H. Enamel Surface Evaluation after Removal of Orthodontic Composite Remnants by Intraoral Sandblasting Technique and Carbide Bur Technique: A Three-Dimensional Surface Profilometry and Scanning Electron Microscopic Study. J Int Oral Health 2015; 7(Suppl 2): 34-9.
23. Almeida HC, Vedovello Filho M, Vedovello SA, Young AA, Ramirez-Yañez GO. ER: YAG laser for composite removal after bracket debonding: A qualitative SEM analysis. Int J Orthod 2009; 20: 9-13.
24. Burke EJ, Jr, Hoke J, Gomes E, Wolbarsht M. Wet versus dry enamel ablation by Er:YAG laser. J Prosthet Dent 1992; 67: 847-51. [CrossRef]

25. Ryf S, Flury S, Palaniappan S, Lussi A, van Meerbeek B, Zimmerli B. Enamel loss and adhesive remnants following bracket removal and various clean-up procedures in vitro. Eur J Orthod 2012; 34: 25-32. [CrossRef]
26. Zach L, Cohen G. Pulp response to externally applied heat. Oral Surg Oral Med Oral Pathol 1965; 19: 515-30. [CrossRef]
27. Eriksson A, Albrektsson T, Grane B, Mc Queen D. Thermal injury to bone. A vital microscopic description of heat effects. Int J Oral Surg 1982; 11: 115-21. [CrossRef]
28. Baldissara P, Catapano S, Scotti R. Clinical and histological evaluation of thermal injury tresholds in human teeth: a preliminary study. J Oral Rehabil 1997; 24: 791-801. [CrossRef]
29. Mank S, Steineck M, Brauchli LJ. Influence of various polishing methods on pulp temperature: an in vitro study. Orofac Orthop 2011; 2: 348-57. [CrossRef]
30. Takamori K. A histopathological and immuno histochemical study of dental pulp and pulpal nerve fibers in rats after the cavity preparation using Er:YAG laser. J Endod 2000; 26: 95-9. [CrossRef]
31. Correa-Afonso AM, Palma-Dibb RG, Pecora JD. Composite filling removal with erbium:yttrium-aluminum-garnet laser: morphological analyses. Lasers Med Sci 2010; 25: 1-7. [CrossRef]
32. Hibst R, Keller U. Removal of dental filling materials by Er: YAG laser radiation. Proc SPIE Int Soc Opt Eng 1991; 1424: 120-6. [CrossRef]
33. Ozturk B, Usumez A, Ozturk AN, Ozer F. In vitro assessment of temperature change in the pulp chamber during cavity preparation. Prosthet Dent 2004; 91: 436-40.

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Original Article

The Prevalence of Cleft Lip and Palate Patients: A Single-Center Experience for 17 Years

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ABSTRACT

Objective: The aim of the present study was to report the prevalence of cleft lip and palate (CLP), isolated cleft palate (CP), isolated cleft lip (CL), and median cleft (MC) applied in Marmara University School of Dentistry, Department of Orthodontics.

Methods: There were 1058 patients who applied to the center between 2000 and 2017. A total of 1026 patients were included in the study. Files, models, and photographs were evaluated. The patients were divided into six groups: unilateral right or left CLP, bilateral CLP, isolated CP, isolated CL, and MC. The prevalence was identified according to cleft type, side, gender, age, and application year.

Results: The most common type was unilateral CLP (44.3%), which was observed more on the left side (28.9%), followed by CP (28.7%). MC had a minimum ratio (0.3%) between cleft types. Males were more prone to have unilateral CLP (right side, 64.6%) and bilateral CLP (64.1%), whereas females were more prone to have CP (59.9%). The greatest number of applications was recorded in 2004, and the patients mostly applied in the neonatal period (64.9%). The ratios of complete cleft cases in all types of clefts were statistically significantly higher.

Conclusion: Unilateral CLP was the most common cleft type and seen more on the left side. While males were affected more by CLP, isolated CP was seen more in females than in males.

Keywords: Cleft lip and palate, prevalence, single center

INTRODUCTION

Cleft lip and palate (CLP) is one of the most prevalent malformations occurring in the head and neck region. The etiology of this malformation is multifactorial, and the incidence of clefts may be affected by ethnic, racial, geographic, and socioeconomic factors (1). Current knowledge indicates that orofacial clefts occur in approximately 1 in 700 live births, and that 3200 new cases per year are expected with the population growth worldwide (2, 3).

For the epidemiology of CLP, there are well-designed overviews, which include regional data from the European Registration of Congenital Anomalies and Twins, International Clearinghouse for Birth Defects Monitoring Systems, and National Birth Defects Study. However, Turkey is not included in those groups and does not have any national data showing the prevalence of CLP cases. A few studies were conducted in different regions of Turkey (Ankara (2, 4), Denizli (5), and Konya (1)) reporting the ratio and relationship of CLP with other malformations. Therefore, current data are insufficient for prevalence of CLP in Turkey.

According to national records, almost 30% of the whole population in Turkey lives in Istanbul. Two state universities and two private universities apply preoperative treatment to newborns with CLP in Istanbul regularly. A large number of the patients come from neighboring/other cities to Istanbul and to our clinic to receive preoperative treatment.

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The aim of the present study was to report the prevalence of CLP (unilateral or bilateral), isolated cleft palate (CP), isolated cleft lip (CL), and median cleft (MC) patients who applied in Marmara University School of Dentistry, Department of Orthodontics for treatment.

METHODS

The present study was conducted by using the records in the cleft archive of Marmara University School of Dentistry, Department of Orthodontics. According to registration records, a total of 1058 patients applied to the clinic between 2000 and 2017. The routine protocol of our clinic for clefts consisted of filling out a special CLP form (including information about birth date, weight, height, cleft type, birth type, name of the gynecologist, parents' ages, profession, birthplace, smoker or nonsmoker, any drug usage, radiation exposure, number of children, and presence of cleft in the family), extraoral and intraoral photographs, and impressions. Informed consent was obtained from all patients or their parents for use of their records.

Files, stone/digital models, and photographs of 1026 patients were evaluated. The patients were divided into six groups: unilateral right or left CLP, bilateral CLP, isolated CP, isolated CL, and MC. The prevalence was classified according to cleft type, cleft side, gender, and subgrouped according to years and ages.

Exclusion criteria were patients who refused to fill out the CLP forms, clefts combined with syndromes, and clefts with undefined and insufficient information.

The Statistical Package for Social Sciences version 22.0 program (IBM Corp.; Armonk, NY, USA) was used for statistical analysis. Chi-square analysis was used for comparisons. A $p<0.05$ was considered as significant. When the total number of cases in some categories was insufficient, these categories were removed from the study and then compared for cross tabulation by using Chi-square analysis.

Table 1. Distribution of gender

	Frequency (n)	%
Boys	556	54.2
Girls	470	45.8
Total	1026	100

Table 2. Type of cleft

	Frequency (n)	%	Valid %	Cumulative %
Bilateral CLP	262	25.5	25.5	25.5
CP	294	28.7	28.7	54.2
CL	12	1.2	1.2	55.4
MC	3	0.3	.3	55.7
Unilateral CLP-right	158	15.4	15.4	71.1
Unilateral CLP-left	297	28.9	28.9	100.0
Total	1026	100.0	100.0	

RESULTS

The number of males (n=556; 54.2%) who applied to the university with chief complaints of cleft was higher than that of females (n=470; 45.8%) (Table 1).

The most common type of cleft was unilateral CLP with a ratio of 44.3% (n=455 patients), followed by isolated CP with 28.7% (n=294 patients) (Table 2). Unilateral CLP was seen more on the left side with a ratio of 28.9% (n=297 patients) than on the right side regardless of gender difference. Bilateral CLP had a ratio of 25.5% (n=262 patients). Median (n=3; 0.3%) and lip (n=12; 1.2%) clefts presented the minimum ratios.

Regarding the application period for treatment need, it was seen that 64.9% of the patients (n=666) applied in the neonatal period (0-1 year) (Table 3). The second highest ratio recorded was 11.31% (6-10 years), and the lowest ratio was recorded after 30 years old.

The greatest number of applications was recorded in 2003 (n=110 patients) and 2004 (n=118), whereas the minimum number (n=20) was in 2015 (Table 4). The distribution of the patients according to years, gender, and cleft types is shown in Table 4.

Since lip and MC types showed inadequate sample numbers, statistical comparisons were performed by chi-square tests after these categories were excluded.

Comparisons regarding cleft type and gender showed that bilateral CLP was seen to be statistically significantly higher in boys (64.1%); however, isolated CP was seen to be statistically significantly higher in girls (59.9%). Unilateral right-sided CLP was seen to be significantly higher in boys (64.6%), whereas there was no statistically significant difference between the genders with regard to unilateral left-sided CLP (Table 5).

The ratios of complete cases in unilateral and bilateral cleft types were statistically significantly higher than those of incomplete cleft types (Table 6).

DISCUSSION

The racial prevalence is highest in Whites, followed by Hispanics, Asians, and Africans, respectively (6, 7). The national US average

Table 3. Distribution of ages

Age (years)	n	%
<1	666	64.9
1–5	99	9.65
6–10	116	11.31
11–15	75	7.31
16–20	46	4.48
21–25	15	1.47
26–30	5	0.49
>30	4	0.39

Table 4. Distribution of the patients according to application years

		Male							Female						
Years	Total	Total	BL	Palate	Lip	Median	UL—right	UL—left	Total	BL	Palate	Lip	Median	UL—right	UL—left
2000	47	25	10	3	1	0	5	6	22	6	5	0	0	6	5
2001	27	16	7	2	1	0	1	5	11	2	4	0	0	0	5
2002	66	45	13	17	0	0	7	8	21	4	6	1	0	4	6
2003	110	56	20	11	2	0	7	16	54	16	18	0	1	4	15
2004	118	65	16	13	0	0	9	27	53	9	16	0	0	7	21
2005	81	45	17	6	0	0	7	15	36	9	11	1	0	3	12
2006	71	39	11	4	1	0	11	12	32	4	11	1	0	5	11
2007	71	42	14	9	1	0	9	9	29	5	10	0	0	7	7
2008	71	33	11	5	0	0	10	7	38	7	13	0	0	1	17
2009	52	26	4	11	0	0	7	4	26	7	14	0	1	1	3
2010	55	30	7	6	0	0	6	11	25	3	12	1	0	3	6
2011	41	21	7	4	0	0	5	5	20	4	6	0	0	4	6
2012	49	22	6	4	1	0	5	6	27	3	15	0	0	3	6
2013	40	25	10	2	0	1	5	7	15	5	6	0	0	1	3
2014	42	25	7	4	0	0	4	10	17	3	6	0	0	3	5
2015	20	9	3	1	1	0	2	2	11	2	6	0	0	1	2
2016	31	16	3	10	0	0	1	2	15	2	7	0	0	1	5
2017	34	16	2	6	0	0	1	7	18	3	10	0	0	2	3

Table 5. Comparisons Regarding Cleft Type and Gender

			Gender		
			Male	Female	Total
CLEFT TYPE	Bilateral CLP	Count	168_a	94_b	262
		% Within cleft type	64.1%	35.9%	100.0%
		% Within gender	30.7%	20.3%	25.9%
	CP	Count	118_a	176_b	294
		% Within cleft type	40.1%	59.9%	100.0%
		% Within gender	21.6%	37.9%	29.1%
	Unilateral CLP-right	Count	102_a	56_b	158
		% Within cleft type	64.6%	35.4%	100.0%
		% Within gender	18.6%	12.1%	15.6%
	Unilateral CLP-left	Count	159_a	138_a	297
		% Within cleft type	53.5%	46.5%	100.0%
		% Within gender	29.1%	29.7%	29.4%

There is a statistically significant difference between the genders indicated by small letters in the same line ($p < 0.05$); Chi-square tests

Table 6. Comparison of complete/incomplete cases in unilateral and bilateral cleft types

			Total	Complete	Incomplete
Cleft type	Bilateral	Count	231_a	29_b	260
		% within cleft type	88.8%	11.2%	100.0%
	Unilateral-right	Count	131_a	27_b	158
		% within cleft type	82.9%	17.1%	100.0%
	Unilateral-left	Count	230_a	67_b	297
		% within cleft type	77.4%	22.6%	100.0%

There is a statistically significant difference between the complete/incomplete cases indicated by small letters in the same line ($p<0.05$); Chi-square tests

rate was 7.75% with the highest value in Maryland (21.46%), and the lowest was found in West Virginia (2.59%) (8). American Indians had the highest ratio (9), and African-Americans had the lowest ratio from 0.21 to 0.41 per 1000 live births (10). Whites

in Western Europe and the United States had an incidence rate ranging from 0.77 to 1.40 per 1000 live births (9).

Asian countries demonstrate close ratios. The incidence rates were from 1.14 to 2.13 per 1000 live births in Japanese and 1.81 per 1000 or 1 in 554 live births in South Koreans (11, 12). Murray and Martelli-Junior (13, 14) have reported the incidence rates to be 1.94 and 1.46 per 1000 live births in the Philippines and Brazil, respectively. In Caucasians, the incidence for CL with or without palate was between 0.6 and 1.7 per 1000 live births (2, 3).

In the literature, it was reported that an average of 66.9% of the affected children had CLP. In our study, the most common cleft type was also CLP (69.8%). However, the average ratio for CLP may increase or decrease according to the regions (Mexico–South America and USA have a higher proportion, 66.9% and Eastern Europe, the British Isles, and South-Mediterranean Europe have lower proportion) (6). CLP was seen in higher ratios in Latin American and Asian (China and Japan) populations (15), thus coinciding with the results in our department. Furthermore, isolated CP was reported in higher ratios in Canada and Northern Europe, which was in contrast to our ratio (6).

Literature reviews reported that CLP tends to be unilateral and occurs more frequently on the left side (16). The International Perinatal Database of Typical Oral Clefts study results showed that 30.2% of the CLP group had bilateral cleft and 69.8% had unilateral cleft. The defect ratios were 41.1% on the right side and 58.9% on the left side (6). Although the laterality was the same as our study, the percentage was slightly higher (65.27% on the left side in our study).

CL with or without CP was seen more often in males; however, CP was seen more frequently in females (17). Van den Akker (18) and Stoll (19) found that boys appear to be affected more in bilateral cases, thereby coinciding with our results. On the other hand, Meskin (20) and Henriksson (21) reported that girls had bilateral CL more than boys.

When we overlooked the studies regarding the incidence rate of CL with or without palate in Turkey, it was reported to be 0.95 per 1000 births, and the ratio of isolated CP was reported to be 0.77 per 1000 births (4). According to the study in Hacettepe University, Ankara, Turkey, 64.4% of the patients had CL with or without CP, and 35.6% had isolated CP (4). Altunhan et al. (1) published a study about the incidence of congenital anomalies associated with CP and CLP in Konya region and found that 71% of the patients have CLP, and that in 80% of the patients, only one side is affected. Another study including Denizli region reported 65.5% CP, 21.6% CL, and 12.9% CLP ratios between 2004 and 2010 (5).

Gender differences also exist for CLP. Boys are affected more often and have more severe clefts than girls (22, 23). However, girls are affected more often with isolated CP than boys. In Ankara, Turkey, Borçbakan (2) reported a study with 1000 patients between 1955 and 1965 and found that males appear to be affected more; however, they explained that more males applied to their clinic.

In our study, the frequency distributions were 69.8% for CLP and 28.7% for isolated CP. In Hacettepe University's study, 64.4% of the patients had CL with or without CP, and 35.6% had isolated CP, thus coinciding with our results although the ratios showed minimal difference (4). Our study results also coincided with the study by Altunhan et al. (1) in Konya region. Although both studies showed that unilateral CLP was more often, the ratio for unilateral CLP was reported to be 17.3%, which was significantly lower than the ratio in our study. However, males were found to be affected more in our study, which was a controversial result in Konya region's study (1).

In 2013, Tomatir et al. (5) reported that isolated CP is seen more frequently (65.5%), which did not coincide with our results (28.7%). However, the results were almost similar regarding genders. Both studies showed that males are affected by clefts more often. Previous studies showed that isolated CP was seen more frequently in girls. While our results coincided with the literature, Borçbakan et al. (2) in 1969 reported that all types of clefts are seen more often in males; however, they explained that their results have more male than female patients. They also found that unilateral CLP has a higher ratio, thereby coinciding with our results.

One of the disadvantages of these studies might be the lack of standardization in classification. While Borçbakan (2) and Tomatır (5) classified their patients as CL, CP, and CLP, Altunhan (1) and Tunçbilek (4) classified their patients as CP and CLP. Furthermore, Altunhan (1) and Borçbakan (2) divided the patients into two groups as unilateral and bilateral clefts. However, only Borçbakan (2) subgrouped the patients according to laterality as right and left sides. Therefore, the patients were divided into as many subgroups as possible in our study.

An increase in the number of patients who applied was observed between 2000 and 2005, which might be related with the application of nasoalveolar molding (NAM) that became widespread, and the success of this treatment protocol was approved. Furthermore, surgeons started to refer more patients to the orthodontists because of the positive effects of NAM therapy. The reason for the steadily descending number of applicants after 2005 might be explained by other faculties that started to treat CLP patients in many other cities every year, suggesting that many patients applied to the faculties closer to them. In addition, in 2015, there is a critical decrease in the number of applicants because our faculty moved from the original campus to the new one in another county, and thus we were unfortunately unable to accept new patients during this period. They were all referred to other hospitals. After the settlement was finished, the number of CLP applicants started to increase; however, since many other faculties treat CLP patients nowadays, it is thought that the number will never increase as in the previous years. On the other hand, the treatment of patients with CLP requires experience. Therefore, such patients should be treated by specialized and experienced individuals in CLP centers.

On the other hand, when we examined the application period for treatment need, there was a negative correlation between

ages and application numbers, suggesting that adult applicants are not motivated to seek for orthodontic treatments. This might be also explained by the reason that the patients usually continue their orthodontic treatments in the same university, where they applied for presurgical infant orthopedics during the first months of their lives. Therefore, 64.9% of the patients who applied to our clinic for treatment were in the neonatal period (0–1 year). Second, there was an increase between the ages of 6 and 10 years (11.31%), which is the period of mixed dentition that malocclusions become more pronounced and primer orthodontic treatments are started, cross bites were corrected, neighboring teeth to the cleft area were leveled, orthopedic treatment, such as facemask, was applied, and bone grafting was performed.

Only few studies grouped the patients as complete or incomplete. Sivertsen et al. (24) reported that the ratio of complete cases (81%) is significantly higher than that of incomplete cases. In their study, 88% of the patients had bilateral complete CLP, which is very similar to the ratio found in our study (88.8%). In addition, they reported that 77% of the patients have unilateral complete CLP, whereas they found no significant difference in laterality. Carroll et al. (25) only included unilateral CLP cases and found that 88.8% of the patients have unilateral complete CLP and no significant difference in laterality. In our study, although the patients were divided into two as right and left unilateral CLPs, the ratios were similar (82.9% and 77.4%, respectively). Martelli-Junior et al. (14) reported complete unilateral CLP as the most prevalent cleft type with a ratio of 26.19% between all cleft types. When complete cases were evaluated in-between, unilateral CLP was found to be 66%, and bilateral CLP was found to be 34%. In another study from Brazil, Freitas et al. (26) reported that the most common cleft type is complete CLP (37.1%), similar to our study. Conversely, only Shapira et al. (27) found that incomplete CLP is the most frequent type of cleft (71%).

CONCLUSION

Unilateral CLP was the most common cleft type applied for treatment in Marmara University, Faculty of Dentistry, Department of Orthodontics, and most of the patients applied in the neonatal period (0-1 year). Furthermore, unilateral cleft was seen more frequently on the left side. Males were affected more by CLP, and isolated CP was seen more in females than in males. The ratios of complete cases were statistically significantly higher than those of incomplete cleft types. While the number of applicants increased between 2000 and 2004, over the years, the number started to decrease because of new faculties.

Although Istanbul might be considered as a preferable city for reflecting a general data about the prevalence of CLP in Turkey because of the reasons mentioned above, it still does not reflect a clear data for whole Turkey. In fact, it would be better to conduct that kind of study with collecting data from those three universities. Furthermore, comprehensive national studies are needed to assess the real national data.

Ethics Committee Approval: Ethics committee approval was received for this study from the Ethics Committee of Marmara University.

Informed Consent: Written informed consent was obtained from the patients and the parents of patients who participated in this study.

Peer-review: Externally peer-reviewed.

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REFERENCES

1. Altunhan H, Annagür A, Konak M, Ertuğrul S, Ors R, Koç H. The incidence of congenital anomalies associated with cleft palate/cleft lip and palate in neonates in the Konya region, Turkey. Br J Oral Maxillofac Surg 2012; 50: 541-4. [CrossRef]
2. Borçbakan C. An analysis of 1000 cases of cleft lip and palate in Turkey. Cleft Palate J 1969; 6: 210-2.
3. Cobourne MT. The complex genetics of cleft lip and palate. Eur J Orthod 2004; 26: 7-16. [CrossRef]
4. Tunçbilek G, Özgür F, Balcı S. 1229 Additional malformations and syndromes in 1229 cleft lip and palate patients. Çocuk Sağlığı ve Hast Derg 2004; 47: 172-6.
5. Tomatir AG, Kiray Vural B, Acikbas I, Akdag B. Registries of cases with neural tube defects in Denizli, Turkey, 2004-2010. Genet Mol Res 2014; 13: 8537-43. [CrossRef]
6. IPDTOC Working Group. Prevalence at birth of cleft lip with or without cleft palate: data from the International Perinatal Database of Typical Oral Clefts (IPDTOC). Cleft Palate Craniofac J 2011; 48: 66-81. [CrossRef]
7. Loane M, Dolk H, Kelly A, Teljeur C, Greenlees R, Densem J; EUROCAT Working Group. Paper 4: EUROCAT statistical monitoring: identification and investigation of ten year trends of congenital anomalies in Europe. Birth Defects Res A Clin Mol Teratol 2011; 91: 31-43. [CrossRef]
8. Tanaka SA, Mahabir RC, Jupiter DC, Menezes JM. Updating the epidemiology of cleft lip with or without cleft palate. Plast Reconstr Surg 2012; 129: 511-8. [CrossRef]
9. Ross RB, Johnston MC. Cleft lip and palate. Huntington, New York: Robet E. Kriger Publisher Co, 1978.
10. Vanderas AP. Incidence of cleft lip, cleft palate, and cleft lip and palate among races: A review. Cleft Palate J 1987; 24: 216-25.
11. Natsume N. Incidence of cleft lip and palate among Japanese newborns, 1982 to 1984. Plast Reconstr Surg 1987; 79: 499-501. [CrossRef]
12. Kim S, Kim WJ, Oh C, Kim JC. Cleft lip and palate incidence among the live births in the Republic of Korea. J Korean Med Sci 2002; 17: 49-52. [CrossRef]
13. Murray JC. Gene/environment causes of cleft lip and/or palate. Clin Genet 2002; 61: 248-56. [CrossRef]
14. Martelli-Junior H, Porto LV, Martelli DR, Bonan PR, Freitas AB, Della Coletta R. Prevalence of nonsyndromic oral clefts in a reference hospital in the state of Minas Gerais, Brazil, between 2000-2005. Braz Oral Res 2007; 21: 314-7. [CrossRef]
15. Mossey P. Global strategies to reduce the healthcare burden of craniofacial anomalies. Br Dent J 2003; 195: 613. [CrossRef]

16. Jensen BL, Kreiborg S, Dahl E, Fogh-Andersen P. Cleft lip and palate in Denmark, 1976-1981: epidemiology, variability, and early somatic development. Cleft Palate J 1988; 25: 258-69.
17. Derijcke A, Eerens A, Carels C. The incidence of oral clefts: a review. Br J Oral Maxillofac Surg 1996; 34: 488-94. [CrossRef]
18. Van Den Akker AM, Hoeksma JB, Prahl-Andersen B. Incidence of cleft lip and palate in the Netherlands. Ned Tijdschr Tandheelkd 1987; 94: 520-4.
19. Stoll C, Alembik Y, Dott B, Roth MP. Epidemiological and genetic study in 207 cases of oral clefts in Alsace, north-eastern France. J Med Genet 1991; 28: 325-9. [CrossRef]
20. Meskin LH, Pruzansky S, Gullen WH. An epidemiologic investigation of factors related to the extent of facial clefts. I. Sex of patient. Cleft Palate J 1968; 5: 23-9.
21. Henriksson TG. Classification of atypic facial clefts incidence in the Uppsala region 1950-1979. Läkartidningen 1981; 78: 3267-71.
22. Garcia-Godoy F. Cleft lip and palate in Santo Domingo. Community Dent Oral Epidemiol 1980; 8: 89-91. [CrossRef]
23. Shapira Y, Blum I, Haklai Z, Shpack N, Amitai Y. Nonsyndromic orofacial clefts among Jews and non-Jews born in 13 hopitals in Israel during 1993-2005. Community Dent Oral Epidemiol 2018; 46: 586-91. [CrossRef]
24. Sivertsen A, Wilcox A, Johnson GE, Abyholm F, Vindenes HA, Lie RT. Prevalence of major anatomic variations in oral clefts. Plast Reconstr Surg 2008; 121: 587-95. [CrossRef]
25. Carroll K, Mossey PA. Anatomical Variations in Clefts of the Lip with or without Cleft Palate. Plast Surg Int 2012; 2012: doi: 10.1155/2012/542078. [CrossRef]
26. Freitas JA, Dalben Gda S, Santamaria M Jr, Freitas PZ. Current data on the characterization of oral clefts in Brazil. Braz Oral Res 2004; 18: 128-33. [CrossRef]
27. Shapira Y, Lubit E, Kuftinec MM, Borell G. The distribution of clefts of the primary and secondary palates by sex, type, and location. Angle Orthod 1999; 69: 523-8.

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Original Article

Assessment of Reliability of YouTube Videos on Orthodontics

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ABSTRACT

Objective: In addition to being an entertainment channel, YouTube is also one of the most popular visual information sources today. People search YouTube to consult also on orthodontics, as well as on many other topics. The objective of the present study was to analyze the quality and reliability of information of the videos on YouTube about orthodontics.

Methods: YouTube was searched systematically by two researchers on orthodontics by using the keywords "Orthodontics," "Orthodontist," and "Orthodontic Treatment." Videos on the first three pages (60 videos) for each keyword were assessed. Researchers evaluated the reliability of the videos by using the Reliability Score (adapted from DISCERN) and the quality of the videos by using the Global Quality Score (GQS).

Results: The mean GQS results were 2.6±1.3 for videos in the "Orthodontist" group, 3.2±1.3 for videos in the "Orthodontics" group, and 2.3±1.2 for videos in the "Orthodontic Treatment" group on a 5-point scale. The Reliability Score results were 2, 2, and 1.5 for videos in the "Orthodontist," "Orthodontics," and "Orthodontic Treatment" groups, respectively, on a 5-point scale. The Intraclass Correlation Coefficient results presented a positive relationship between the researchers.

Conclusion: Owing to the lack of peer-review process and pre-upload scientific evaluation process, videos on YouTube can lead the public to misinformation.

Keywords: YouTube, internet, orthodontics, orthodontist, orthodontic treatment

INTRODUCTION

Easy and fast accessibility, patients' wish for accessing more information, and being a cost-effective way of reaching professional healthcare consultation are the parameters that triggered the use of the internet on seeking medical information in recent years (1). It has been found that 8 out of 10 internet users searched the internet for accessing healthcare data (2).

Even though many of its videos' scientific reliability and credibility are open to question (3), YouTube, as a free access video-sharing site, is one of the most visited platforms by professionals and lay people (4). A total of 100 million videos are viewed, and >65.000 videos are uploaded on YouTube everyday (1). Google, Facebook, and YouTube are the most frequently visited websites, respectively (2).

The public's comprehension on medicine, illness, and death is strongly shaped by media images since the 1990's. Since then, there has always been incorrect and deceptive information on media (5). After many years, the reliability and the quality of the information on the internet are also open to question in this digital age that we are living in (2).

The videos on YouTube could be both educational and aimed at entertainment; however, they do not have a scientific peer-review process or standardized methodology for acception (4). Owing to consumer-generated

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strategy, the lack of peer review and detailed evaluation of the uploaded data on YouTube can result in spreading of misinformation (6).

Various studies analyzed the quality and the content of YouTube videos on various healthcare issues in the literature (1, 7-11). The aim of the present study was to analyze the reliability and the quality of the most-viewed videos on YouTube "related directly with orthodontics," by using the keywords "Orthodontics," "Orthodontist," and "Orthodontic Treatment." These keywords were found to be searched frequently on Google about orthodontics by lay people, by using Google Trends.

METHODS

As the paper does not deal with humans or any material previously collected from humans, no ethical approval was taken.

Video Selection

YouTube (www.youtube.com) was searched for three keywords: "Orthodontics," "Orthodontic Treatment," and "Orthodontist" on July 8, 2018. These keywords were found to be searched frequently on Google about orthodontics by lay people, by using Google Trends application. Google Trends is an online search tool that analyzes a given search term that is entered into Google's search engine relative to the total search volume. The search results were 267.000 videos in total for "Orthodontics," 61.700 videos in total for "Orthodontic Treatment," and 141.000 videos in total for "Orthodontist."

Exclusion criteria were videos in languages other than English, videos >10 min, videos with no sounds or visuals, duplicate videos, and not-related videos.

The remaining videos excluded from exclusion criteria were considered as suitable videos (Figure 1).

The YouTube account of one of the researchers was used for the present study. All related video links were sorted by "sort by view-count" with no additional filters.

In a recent study, it was mentioned that 95% of people were viewing only the first 60 videos of an online search (4). We preferred to use the research method by Desai et al. (4), and the top 60 videos (first 3 pages) were assessed according to this criteria.

	Frequency (n)	%
Orthodontist (n=60)		
Suitable videos	31	51.7
Unsuitable videos	29	48.3
Long	18	62.1
No access	7	24.1
Another language	3	10.3
No voice, no visual	1	3.4
Orthodontics (n=60)		
Suitable videos	42	70.0
Unsuitable videos	18	30.0
Long	9	50.0
No voice, no visual	5	27.8
No access	3	16.7
Another language	1	5.6
Orthodontic treament (n=60)		
Suitable videos	35	58.3
Unsuitable videos	25	41.7
No voice, no visual	21	84.0
Long	3	12.0
No access	1	4.0

Figure 1. The distribution of the included (suitable) and excluded (unsuitable) videos according to the groups

Reliability Score (Adapted from DISCERN)

1. Are the aims clear and achieved?
2. Are reliable sources of information used?
3. Is the information presented balanced and unbiased?
4. Are additional sources of information listed for patient reference?
5. Are areas of uncertainty mentioned?

Global Quality Score (GQS) Five-Point Scale

Score Description

1. Poor quality, poor flow of video, most information missing, not at all useful for patients
2. Generally poor quality and poor flow, some information listed but many important topics missing, of very limited use to patients
3. Moderate quality, suboptimal flow, some important information is adequately discussed but others poorly discussed, somewhat useful for patients
4. Good quality and generally flow. Most of the relevant information is listed, but some topics not covered, useful for patients
5. Excellent quality and flow, very useful for patients

Figure 2. Reliability Score (adapted from DISCERN) and Global Quality Score (GQS) on a 5-point scale

Table 1. The frequency distribution of the GQS values according to the groups

	Orthodontist		Orthodontics		Orthodontic treatment	
Score	**GS (Researcher 1)**	**DDK (Researcher 2)**	**GS**	**DDK**	**GS**	**DDK**
1	9 (29)	11 (35.5)	3 (7.1)	6 (14.3)	9 (25.7)	13 (37.1)
2	5 (16.1)	3 (9.7)	10 (23.8)	9 (21.4)	13 (37.1)	9 (25.7)
3	8 (25.8)	7 (22.6)	11 (26.2)	9 (21.4)	7 (20)	8 (22.9)
4	5 (16.1)	9 (29)	7 (16.7)	10 (23.8)	2 (5.7)	3 (8.6)
5	4 (12.9)	1 (3.2)	11 (26.2)	8 (19)	4 (11.4)	2 (5.7)
ICC	0.905 (0.803-0.954)		0.923 (0.857-0.959)		0.941 (0.883-0.970)	

GQS: global quality score; ICC; intraclass correlation coefficient

Table 2. The descriptive statistics of the GQS values according to the groups

	Mean±SD	Median (min-max)
Orthodontist	2.6±1.3	2.5 (1–5)
Orthodontics	3.2±1.3	3.3 (1–5)
Orthodontic treatment	2.3±1.2	2.0 (1–5)
Total	2.8±1.3	2.5 (1–5)

GQS: global quality score

Two independent researchers, GS and DDK, both orthodontists with 10 years of experience viewed and assessed videos for reliability of the content and quality of the videos.

Assessment of Videos

After the exclusion of unsuitable videos from the results according to the exclusion criteria, all of the remaining suitable videos were analyzed and scored from 1 to 5 (Reliability Score) for content, accuracy, and reliability by using a 5-point scale (Figure 2). This scale was based on five questions that were derived from DISCERN tool, which is a tool used for assessment of written health information (12).

To assess the quality of the videos, Global Quality Scale (GQS) was used to rate the general quality of the videos (13). This rating was also made by using a 5-point scale (Figure 2). The scoring system was based on the usefulness and general concern of the video to the patient who would watch the video.

Statistical Analysis

The Statistical Package for Social Sciences version 23 (IBM Corp., Armonk, NY, USA) was used for data entry and analysis. Kolmogorov-Smirnov test was used in the assessment of the conformity of the data for normal distribution. Kruskal-Wallis test was used for assessment of non-normally distributed variables. Intraclass Correlation Coefficient (ICC) analysis and Kappa test were used for assessment of inter-examiner concordance. Qualitative data were presented as median (min-max), and quantitative data were presented as frequency (%). A p-value <0.05 was considered as significant.

RESULTS

Two researchers scored the videos from 1 to 5 for GQS (Table 1). The correlation between the researchers was evaluated by ICC analysis. According to the results, there was a strong positive correlation between the researchers in all of the groups.

The mean values for the GQS score, which was obtained by measuring the mean values of two researchers, were 2.6 in the "Orthodontist" group, 3.2 in the "Orthodontics" group, and 2.3 in the "Orthodontic Treatment" group, respectively (Table 2). The mean value was 2.8 without any group exception for all of the videos.

Five questions were scored in the reliability scale (Table 3). The best concordance between the researchers was in the "Orthodontist" group while evaluated for "Are the aims clear and achieved?" question. The median values of GQS differed according to the groups (p=0.007) (Table 4). There was no difference between the medians of reliability values according to the groups for GS (p=0.386) (Table 5). There was no difference between the medians of reliability values according to the groups for DDK (p=0.187). There was no difference between the median of the mean values of both researchers' scores according to the groups (p=0.303).

There was no difference between the median total views according to the groups (p=0.050) (Table 6). There was a difference between the median video durations according to the groups (p=0.016). There was a difference between the "Orthodontist" group and the "Orthodontic Treatment" group.

There was a difference between the median likes according to the groups (p=0.016). There was no difference between the median dislikes according to the groups (p=0.065).

DISCUSSION

As being a free access video-sharing site, YouTube is one of the most popular social media platforms comprising videos on the diagnosis, treatment, and prevention of illnesses (6). However, the quality of the information included by YouTube is still questionable (2). Knösel and Jung (14) reported that there is a large range of data on orthodontics on YouTube, and that the biggest part of these videos is uploaded by orthodontic patients. Some researchers stated that because of self-anecdotal reporting and personal opinions, the quality and reliability of videos on YouTube are suspicious (6, 15, 16). Additionally, the authors uploading the videos on YouTube are not directed for a scientific peer-review process, not asked for source of their videos, not

Table 3. The frequency distribution of the reliability values according to the groups

Reliability questions	Researcher	Score	Orthodontist	Orthodontics	Orthodontic treatment
Are the aims clear and achieved?	GS	0	9 (29)	3 (7.1)	4 (11.4)
		1	22 (71)	39 (92.9)	31 (88.6)
	DDK	0	10 (32.3)	6 (14.3)	8 (22.9)
		1	21 (67.7)	36 (85.7)	27 (77.1)
	K value		0.773*	0.632*	0.607*
Reliable sources info?	GS	0	10 (32.3)	15 (35.7)	15 (42.9)
		1	21 (67.7)	27 (64.3)	20 (57.1)
	DDK	0	20 (64.5)	20 (47.6)	24 (68.6)
		1	11 (35.5)	22 (52.4)	11 (31.4)
	K value		0.415**	0.566**	0.512**
Balanced and unbiased?	GS	0	11 (35.5)	23 (54.8)	24 (68.6)
		1	20 (64.5)	19 (45.2)	11 (31.4)
	DDK	0	20 (64.5)	27 (64.3)	26 (74.3)
		1	11 (35.5)	15 (35.7)	9 (25.7)
	K value		0.464**	0.510**	0.721*
Additional sources info?	GS	0	19 (61.3)	28 (66.7)	28 (80)
		1	12 (38.7)	14 (33.3)	7 (20)
	DDK	0	22 (73.3)	28 (66.7)	29 (82.9)
		1	8 (26.7)	14 (33.3)	6 (17.1)
	K value		0.619*	0.571**	0.717*
Are areas of uncertainty mentioned?	GS	0	22 (71)	30 (71.4)	29 (82.9)
		1	9 (29)	12 (28.6)	6 (17.1)
	DDK	0	24 (77.4)	33 (78.6)	32 (91.4)
		1	7 (22.6)	9 (21.4)	3 (8.6)
	K value		0.665*	0.559**	0.624*

K: kappa coefficent
*There is good concordance between the researchers.
**There is moderate concordance between the researchers.

Table 4. Comparison of GQS scores according to the groups

	Median (min-max)	p
Orthodontist	2.5 (1-5) ab	
Orthodontics	3.3 (1-5) a	0.007
Orthodontic treatment	2 (1-5) b	

GQS, Global Quality Score.
Kruskal Wallis, a-b: There is no difference between the same lettered groups.

Table 5. Comparison of Reliability Scores according to the groups.

	Reliability (GS)	Reliability (DDK)	Overall rating
	Median (min-max)	Median (min-max)	Median (min-max)
Orthodontist	3 (0-5)	1 (0-5)	2 (0-5)
Orthodontics	2 (0-5)	2 (0-5)	2 (0-5)
Orthodontic treatment	2 (0-5)	1 (0-5)	1.5 (0-5)
Total	2 (0-5)	1 (0-5)	2 (0-5)
p	0.386	0.187	0.303

Kruskal-Wallis

required to report the currency of their videos, and not asked to update their videos in time (4, 6, 8).

Previous investigations proved the contrast between the quality of the videos and user interest (8, 9, 11). In their study, Singh et al. (6) used the DISCERN assessment tool to assess the content of videos, whereas Singh et al. (6) and Bernard et al. (13) used GQS to assess the quality of the videos. In the present study, DISCERN questionnaire was used to evaluate the reliability of the videos, and GQS was used to assess the overall quality of the videos.

In the present study, the search results were 267.000 videos in total for "Orthodontics," 61,700 videos in total for "Orthodontic Treatment," and 141.000 videos in total for "Orthodontist." The term "Orthodontics" is found to be more searched because it is thought to include both the terms "Orthodontist" and "Orthodontic Treatment." In their study, Murigiah et al. (11) categorized the videos on YouTube into three groups as "useful," "misleading," and "patient views." In our study, videos were not categorized into these groups for an objective evaluation and to avoid bias. Videos with no access, with no sound or visual, >10 min, and in other languages than English were assessed as "unsuitable" videos for the present study. Overall, 29 (48.3%) of the 60 videos in the "Orthodontist" group, 18 (30%) of the 60 videos in the "Orthodontics" group, and 25 (41.7%) of the 60 videos in the "Orthodontic Treatment" group were not evaluated because of being unsuitable. The remaining videos in each group were evaluated

Table 6. Comparison of total views, video duration, and likes and dislikes according to the groups

	Total views Median (min-max)	Video durations (mins) Median (min-max)	Likes Median (min-max)	Dislikes Median (min-max)
Orthodontist	25,049 (606-1,044,537)	3.4 (1–9.5) a	85 (8–4002) a	9 (0–295)
Orthodontics	25,548 (256-1,622,070)	2.4 (0.3–9.2) ab	71.5 (0–5397) ab	5.5 (0–417)
Orthodontic treatment	6689 (13-40,510,079)	1.5 (0.5–9.6) b	33 (0–77,908) b	3 (0–15,272)
Total	22,976 (13-40,510,079)	2.3 (0.3–9.6)	56.5 (0–77,908)	6 (0–15,272)
p-Value	0.050	0.016	0.016	0.065

a-b: There is no difference between the same lettered groups.

as "suitable" for the study and were assessed for quality and reliability.

In their study, Desai et al. (4) selected the videos according to the sources and YouTube channels by which the videos were uploaded. However, Fox (17) stated that 75% of people using to reach medical data on the internet never inspect the information source. In the present study, all of the videos on the first three pages of all groups were evaluated to assess the overall data on orthodontics on a single YouTube search for a point in time, to achieve a more objective assessment. As a result of this, data were not evaluated according to the uploading channels or sources.

In previous studies, which assessed the content, reliability, and quality of the videos on YouTube on different medical topics, only 48% of immunization videos, 61% of H1N1 videos, and 58% of kidney stone videos were found to be useful (6).

Contrary to this, it was found that 32% of immunization videos, 23% of H1N1 videos, and 18% of kidney stone videos were spreading misinformation (6). In a very recent study, in 2018, Olkun and Ari Demirkaya (18) examined websites about lingual orthodontics and found the quality of the information on the websites to be low. Canigur Bavbek and Tuncer Balos (19) evaluated the Turkish websites about orthognathic surgery in a similar way to the method that we used in our study and found the overall quality of the scientific content of the websites at low or medium level. In their study, Lena and Dindaroğlu (20) found the content of the YouTube™ videos on lingual orthodontics to be incomplete. They mentioned that orthodontists should be aware of the information on YouTube™. In accordance with all of these results, the overall quality of the videos assessed in the present study was found to be average, and the reliability of the videos was low-grade. It was found that the reliability and the quality of the videos on YouTube about orthodontics are mostly of poor quality and unreliable.

Despite the recent tendency of academic institutions and journals to constitute their own educative YouTube channels, in a previous study, the researchers stated that the healthcare authorities and organizations issued a small number of highly educational and/or suitable medical videos (21). Only 27% of videos were found to be highly educational among medical videos (4, 8). However, it was shown that lay people are less interested in highly educational videos (4).

Hegarty et al. (2) stated that healthcare professionals should provide more information to social media resources, such as Google and YouTube, thus preventing misinformation of the community. Canigur Bavbek and Tuncer Balos mentioned that professional institutions, such as universities and educational institutions, which provide information to the community without the expectation of earnings, can overcome the lack of reliable information in this field (19).

The limitations of our study were: it was constructed only on YouTube videos not sorting any other healthcare sites; it was based on English language videos, but there were also local language videos uploaded on orthodontics; it was made in a single sort of the site in a particular time, but the content of the websites changes every second; and the assessment was made by professionals so the opinion of the public may have been dismissed.

CONCLUSION

The reliability of the videos assessed in the present study was found to be low-grade. The overall quality of the videos assessed in the present study was found to be average. Despite the fact that all of the information about orthodontics on YouTube is not accurate, YouTube can help to increase awareness about orthodontic treatments. Therefore, orthodontists should pay attention to inadequate data guiding patients on YouTube.

Ethics Committee Approval: As the paper does not deal with humans or any material previously collected from humans, no ethical approval was taken.

Peer-review: Externally peer-reviewed.

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REFERENCES

1. Hassona Y, Taimeh D, Marahleh A, Scully C. YouTube as a source of information on mouth (oral) cancer. Oral Dis 2016; 22: 202-8. [CrossRef]
2. Hegarty E, Campbell C, Grammatopoulos E, DiBiase AT, Sherriff M, Cobourne MT. YouTube™ as an information resource for orthognathic surgery. J Orthod 2017; 44: 90-6. [CrossRef]

3. ElKarmi R, Hassona Y, Taimeh D, Scully C. YouTube as a source for parents' education on early childhood caries. Int J Paediatr Dent 2016; 27: 437-43. [CrossRef]
4. Desai T, Shariff A, Dhingra V, Minhas D, Eure M, Kats M. Is content really king? An objective analysis of the public's response to medical videos on YouTube. PLoS One 2013; 8: doi: 10.1371/journal.pone.0082469. [CrossRef]
5. Diem SJ, Lantos JD, Tulsky JA. Cardiopulmonary resuscitation on television. Miracles and misinformation. N Engl J Med 1996; 334: 1578-82. [CrossRef]
6. Singh AG, Singh S, Singh PP. YouTube for information on rheumatoid arthritis-a wakeup call? J Rheumatol 2012; 39: 899-903. [CrossRef]
7. Keelan J, Pavri-Garcia V, Tomlinson G, Wilson K. YouTube as a source of information on immunization: a content analysis. JAMA 2007; 298: 2482-4. [CrossRef]
8. Steinberg PL, Wason S, Stern JM, Deters L, Kowal B, Seigne J. YouTube as source of prostate cancer information. Urology 2010; 75: 619-22. [CrossRef]
9. Pandey A, Patni N, Singh M, Sood A, Singh G. YouTube as a source of information on the H1N1 influenza pandemic. Am J Prev Med 2010; 38: 1-3. [CrossRef]
10. Sood A, Sarangi S, Pandey A, Murugiah K. YouTube as a source of information on kidney stone disease. Urology 2011; 77: 558-62. [CrossRef]
11. Murigiah K, Vallakati A, Rajput K, Sood A, Challa NR. YouTube as a source of information on cardiopulmonary resuscitation. Resuscitation 2011; 82: 332-4. [CrossRef]
12. Charnock D, Shepperd S, Needham G, Gann R. DISCERN: an instrument for judging the quality of written consumer health information on treatment choices. J Epidemiol Community Health 1999; 53: 105-11. [CrossRef]
13. Bernard A, Langille M, Hughes S, Rose C, Leddin D, Veldhuyzen van Zanten S. A systematic review of patient inflammatory bowel disease information resources on the World Wide Web. Am J Gastroenterol 2007; 102: 2070-7. [CrossRef]
14. Knösel M, Jung K. Informational value and bias of videos related to orthodontics screened on a video-sharing Web site. Angle Orthod 2011; 81: 532-9. [CrossRef]
15. Briones R, Nan X, Madden K, Waks L. When vaccines go viral: an analysis of HPV vaccine coverage on YouTube. Health Commun 2012; 27: 478-85. [CrossRef]
16. Lewis SP, Heath NL, Sornberger MJ, Arbuthnott AE. Helpful or harmful? An examination of viewers' responses to nonsuicidal self-injury videos on YouTube. J Adolesc Health 2012; 51: 380-5. [CrossRef]
17. Fox S. Online health search, Pew Internet & American Life Project. Page: iii, 2006.
18. Olkun HK, Demirkaya AA. Evaluation of Internet Information about Lingual Orthodontics Using DISCERN and JAMA Tools. Turk J Orthod 2018; 31: 50-4. [CrossRef]
19. Bavbek NC, Tuncer BB. Information on the Internet Regarding Orthognathic Surgery in Turkey: Is It an Adequate Guide for Potential Patients? Turk J Orthod 2017; 30: 78-83. [CrossRef]
20. Lena Y, Dindaroğlu F. Lingual orthodontic treatment: A YouTube™ video analysis. Angle Orthod, 2017; 88: 208-214. [CrossRef]
21. Knösel M, Jung K, Bleckmann A. YouTube, dentistry, and dental education. J Dent Educ 2011; 75: 1558-68. [CrossRef]

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Original Article

Neonatal Functional Treatment for Pierre Robin Sequence

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ABSTRACT

Objective: Pierre Robin Sequence (PRS) is a heterogeneous pathological condition characterized by the coexistence of micrognathia, glossoptosis, and cleft palate, resulting in upper airway tract obstruction. Among the treatment modalities, the orthodontic approach is one part of the comprehensive care of those patients and will be present in the treatment modalities during all the growth period of the child.

Methods: All patients with PRS observed in the period 2013-2017 were treated with a definite functional approach. The results were retrospectively analyzed with regard to functional outcome, total treatment time, and number of plates provided for a single patient.

Results: In all the patients, the indicated treatment protocol has been applied as early impression and plate supply, stimulation of bottle feeding with the use of the plate, eventual substitution of the plate if no more adequate to the transverse and sagittal growth of the palate, and continuing the use until the surgical closure of the cleft. All the patients showed a positive outcome to the proposed treatment approach, evaluated with regard to the incidence of feeding improvement and weight gain, to the limit for the surgical phase, in the absence of adverse effects.

Conclusion: The use of a functional obturator plate, removing functional alterations to mandibular growth, reduces and, in some cases, eliminates the need for surgical intervention. As also stated in the literature, if despite the presence of the plate nutritional problems persist, immediate different surgical approaches, mainly mandibular osteodistraction, become necessary.

Keywords: Pierre Robin Sequence, functional orthodontic treatment, cleft palate, obturator plate

INTRODUCTION

Pierre Robin Sequence (PRS) is a heterogeneous pathological condition characterized by the coexistence of micrognathia, glossoptosis, and cleft palate, resulting in upper airway tract obstruction. The characteristic appearance of patients with PRS is their chinless shape, determined by mandibular hypoplasia or micrognathia. Glossoptosis with upper airway obstruction is the result of mandibular micrognathia. The main symptom of respiratory obstruction consists of an apnea crisis, often during sleep OSAS: obstructive sleep apnea syndrome.

The cleft palate, which is the last element in the pathogenetic sequence, is the consequence of an altered tongue position during the fetal period; its interposition both between the palatine processes and the maxillary processes prevents their fusion. The cleft affects the soft palate and the posterior portion of the hard palate; the remaining part of the hard palate always presents a pronounced concavity (Figure 1, 2). Therefore, the tongue is the cause of the cleft, preventing the migration and fusion of palatal structures; after birth, the tongue continues to fill the pharyngeal space, resulting in glossoptosis and respiratory crisis. The presence of cleft palate is not essential to characterize the PRS; there are cases of micrognathia and glossoptosis without cleft, but a deep palatal vault caused by tongue pressure is always present (1-3) (Figure 3). In this case, the clinical picture and symptoms are less severe. Facial appearance is always characteristic (Figure 4, 5).

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The Pierre Robin Sequence can be considered as a malformation with embryologic dysfunctional pathogenesis. The recognition of the pathogenetic mechanism is the premise to a therapeutic orthopedic-functional approach, which should be performed in the neonatal period.

Recently, Van Lieshout et al. (4), in a survey conducted among European clinicians, investigated the most commonly used procedures of therapeutic approach to RS in Europe. In most cases, the decisive factor was related to the patient's breathing possibilities and, therefore, to the need for treatment of the respiratory difficulty that may be present.

In cases of mild obstruction, the most frequent therapy was to maintain the prone position or, if unsuccessful, the use of a nasopharyngeal airway. The surgical procedures varied widely from country to country, but in cases of severe obstruction, mandibular osteodistraction was the most frequent treatment modality (4, 5).

In the present study, we emphasize the role of functional therapy and how it is conducted, starting from the immediate neonatal period until palatoplasty, and provide a summary of the therapies performed at our institution over the last 5 years.

The aim of the present study was to present the treatment protocol applied in the Department of Oral and Maxillofacial sciences in 20 consecutive patients treated with an immediate functional therapy based on the above-indicated pathogenetic mechanism. Moreover, the study presented the details of the treatment timing and devices in the sample analyzed and evaluated the treatment results with regard to the positive or negative out-

Figure 1. PRS with complete palate cleft

Figure 2. PRS with posterior palate cleft

Figure 3. PRS with pseudo palate cleft

Figure 4. Characteristic shape of a child with PRS

come based on the characteristic of feeding and weight gain up to 8 kg, requested for the surgical phase of cleft closure.

METHODS

A total of 31 patients with features of cleft palate were treated in the Orthodontic Department of the Sapienza University of Rome in the period January 2013-June 2017. Of the 31 patients, 20 were identified as affected by PRS.

Treatment Protocol

The orthodontist begins his intervention just after the birth of the patient and closely follows the patient through all developmental stages, in close communication with other specialists.

Orthodontic treatment occurs in specific stages of development, with well-defined therapeutic goals accepted by plastic and maxillofacial surgeons. This includes the following: a primary treatment with the use of pre-surgical functional obturator or orthopedic plates and treatment for deciduous or mixed dentition to improve and guide mandibular growth.

The clinical protocol is an early approach since the very first days of life; impressions in polyvinyl siloxane (PVS) are obtained for construction of an obturator plate, which will be used until the primary closure of the cleft, to facilitate the small patient during suction and breathing.

Thus, the functional plate is usually applied in the first to second week of life and plays a key role in restoring the anatomical individuality of the oral and nasal cavities, holding down the tongue, and recovering the physiological functions of the stomatognathic apparatus (5).

This device will help restore a correct tongue's posture necessary to avoid worsening of the cleft and to allow physiological mandibular growth.

According to the orthodontic functional treatment principles of the Cleft Lip and Palates Zurich School (6, 7), the plate guides the

Figure 5. Latero-lateral cephalogram of a newborn with PRS

Figure 7. Kit of trays for newborns

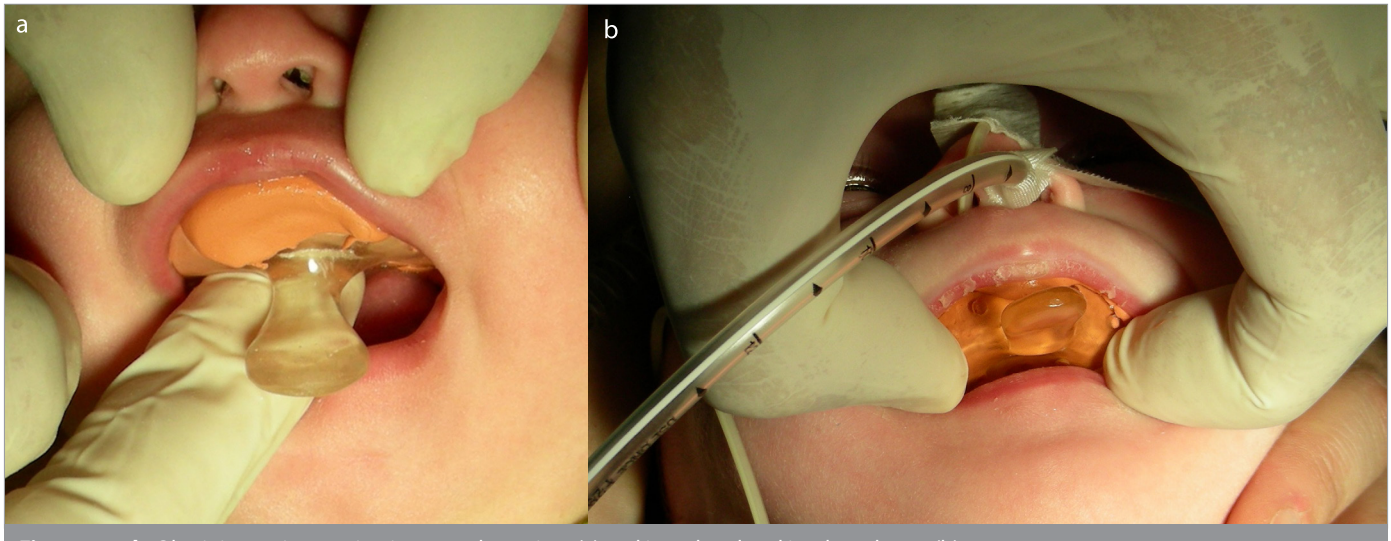


Figure 6. a, b. Obtaining an impression in an awake patient (a) and in sedated and intubated ones (b)

development of the maxillary segments, promoting the medial approach of the palatal processes, thus making surgical treatment easier.

Moreover, the early application of the plate helps the young patient to accept and immediately consider it a natural anatomic part.

The first impression for construction of the plate is always done in a controlled environment under the supervision of a pediatrician and anesthetist and under cardiorespiratory monitoring, usually with the patient awake; sedation is needed only in a limited number of cases, based on the judgment of the anesthetist (Figure 6. a, b).

A set of trays, built on models of cleft patients, is available for selection of the correct size (Figure 7); only in particular anatomic conditions is it necessary to build an individual tray.

According to the Zurich School (6, 7), the impression material for construction of the plate is PVS, and the plate is made with acrylic resin, without relining the soft resin (Figure 8).

Before application, we discard the middle part of the plate to remove its contact with the palatal processes to allow for free growth medially and inferiorly (Figure 9).

Figure 8. Impression in silicon material

Figure 9. Discarding the plate to allow free growth medially and inferiorly

Figure 10. Application of a prosthetic paste on the functional plate

Figure 11. Application of the functional plate: newborn patient feeding with an obturator plate

In this method, the support of the plate to the maxilla is circular on the alveolar processes; to ensure the perfect adhesion of the plate, we use a neutral and hypoallergenic prosthetic adhesive paste (Kukident Neutral) that can also play a notable role of atraumatic thickness (Figure 10).

The plasticity of the adhesive amplifies the functional stimulus on the upper jaw by pressure variations that occur in the oral cavity with tongue movement, in particular during sucking (Figure 11).

Patients wear the plate full-time, removing it only once daily to clean it.

Clinical examinations are performed monthly to evaluate possible early teeth eruptions or decubitus and eventually the increases in the maxillary dimension.

Figure 12. Final aspect of the functional plate

In some cases, in fact, two functional plates are built for each patient, at a distance of 3-4 months apart, to meet the growth of the mouth of the patient and to favor the reunion of the palatine bones. In a very small newborn, it was also necessary to build three functional plates before reaching the ideal body weight (8 kg) necessary to undergo palatoplasty.

The primary treatment goal is to provide the stomatognathic apparatus with a new morphological and functional environment through repositioning lingual posture and restoring functional balance, allowing for a normal growth pattern. We encourage the use of a pacifier to amplify the functional stimulus. Thus, this orthopedic-functional therapeutic protocol provides the use of two elements, namely, the functional plate and the baby pacifier. The therapeutic mechanism of such therapeutic functional devices is described below.

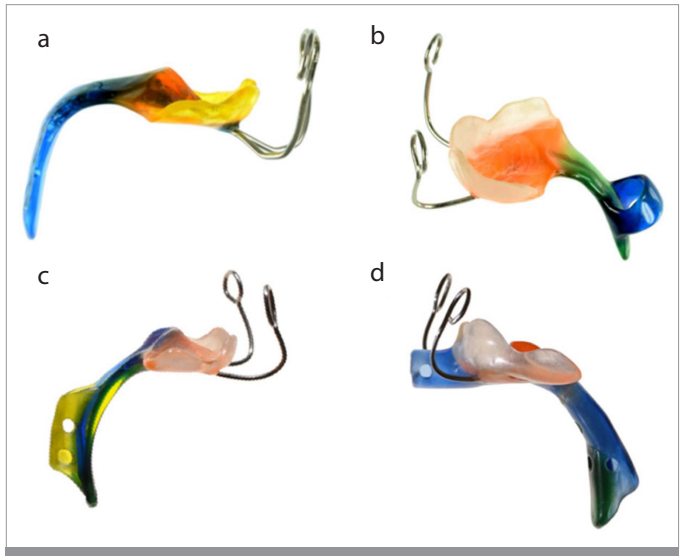


Figure 13. a-d. Various types of palatal plates used PRS. Data from *Müller–Hagedorn et al. Head & Face Medicine (2017) 13:4*

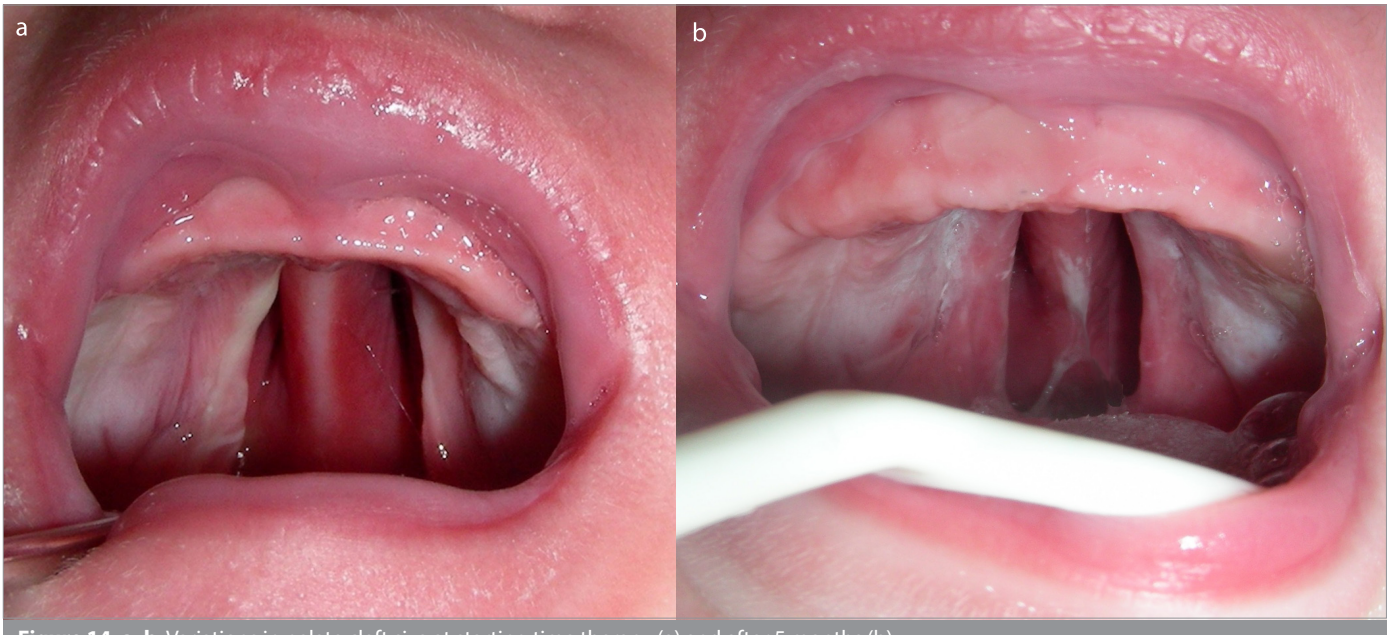


Figure 14. a, b. Variations in palate cleft size at starting time therapy (a) and after 5 months (b)

Case Series

We collected all the data of the 20 infants with PRS. All of them had a cleft palate, and 15 had a complete cleft palate.

The patients were referred to the Pre-Surgical Orthodontic Service both from the Pediatric Department of the same hospital, Policlinico Umberto I of Rome, and from other hospitals.

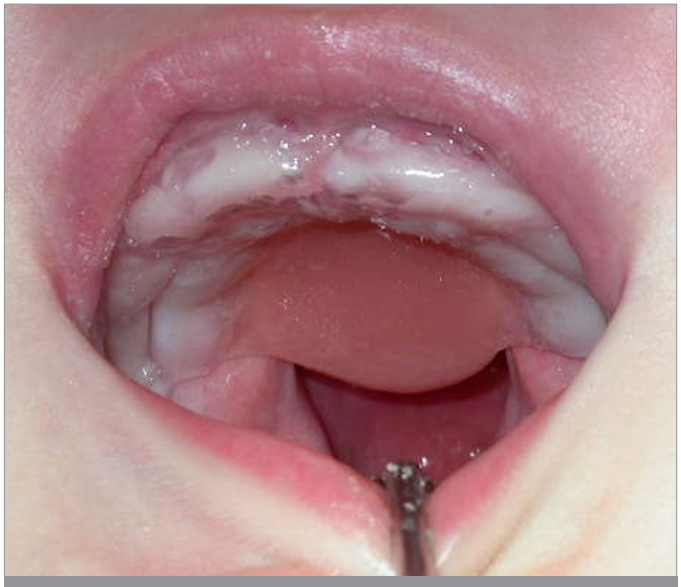


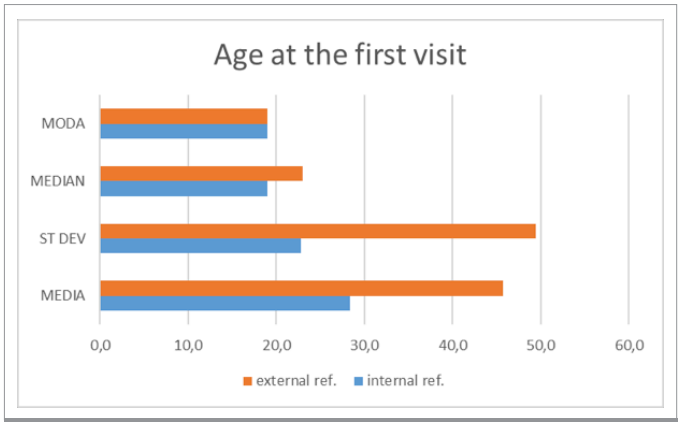
Figure 15. Obturator plate positioned

All the patients were treated with the protocol mentioned above. The palatal plate was delivered to the patient and checked immediately both for presence of excessive pressure on the mucosa and for possibility to nipple or bottle feeding.

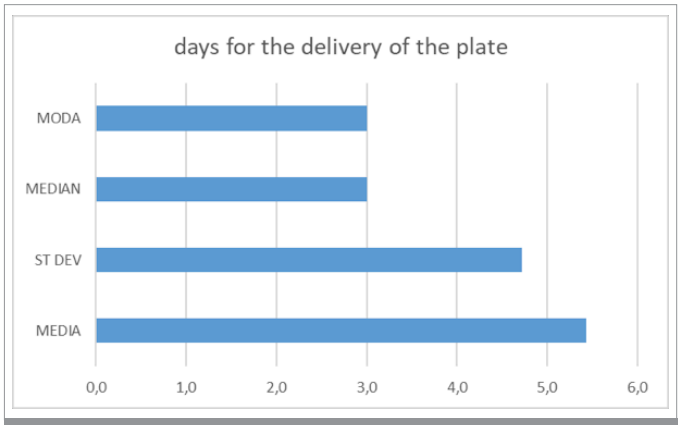
All the patients also underwent a polysomnographic control after the application of the plate to control the eventually present respiratory difficulties.

A second check for presence of eventually present decubitus was made 1 week after plate delivery.

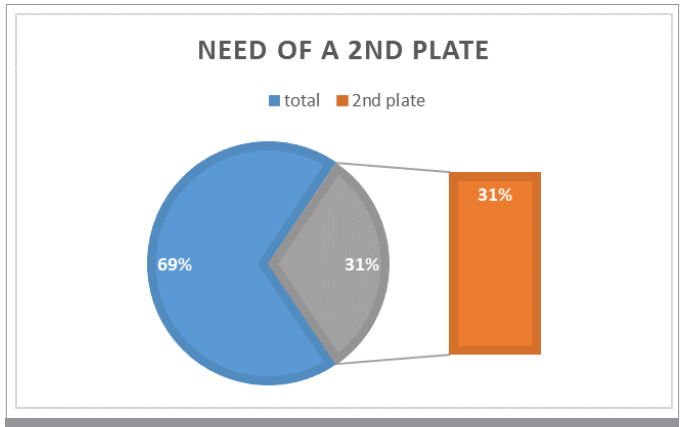
From that moment, a periodical control in the pediatric unit, to verify the weight gain and the grooving curve of the patients, is planned, and the periodicity is decided from the global evaluation of the patient. The pediatric unit also takes care of the need of subsequent polysomnographic evaluation. A weight increase is considered an indirect index of the feeding efficiency with the use of the plate.



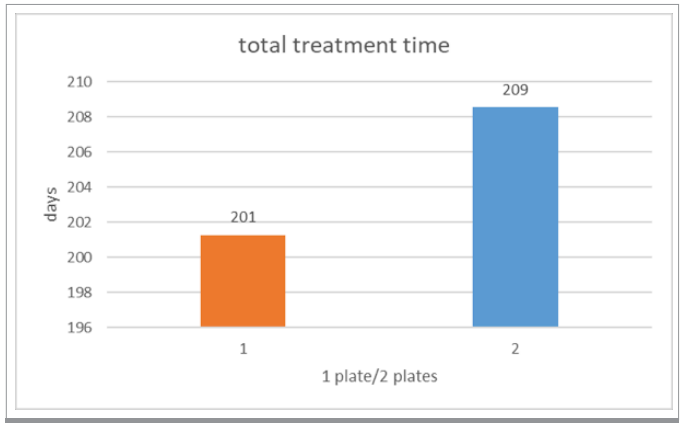
Graph 1. Patient's age at the first control (days)



Graph 2. Total time (days) needed for delivery of the plate



Graph 3. The total number of patients needing a second plate was 9 out of 20 (31%)



Graph 4. Treatment time in days in the group receiving one plate versus the group receiving two plates

RESULTS

The ages of the patients at the first visit were within the first 2 weeks (six cases), within month 1 (eight cases), and within month 4 (six cases) of life. The median age was different for subjects referred from the same hospital with respect to those coming from other hospitals (Graph 1).

Impressions for construction of the first functional obturator plate were made for 16 (80%) patients within 7 days from the first visit. In three patients, the impression was obtained between days 10 and 14 because the children had not been fasting within 4 h of the procedure. In fact, fasting for 4 h prior to the procedure is mandatory to prepare the patient for obtaining the impression for the functional obturator plate. In only 1 (5%) patient, there was a need to repeat the impression because the borders were not completely visible in the first one. The functional plate was delivered in a median time of 5 days, ranging between 1 and 10 days (Graph 2).

In only nine patients, there has been a need of a second plate to reach the target weight (Graph 3). The second plate was delivered at a median age of 119±47 days. The total treatment time was 201±55 days, with only a slight difference in the subgroup of patients needing two plates instead of only one (total treatment time 209±54 days) (Graph 4).

DISCUSSION

In our decade-long clinical practice with children affected by PRS, the difficulties facing young patients are breathing and feeding order. The extreme heterogeneity of the family structure, such as geographic origin, caste, wealth, ethnicity, and education, led us to develop a therapeutic support system that is practical, functional, simple, and cost effective.

A positive aspect of the use of a functional plate is its simplicity of construction and management (Figure 12). The plate is constituted by a semilunar resin base recessed within, on which is spread a small amount of adhesive prosthetic paste. The adhesive paste, together with the precise plate adhesion to tissues, is very stable due to surface tension, without the need for extraoral aids, such as braces, hooks, plasters, or elastics (8-11).

The plate differs from the plate shape suggested by several authors (12-14) usually designed with pharyngeal extension, i.e., the pre-epiglottic baton plate (PEBP). The pharyngeal extension is dedicated to the increase of posterior respiratory space mainteinance, but often is not well tolerated from the patient and more difficult to use during feeding (Figure 13).

The functional plate we suggest results in a palatal cleft filling while preventing the growth of the palatine processes and rather guiding and stimulating pre-surgical reduction of the size of the cleft (Figure 14. a, b).

The position of the plate causes a redistribution of the buccal space while reducing the height of the palate, and consequently, a postural re-education and lowering of the tongue happens, thus stimulating mandibular growth (Figure 15). Moreover, the separation of the oral and nasal cavities is achieved, improving breathing without the need for hypopharyngeal extensions that can decrease the baby's comfort or necessitate frequent and removal. The rigidity of the functional plate allows the child to properly latch onto the mother's nipple and/or an artificial nipple, thus improving feeding.

Patient Cohort Analysis

All 20 patients in our cohort received an immediate benefit from the use of the functional obturator plate, particularly with regard to breathing and feeding. The presence of a functional plate enables them to feed without aspiration and coughing; latching is accomplished because the functional plate re-creates the palatal plane. Feedings are longer, more nutritious, and less fatiguing to the small patient.

An obvious comparison is with other palatal plate shapes used in the literature to close the cleft in those patients. PEBP, an "orthodontic appliance with a velar extension shifting the base of the tongue forward," is the most widely used as defined by Buchenau (11, 15).

As referred from the literature, the positive effect of the velar extension is to reduce apnea episodes due to the effect of shifting the tongue base forward. A certain difficulty in the degree of tolerance of this plate has been reported due to the gag reflex.

As verified in our sample, during sleep, the functional plate descripted avoids glossoptosis, reducing the phenomena of OSA.

If necessary, small adjustments to the plate can be made; the plate is applied as soon as possible for natural bottle feeding. This functional activity is very important to stimulate the lingual, perioral, and mandibular muscles to increase intraoral pressure and mandibular growth (Figure 11).

The use of a baby pacifier in association with the obturator plate favors the oral frontal seal. Its encumbrance pushes the tongue down and forward, stimulating a more correct position. The resulting muscular activation and increased intraoral pressure acts as a stimulus for mandibular growth.

Respiratory efficiency plays an important role in patient recovery.

As referred in the literature, "tongue-lip adhesion and tongue repositioning increase the efficiency of natural breathing reducing the number of apnea/hypopnea episodes" (16).

One of the positive effects of the palatal plate is the position of the tongue, forced forward from the lowering of the palatal surface; in addition, the closure of the palatal cleft avoids tongue insertion in this space, partially responsible of its backward fall. The final effect is so similar to a series of therapeutic approaches that imply a change in the tongue position, such as the tongue–lip adhesion. The lack of valuable randomized studies on the effect on the successful relief of the airway obstruction of the orthodontic appliances implies the need for further research (17), in particular comparing the results of the

respiratory pattern in patients treated with conservative functional approach with palatal plates to the breathing relief of the surgical approach (18, 19).

Further development of the present study could be referred to the evaluation of measurable parameters, such as polysomnographic records or the closure amount of cleft size or interarch widths or depth of the maxilla. For polysomnographic records, in the routine care of the hospitals considered, all these patients are initially monitored for respiratory status in the pediatric intensive care unit, where the polysomnographic record (PSG) is also performed. All these patients are discharged only if no risk of apnea–hypopnea is present; thus, data are not planned to be recorded periodically. Similarly, as also reported in the literature, a general agreement about the guideline for timing and periodical assessment of the PSG is still not achieved (22).

Finally, the appraisal of the changes of maxillary shape and depth and the possibility of a tridimensional evaluation before the surgical procedures is limited to the need of a new impression of the maxillary arch; thus, in the sample used for the present study, data were available only for subjects who underwent a second plate construction and only limited to the first phase of treatment.

Eventually, future improvement of the impression procedure would allow the patients to have several impressions also in the first period.

CONCLUSION

The use of a functional obturator plate, combined with the active use of a pacifier, causes neuromuscular and morphological changes of the stomatognathic system, removing functional alterations to mandibular growth and consequently beginning a process of structural and morphological normalization. This treatment with a functional plate reduces and, in some cases, eliminates the need for surgical intervention, such as tongue-lip adhesion (which was not performed), nasopharyngeal airway, or other types of interventions used to treat apnea. In fact, repositioning and re-education of lingual posture is essential to improve and permanently correct respiratory problems and gradually recover the sucking reflex (20, 21). In our view, the first stage of functional-orthopedic postural therapy could be aided by keeping the baby in the prone position. If after 15 days of plate application nutritional problems persist, a different surgical approach is necessary.

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Informed Consent: Written informed consent was obtained from the parents' or legal guardians of the patients who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - A.S., V.M.; Design - G.G.; Supervision - A.S., G.G.; Fundings - V.M., R.V.; Materials - A.S., V.M., R.V.; Data Collection and/or Processing - G.G.; Analysis and/or Interpretation - G.G., V.M.; Literature Search - E.B.; Writing Manuscript - G.G.; Critical Review - G.G., E.B.; Other - E.B.

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REFERENCES

1. Leonardo ME, Mantuano MT, Silvestri A. Nuovo inquadramento patogenetico disfunzionale e ruolo della terapia funzionale nella sequela di Pierre Robin. Ortognatodonzia Italiana 2000; 9-3: 339-44.
2. Shprintzen RJ. The implications of the diagnosis of Robin sequence. Cleft Palate Craniofac J 1992; 29: 205-9. [CrossRef]
3. Cole A, Lynch P, Slator R. A new grading of Pierre Robin Sequence. Cleft Palate Craniofac J 2008; 45: 603-6. [CrossRef]
4. van Lieshout MJ, Joosten KF, Mathijssen IM, Koudstaal MJ, Hoeve HL, van der Schroeff MP, et al. Robin sequence: A European survey on current practice patterns. J Craniomaxillofac Surg 2015; 43: 1626-31. [CrossRef]
5. Cascone P, Papoff P, Arangio P, Vellone V, Calafati V, Silvestri A. Fast and early mandibular osteodistraction (FEMOD) in severe Pierre Robin Sequence. J Craniomaxillofac Surg 2014; 42: 1364-70. [CrossRef]
6. Kogo M, Okada G, Ishii S, Shikata M, Iida S, Matsuya T. Breast feeding for Cleft Lip and Palate Patiens, using the Hotz-type Plate Cleft Palate Craniofac J 1997: 34: 351-3. [CrossRef]
7. Hotz H, Gnoinski W. Comprehensive care of cleft lip and palate children at Zurich University: a preliminary report. Am J Orthod 1976; 70: 481-503. [CrossRef]
8. Bacher M, Sautermeister J, Urschitz MS, Buchenau W, Arand J, Poets CF. An oral appliance with velar extension for treatment of obstructive sleep apnea in infants with Pierre Robin Sequence. Cleft Palate Craniofac J 2011; 48: 331-6. [CrossRef]
9. Radhakrishnan J, Sharma A. Feeding plate for a neonate with Pierre Robin sequence. J Indian Soc Pedod Prev Dent 2011; 29: 239-43. [CrossRef]
10. Oliver HT. Construction of orthodontic appliances for the treatment of newborn infants with cleft of the lip and palate. Am J of Orthodontics 1969; 56: 468-73. [CrossRef]
11. Müller-Hagedorn S, Buchenau W, Arand J, Bacher M, Poets CF. Treatment of infants with Syndromic Robin sequence with modified palatal plates: a minimally invasive treatment option. Head Face Med 2017; 13: 4. [CrossRef]
12. Gómez OJ, Barón OI, Peñarredonda ML. Pierre Robin Sequence: An Evidence-Based Treatment Proposal. J Craniofac Surg 2018; 29: 332-8.
13. Poets CF, Bacher M. Treatment of upper airway obstruction and feeding problems in robin-like phenotype. J Pediatr 2011; 159: 887-92. [CrossRef]
14. Poets CF, Maas C, Buchenau W, Arand J, Vierzig A, Braumann B, et al. Multicenter study on the effectiveness of the pre-epiglottic baton plate for airway obstruction and feeding problems in Robin sequence. Orphanet J Rare Dis 2017; 12: 46. [CrossRef]
15. Buchenau W, Wenzel S, Bacher M, Müller-Hagedorn S, Arand J, Poets CF. Functional treatment of airway obstruction and feeding problems in infants with Robin sequence. Arch Dis Child Fetal Neonatal Ed 2017; 102: 142-6. [CrossRef]
16. Camacho M, Noller MW, Zaghi S, Reckley LK, Fernandez-Salvador C, Ho E, et al. Tongue-lip adhesion and tongue repositioning for obstructive sleep apnoea in Pierre Robin sequence: A systematic review and meta-analysis. J Laryngol Otol 2017; 131: 378-83. [CrossRef]
17. Bütow KW, Naidoo S, Zwahlen RA, Morkel JA. Pierre Robin sequence: Subdivision, data, theories, and treatment - Part 4: Recommended management and treatment of Pierre Robin sequence and its application. Ann Maxillofac Surg 2016; 6: 44-9. [CrossRef]

18. Ramieri V, Basile E, Bosco G, Caresta E, Papoff P, Cascone P. Three-dimensional airways volumetric analysis before and after fast and early mandibular osteodistraction. J Craniomaxillofac Surg 2017; 45: 377-80. [CrossRef]
19. van Lieshout MJ, Joosten KF, Mathijssen IM, Koudstaal MJ, Wolvius EB, van der Schroeff MP. Non-surgical and surgical interventions for airway obstruction in children with Robin Sequence. J Craniomaxillofac Surg 2016; 44: 1871-9. [CrossRef]
20. Mackay DR. Controversies in the diagnosis and management of the Robin sequence. J Craniofac Surg 2011; 22: 415-20. [CrossRef]
21. Turner L, Jacobsen C, Humenczuk M, Singhal VK, Moore D, Bell H, et al. The effects of lactation education and a prosthetic obturator appliance on feeding efficiency in infants with cleft lip and palate. Cleft Palate Craniofac J 2008; 38: XX [CrossRef]
22. Khayat A, Bin-Hassan S, Al-Saleh S: Polysomnographic findings in infants with Pierre Robin sequence. Ann Thorac Med 2017; 12: 25-9. [CrossRef]

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Original Article

Intra-examiner and Inter-examiner Reproducibility in Irregularity Index Measurements

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ABSTRACT

Objective: This study aimed to assess intra-examiner and inter-examiner reproducibility in irregularity index measurements.

Methods: Twenty plaster casts of moderately crowded arches were randomly selected, and five contact point displacements (CPD) at lower anterior segment (through no. 33 to no. 43) were recorded using digital calipers on two different time points by three examiners to determine irregularity index (sum of five CPDs). To evaluate intra-examiner and inter-examiner differences, paired t-test and analysis of variance were used, respectively. Correlation analyses were performed between examiner pairs, and intra-class correlation coefficients (ICC) were determined. Statistical significance was set at $p \leq 0.05$.

Results: Only a few of the repeated measurements of examiners showed significant differences ($p \leq 0.05$). All researchers were consistent in repeated measurements ($p=0.000$), and ICCs ranged between 0.916 and 0.986. For one CPD measurement, a statistically significant difference was detected among examiners ($p=0.020$). High correlation was found for inter-examiner repeatability ($p<0.05$), and ICCs ranged between 0.739 and 0.984. But when the difference of 1.5 mm among measurements was set as clinically relevant, the percentages of these values for repeated measures were 15%, 5%, and 45% for examiner 1, 2, and 3, respectively. These percentages were 25%, 80%, and 65% for examiner pairs.

Conclusion: Irregularity index may be a misleading index to determine anterior alignment especially when measuring small CPD.

Keywords: Irregularity index, reproducibility, tooth crowding, dental model

INTRODUCTION

The pretreatment incisor crowding is considered an important factor for post-retention stabilization (1-3). In the daily clinical practice, it is subjectively recorded but rarely measured. A method called as Little's Irregularity Index (LII) was developed by Little (4) to measure the misalignment of the mandibular anterior teeth. The contact point displacements (CPDs) of six mandibular anterior teeth were measured, and the total amount of displacements provided a total score of irregularity (4). This method is simple and reliable to calculate the "quantitative score of mandibular alignment," but it is insufficient to define the severe single tooth displacement (4, 5). LII was accepted as a valid outcome measure to evaluate retention procedures according to Cochrane Collaboration's review (6).

Little's Irregularity Index has long been used to evaluate the post-retention stability; and recently, the orthodontists have extended its inclusion for maxillary arch to evaluate the effects of various brackets (7, 8), retainers (9-11), and treatment modalities (11, 12).

The reproducibility of the LII has been tested by comparing two separate occasion of measurements recorded by different examiners (4, 8, 13). The results of the studies (8, 13, 14) showed significantly high correlations. However, in some studies (15, 16), the index was reported not to yield reliable results, and consequently no consensus was

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Table 1. Statistical comparison of intra-examiner and inter-examiner differences

	Examiner 1						Examiner 2						Examiner 3						ANOVA
	T1		T2		Difference		T1		T2		Difference		T1		T2		Difference		
CPDs	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
33–32	1.81	1.15	2.05	1.22	−0.24***	0.27	1.89	1.14	2.05	1.15	−0.16*	0.34	2.55	1.20	2.73	1.45	−0.18	0.58	ns
32–31	1.63	1.01	1.79	1.03	−0.16**	0.24	1.78	0.98	1.87	0.99	−0.09	0.38	2.08	1.25	2.25	1.17	−0.17	0.47	ns
31–41	1.02	0.85	1.09	0.83	−0.07	0.27	0.98	0.85	1.03	1.01	−0.04	0.42	1.36	1.05	1.52	1.22	−0.15	0.36	ns
41–42	1.41	0.92	1.46	0.92	−0.05	0.26	1.29	0.93	1.43	0.98	−0.13	0.34	1.66	1.07	1.9	1.13	−0.24*	0.42	ns
42–43	1.71	0.72	1.91	0.69	−0.17*	0.35	1.91	0.71	2.14	0.73	−0.23**	0.36	2.14	0.83	2.7	1.02	−0.55***	0.51	0.011 (1 vs. 3, 2 vs. 3)
Sum	7.62	2.96	8.31	2.88	−0.69***	0.71	7.87	2.69	8.54	2.87	−0.66**	0.82	9.81	3.34	11.11	3.39	−1.30***	1.30	ns

*p < 0.05; **p < 0.01; ***p < 0.001; ns: non-significant
CPDs: Contact point displacements

reached in the literature. Therefore, this study aimed to evaluate the repeatability of the LII measurements performed on two separate occasions by three independent examiners.

METHODS

Ethical approval was obtained from the research ethics committee of the İzmir Katip Çelebi University (no. 210). A sample size of 20 models was calculated based on 90% statistical power, 0.10 effects size, 0.05 type I error, and 0.85 intra-class correlation coefficient for three raters.

The sample was selected from initial records of patients at Orthodontic Clinic of İzmir Katip Çelebi University. The plaster models were selected according to the following inclusion criteria: (1) fully erupted teeth, (2) moderately crowded mandibular arch, (3) no previous orthodontic treatment, and (4) no missing mandibular teeth (excluding third molars). The casts of patients with craniofacial syndromes or developmental dental anomalies were excluded.

The impression protocol in our clinic was as follows: the mandibular study casts were recorded using alginate impressions (Cavex Tulip, Haarlem, The Netherlands). Alginate was manually mixed according to the manufacturer's instructions. Impressions were rinsed with cold water and then disinfected for 10 min. Dental hard plaster (Denstone; Heraeus Kulzer, South Bend, IN) was poured into the impression and left to harden for 45 min. The casts were removed from the impression and stored at room temperature (22°C±1°C). Samples were given a number to ensure that the patient would not be identified and measurements would be made with a blinded manner.

Three examiners-senior orthodontic residents (E.C.I, R.D, and M.F.S)-who were working independently recorded the measurements on the casts. Each plaster model was measured twice with 1-month interval by the same examiner. The CPDs of the six anterior lower teeth were measured with a digital Vernier caliper.

Special care was taken to measure only the horizontal linear displacements between each CPD by holding the caliper parallel to the occlusal plane based on the protocol defined by Little (4). Vertical displacements between CPDs were not evaluated.

Statistical Analysis

All statistical analyses were performed using the Statistical Package for Social Sciences version 22.0 (IBM Corp, Armonk, NY, USA). Statistical significance was set at $p<0.05$. Data was normally distributed.

The repeatability of measurements for the same examiner was evaluated using ICC, and the mean differences between two measurements were calculated with paired *t*-test. Reproducibility was evaluated with intra-class correlation coefficient (ICC) that is defined as "the proportion of the total variance due to the between subject variance" (17). The comparison among three examiners for CPD differences was performed using analyses of variance (ANOVA).

Table 2. Intra-class correlation coefficients for intra-examiner reproducibility and inter-examiner reliability

	Contact points					Sum
	33-32	32-31	31-41	41-42	42-43	
Intra-examiner reproducibility						
First examiner	0.986	0.986	0.973	0.979	0.928	0.985
Second examiner	0.978	0.96	0.947	0.967	0.933	0.978
Third examiner	0.950	0.961	0.974	0.962	0.916	0.961
Inter-examiner reliability						
First measurements	0.969	0.972	0.970	0.961	0.875	0.975
Second measurements	0.963	0.971	0.971	0.941	0.875	0.971

All ICC's were statistically significant at p=0.000 level

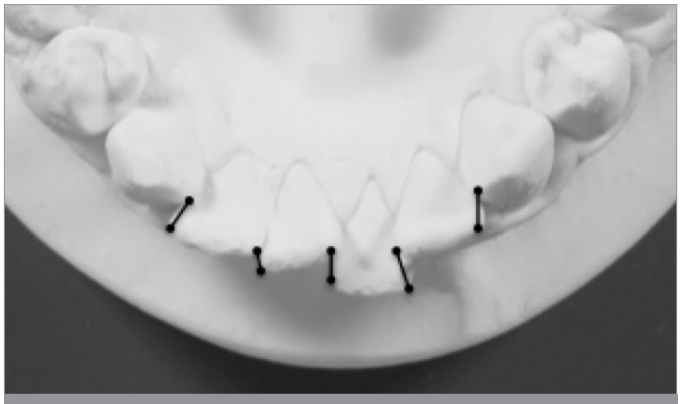

Figure 1. The measurement of contact point displacements

RESULTS

The mean, standard deviation, and mean differences for each of the five CPD (LR 3/2, LR 2/1, L 1/1, LL 1/2, and LL 2/3) measurements for two different time points are given in Table 1. Three out of five measurements for the first examiner and two out of five measurements for the second and third examiners were found to be different between first and second measurements. For all examiners, the sum of CPDs (LII) between time points was found to be different and statistically significant. The differences were 0.69 mm, 0.66 mm, and 1.30 mm for the first, second, and third examiner, respectively. The one-way ANOVA showed statistically significant difference for one measurement (LR 3/2) among examiners. The differences between first and second, and second and third examiners were statistically significant (p=0.011).

Intra-class correlation coefficients for intra-examiner reliability ranged between 0.916 and 0.986 (Table 2). Thus, high intra-examiner reproducibility was recorded (ICC>0.750). Also, ICC for inter-examiner reliability ranged between 0.739 and 0.984. ICCs for sum of CPDs (irregularity index) were higher than 0.750.

The difference more than 1.5 mm between repeated measurements was assumed as clinically relevant; 15% measurements of examiner 1, 5% measurements of examiner 2, and 45% measurements of examiner 3 were more than 1.5 mm. These were 25%, 80%, and 65% for inter-examiner measurements.

DISCUSSION

Several authors have reported high correlation coefficients for repeatability of LII measured on casts by different examiners (8, 14, 16, 18, 19). Similar to the above-mentioned studies, high ICCs were found for the repeated measures of the same investigator and the measurement of investigator couples in this study.

To generalize an acceptable level of orthodontic reliability, Roberts and Richmond (20) suggested that an ICC value of R below 0.4 is poor reliability, between 0.4 and 0.75 is fair to good, and above 0.75 is excellent. In this study, intra-examiner and inter-examiner measurements were found to be statistically correlated (ICC>0.75), while only one value indicates good and the others are excellent for inter-examiner reliability (Table 2). On the other hand, even if the correlations were found high, when the CPDs more than 1.5 mm was assumed as clinically relevant, the percentages of examiner reproducibility values were found relatively variable (Table 2). The correlation coefficients showed a linear relationship between two measurements, but it does not necessarily indicate a direct relationship (13). Therefore, the high correlation coefficients reported in the literature may be deceptive in interpreting examiner reliability. Macauley et al. (16) evaluated coefficients of variation, and reported significant differences among examiners.

In this study, five CPDs that constitute the LII score were statistically analyzed separately different from the literature (4, 8, 13, 14, 18, 21). As the LII has a cumulative nature, single CPD measurement errors magnified when the total amount was calculated as LII score. Sjögren et al. (13) evaluated the reliability of LII between two examiners who had been given written manuals and 8 h of calibration of the measuring technique before study. They found differences and variability between examiners, and reported that the technique is not an appropriate tool to measure the irregularity (13). As the experience of using the index increases, further studies may be performed to find if the rate of error will decrease.

The Little's Irregularity Index evaluation on conventional plaster casts may be challenging because of the use of hand-held cali-

pers that need to be kept parallel to the occlusal plane. In addition, the researcher brought the anatomical tooth contact points "by eye" in line with the caliper tips, without using magnification. If the contact point cannot be reached due to crowding, determination of the contact point as the most probable point may lead to individual differences in measurements. With the advances in digital technology and orthodontics, plaster casts started to be replaced by digital study models (22, 23). Treatment results have been predictably determined with great accuracy using intra-oral scanners (24).

Almasoud and Bearn (14) compared the LII reliability between photographic and cast model assessments, and they showed excellent inter-examiner reliability. They concluded that measurements made on photographic images were reliable and repeatable. They encountered problems with study models like storing models, random assignment, measuring overlapped contact points, and wearing of the model surfaces (14).

The correlation of examiners with ICC was found to be excellent in this study. However, when the difference of 1.5 mm among measurements was set as clinically relevant, the examiners showed different ratios between their own measurements and among themselves. Therefore, according to the repetitive measurements, irregularity index may be a misleading index to determine anterior alignment especially when measuring small CPDs. Photographic and 3D model assessment with LII may be more useful to determine anterior displacement. Future researches are needed to evaluate the accuracy of LII on photographs and digital models.

LII should be performed with great caution to determine anterior alignment especially when measuring small (<0.05) CPDs. The examiner training could be an important factor, and it must be taken into account.

CONCLUSION

Within the limitations of this study, following conclusions may be drawn;

- Correlation of reproducibility of the LII was found statistically high between inter-examiners and intra-examiners.
- The reproducibility of the LII of small CPDs is low.
- Irregularity index may be a misleading index to determine anterior alignment especially when measuring small CPD.

Ethics Committee Approval: Ethics committee approval was received for this study from the Ethics Committee of İzmir Katip Çelebi University (no. 210).

Informed Consent: N/A

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REFERENCES

1. Edwards JG. A long-term prospective evaluation of the circumferential supracrestal fiberotomy in alleviating orthodontic relapse. Am J Orthod Dentofac Orthop 1988; 93: 380-7. [CrossRef]
2. Reitan K. Tissue rearrangement during retention of orthodontically rotated teeth. Angle Orthod 1959; 29: 105-13.
3. Surbeck BT, Årtun J, Hawkins NR, Leroux B. Associations between initial, posttreatment, and postretention alignment of maxillary anterior teeth. Am J Orthod Dentofac Orthop 1998; 113: 186-95. [CrossRef]
4. Little RM. The irregularity index: a quantitative score of mandibular anterior alignment. Am J Orthod 1975; 68: 554-63. [CrossRef]
5. Little RM. Stability and relapse: early treatment of arch length deficiency. Am J Orthod Dentofac Orthop 2002; 121: 578-81. [CrossRef]
6. Littlewood SJ, Millett DT, Doubleday B, Bearn DR, Worthington HV. Retention procedures for stabilising tooth position after treatment with orthodontic braces. Cochrane Database Syst Rev 2006; 1: https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD002283.pub4/full. [CrossRef]
7. Pandis N, Polychronopoulou A, Eliades T. Active or passive self-ligating brackets? A randomized controlled trial of comparative efficiency in resolving maxillary anterior crowding in adolescents. Am J Orthod Dentofac Orthop 2010; 137: 12-3. [CrossRef]
8. Wahab RM, Idris H, Yacob H, Ariffin SH. Comparison of self-and conventional-ligating brackets in the alignment stage. Eur J Orthod 2012; 34: 176-81. [CrossRef]
9. Rowland H, Hichens L, Williams A, Hills D, Killingback N, Ewings P, et al. The effectiveness of Hawley and vacuum-formed retainers: a single-center randomized controlled trial. Am J Orthod Dentofac Orthop 2007; 132: 730-7. [CrossRef]
10. Thickett E, Power S. A randomized clinical trial of thermoplastic retainer wear. Eur J Orthod 2010; 32: 1-5. [CrossRef]
11. Destang D, Kerr W. Maxillary retention: is longer better? Eur J Orthod 2003; 25: 65-9. [CrossRef]
12. Sadowsky C, Schneider BJ, BeGole EA, Tahir E. Long-term stability after orthodontic treatment: nonextraction with prolonged retention. Am J Orthod Dentofac Orthop 1994; 106: 243-9. [CrossRef]
13. Sjögren AP, Lindgren JE, Huggare JÅ. Orthodontic study cast analysis-reproducibility of recordings and agreement between conventional and 3D virtual measurements. J Digit Imaging 2010; 23: 482-92. [CrossRef]
14. Almasoud N, Bearn D. Little's irregularity index: photographic assessment vs study model assessment. Am J Orthod Dentofac Orthop 2010; 138: 787-94. [CrossRef]
15. Harris EF, Vaden JL, Williams RA. Lower incisor space analysis: a contrast of methods. Am J Orthod Dentofac Orthop 1987; 92: 375-80. [CrossRef]
16. Macauley D, Garvey TM, Dowling AH, Fleming GJ. Using Little's Irregularity Index in orthodontics: Outdated and inaccurate? J Dent 2012; 40: 1127-33. [CrossRef]
17. Giraudeau B, Mary JY. Planning a reproducibility study: how many subjects and how many replicates per subject for an expected width of the 95 per cent confidence interval of the intraclass correlation coefficient. Stat Med 2001; 20: 3205-14. [CrossRef]
18. Bernabé E, Flores-Mir C. Estimating arch length discrepancy through Little's Irregularity Index for epidemiological use. Eur J Orthod 2006; 28: 269-73. [CrossRef]

19. Dowling AH, Burns A, Macauley D, Garvey TM, Fleming GJ. Can the intra-examiner variability of Little's Irregularity Index be improved using 3D digital models of study casts? J Dent 2013; 41: 1271-80. [CrossRef]
20. Roberts C, Richmond S. The design and analysis of reliability studies for the use of epidemiological and audit indices in orthodontics. Br J Orthod 1997; 24: 139-47. [CrossRef]
21. Little RM, Riedel RA, Artun J. An evaluation of changes in mandibular anterior alignment from 10 to 20 years postretention. Am J Orthod Dentofac Orthop 1988; 93: 423-28. [CrossRef]
22. Syrek A, Reich G, Ranftl D, Klein C, Cerny B, Brodesser J. Clinical evaluation of all-ceramic crowns fabricated from intraoral digital impressions based on the principle of active wavefront sampling. J Dent 2010; 38: 553-9. [CrossRef]
23. Stevens DR, Flores-Mir C, Nebbe B, Raboud DW, Heo G, Major PW. Validity, reliability, and reproducibility of plaster vs digital study models: comparison of peer assessment rating and Bolton analysis and their constituent measurements. Am J Orthod Dentofac Orthop 2006; 129: 794-803. [CrossRef]
24. Quimby ML, Vig KW, Rashid RG, Firestone AR. The accuracy and reliability of measurements made on computer-based digital models. Angle Orthod 2004; 74: 298-303.

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Original Article

Effect of CO2 Laser on the Prevention of White Spot Lesions During Fixed Orthodontic Treatment: A Randomized Clinical Trial

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ABSTRACT

Objective: This study aimed to assess the effect of carbon dioxide (CO2) laser on prevention of white spot lesions (WSLs) associated with fixed orthodontic treatment.

Methods: In this parallel controlled trial, 554 maxillary anterior teeth in 95 patients with age range of 12-30 years were included. The samples were randomly divided in two groups: 1) CO2 laser (n=278) and 2) control (n=276) groups. Following bracket attachment, the teeth in the laser group were exposed to CO2 laser (0.4 mw, 10.6 µm, 5 Hz) for 20 s, and the control group received placebo light. Incidence, severity, and extent of the lesions were assessed in four surface regions (gingival, incisal, mesial, and distal) at baseline and 6 months post-irradiation. The inter-group comparison was performed by the Mann-Whitney U test and McNemar analysis.

Results: A significant difference regarding WSLs incidence in all teeth was observed between the two study groups ($p<0.001$). The two study groups illustrated a significant difference in lesion extent and incidence in incisal, mesial, and distal regions ($p<0.05$). The WSLs were significantly different in terms of severity in the incisal and mesial sites ($p<0.05$).

Conclusion: The CO2 laser irradiation seemed to effectively prevent incidence of WSLs. In addition, its effectiveness varied depending on the surface region.

Keywords: Carbon dioxide laser, clinical trial, orthodontic treatment, white spot lesion

INTRODUCTION

One of the most common side effects of fixed orthodontic appliances is white spot lesions (WSLs) around the orthodontic bands and brackets (1). Fixed brackets increase the number of susceptible sites to plaque accumulations, and they disturb the balance between enamel demineralization and remineralization processes. This phenomenon ultimately leads to mineral loss and development of WSLs (2). WSLs are enamel subsurface porosities with an opaque milky-white appearance. Previous studies estimated the incidence of these lesions in the fixed orthodontic treatments ranging from 50%-70% (2, 3). Øgaard et al. (4) demonstrated that prevalence of this condition is significantly higher in orthodontic patients even five years post-treatment. Thus, prevention of WSLs is crucial to inhibit the smile esthetics from being compromised.

One method to increase caries resistance is laser irradiation. CO_2 laser is one of the most popular and efficient sources of coherent electromagnetic waves in the infrared spectrum introduced by Patel et al. (5) in 1964. Several

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studies have suggested that CO_2 laser is most effective in prevention of caries, whilst some researches assumed that it was more effective on the soft tissues (6-8). Rodrigues et al. (7) showed that CO_2 laser irradiation increased the acid resistance of enamel due to change in the hydroxyapatite crystals. The CO_2 laser irradiation is assumed to coincide with the absorption bands of carbonate, phosphate, and hydroxyl groups in the enamel and dentin structure. Accordingly, temperatures increasing at the enamel surface and subsurface result in the chemical and structural alterations, such as carbonate content reduction, decomposition of organic matrix, crystals formation of hydroxyapatite, and finally more resistance to acidic attacks (9). Also, Esteves-Oliveira et al. (6) observed less mineral loss and the re-hardening of softened enamel in the samples treated only by CO_2 laser; however, the combination of fluoride and subsequent CO_2 laser irradiation was effective on the inhibition of surface microhardness change. Moreover, they explained that the crystal growth related to the temperature variations, bigger crystals, and less crystallographic imperfections could be the reason for this improvement in hardness. In 2017, Paulos et al. (8) conducted a research on 65 human teeth to study the effect of CO_2 and Nd:YAG laser alone and in combination with fluoride on prevention of enamel caries after periodic acidic challenges. Their findings showed that CO_2 laser alone (with a wavelength of 10.6 µm) prevented enamel demineralization around the brackets even after repeated acidic challenges, and therefore had a deeper effect. In addition, Ramalho et al. (10) concluded that when compared to the fluoride group in all storage periods, both CO_2 laser irradiation alone and the combined fluoride-laser treatment caused less mineral loss. Laser and fluoride have synergistic effect, and they improve the acid resistance of enamel that may be due to the organic matrix removal, enhanced fluoride uptake, and larger surface area for ions binding, including calcium and fluoride. Fluoride changes the bacterial plaque, alters demineralization and remineralization process, and induces calcium fluoride deposition and formation of the fluorohydroxyapatite crystals. These effects depend on the retention of the reaction products over time. Because the several times of topical fluoride application are essential to maintain the anti-caries effect, lasers are alternatively used to prevent caries because of the strong interaction with dental hard tissues (11).

Many studies have been conducted on the effect of CO_2 laser on caries prevention or microhardness enhancement in laboratory conditions (6, 7). Because the scarce numbers of the clinical studies have been focused on this topic, this study aimed to assess the effect of CO_2 laser on the prevention, severity, and the extent of WSLs in clinical conditions. Our hypothesis was that CO_2 laser irradiation has preventive effect on WSLs during fixed orthodontic treatment.

METHODS

This double blind controlled clinical trial began April 2017 in Department of Orthodontics at Hamadan School of Dentistry, Iran. This research was approved by the ethics committee with IR.UMSHA.REC.1396.146 code and registered at www.irct.ir with IRCT2017052927362N2 identifier. The eligible patients were recruited from the Department of Orthodontics at Hamadan Dental School and an orthodontic clinic. The patients were included if they were 12-30 years old with maxillary anterior teeth and required orthodontic treatment. Because the number of patients referred to the department and clinic was low, the age range was considered wide. Also, medical and dental history, intraoral clinical and radiographic examinations were performed. The patients had to accept all the study procedures and protocols, and also had to sign an individual health information disclosure form to use the study data as anonymous for research. The patients who had systemic disorders or medical conditions that would affect oral health (such as HIV, diabetes) and those using drugs that cause xerostomia and un-cooperative patients were excluded from the study. Also, the patients with enamel disorders, such as fluorosis and enamel hypoplasia, were excluded from the study. In addition, the patients with severe crowding in anterior teeth were excluded because of difficulties in laser irradiation to all regions of teeth. The treatment protocols were not important in the patient selection and included extraction or non-extraction treatments.

In this study, 584 teeth from 100 patients were included. Five patients (two patients from the laser group and three from the control group) dropped from the study (four patients moved out of the city and one died). Ultimately, 554 teeth from 95 patients were included in this study. Among them, 35 were male and 60 were female. An informed consent was taken from each patient. The patients were randomly allocated to two groups:

- Laser group (278 teeth from 48 patients)
- Control groups (276 teeth from 47 patients)

Randomization and Blinding

Stratified randomization was performed by permuted blocks based on age (12-20.99 and 21-30 years) and gender. A block size 4 was placed in an envelope. The envelopes were numbered and sealed, and the principal investigator performed the randomization. The patients, the data analyst, and the observers performing the measurements during 6 months were kept blinded to the treatment.

Bonding the Brackets

At the baseline, the teeth were cleaned and polished by water slurry of pumice and rubber cup. Afterwards, the teeth were isolated and treated with 37% phosphoric acid (MorvaEtch, Iran) for 20s. Enamel surfaces were rinsed with distilled water for 15s, and dried with air spray for 15s to remove acid etching gel completely. Adhesive bonding agent (Adper™ single bond, 3M ESPE, USA) was applied on the enamel surfaces according to the manufacturer's instruction, and then was cured for 20s using a light curing unit (Kerr, Orange, Kalif). Fluoride-free Transbond XT resin composite (3M Unitek, Monorovia, California, USA) was applied, and stainless steel brackets with slot size of 22 (3M Unitek, Monorovia, California, USA) were placed while excess composite was removed. Resin composites were cured for 20s (Kerr, Orange, Kalif) with a light intensity of 650 mW/cm^2 from occlusal, gingival, mesial, and distal directions. Finally, the teeth were desiccated with air spray to identify and record any WSLs according to the scoring index.

Laser and Sham Light Irradiation

In the laser group, the maxillary anterior teeth were exposed to CO_2 laser (10.6 µm wavelength, 0.4 mw power, 5 Hz frequency, 0.2 mm diameter, and 9 s pulse time). Laser irradiation was performed by one operator (SK) for 20 s with 5 mm distance from the buccal surface and constant backward and forward movements. Sham light was also irradiated to the samples of the control group with the same protocol. We used Sham light as a placebo light.

To control oral hygiene and other risk factors in both groups, the patients were advised to brush their teeth with a soft toothbrush and fluoridated toothpaste and dental floss twice a day (Crest, 1100 ppm F). Also, they were instructed to avoid the acidic food or drinks and too much sugar.

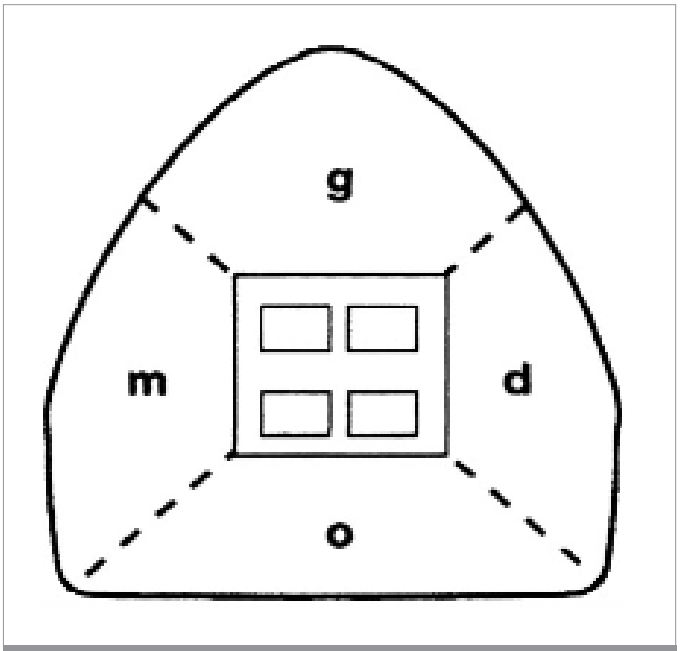

Figure 1. In enamel decalcification index score the tooth surface was divided into four regions occlusal (o), mesial (m), gingival (g), and distal (d); and each region was scored; no decalcification (0), decalcification <50% (1), decalcification >50%, (2) and 100% decalcification (3).

Data Collection Tool

The patients were recalled 6 months post-irradiation, and the incidence, extent, and severity of the lesions were assessed. The data were recorded in two steps:

1) At the base line: one week after brackets bonding
2) Six months later

To avoid false-positive results, the baseline assessment was performed one week after the brackets bonding. During this time, chalky appearance of enamel due to acid etching is disappeared. In each stage, the teeth were examined for the incidence, extent, and severity of WSLs, and several photographs were prepared in baseline and after 6 months. The photographic protocols were standardized and performed by one operator (SK). Five intra-oral photographs (one of the central regions, two of the right and left laterals, two of the right and left canines) were obtained by an SLR camera (Canon 550D, resolution: 18.0 megapixels) with standardized dpi, shade, color, and light. All images were taken from one angle that was perpendicular to the center of the brackets.

- WSLs' incidence

Visual inspection was carried out by two blinded observers. The number of teeth and regions with WSLs at baseline was subtracted from those with WSLs after 6 months, and the differences demonstrated the incidence.

- WSLs' extent

Enamel decalcification index score was used to measure the extent of the lesions (12) (Figure 1). First, the tooth surface was divided into four regions: incisal (i), mesial (m), gingival (g), and distal (d). WSLs were measured by the Digimizer software, and the proportion of each defect was calculated by dividing it into the total surface area. Two observers calculated the extent of the defects for each tooth region by enamel decalcification index score. After measuring the extent of the defects, they were scored as follows: no decalcification (0), decalcification <50% (1), decalcification >50%, (2) and 100% decalcification (3) (Figure 2, 3). The overall score of each tooth was calculated at each time-point, and then the 6-month scores were subtracted from the baseline to measure the change in the lesions.

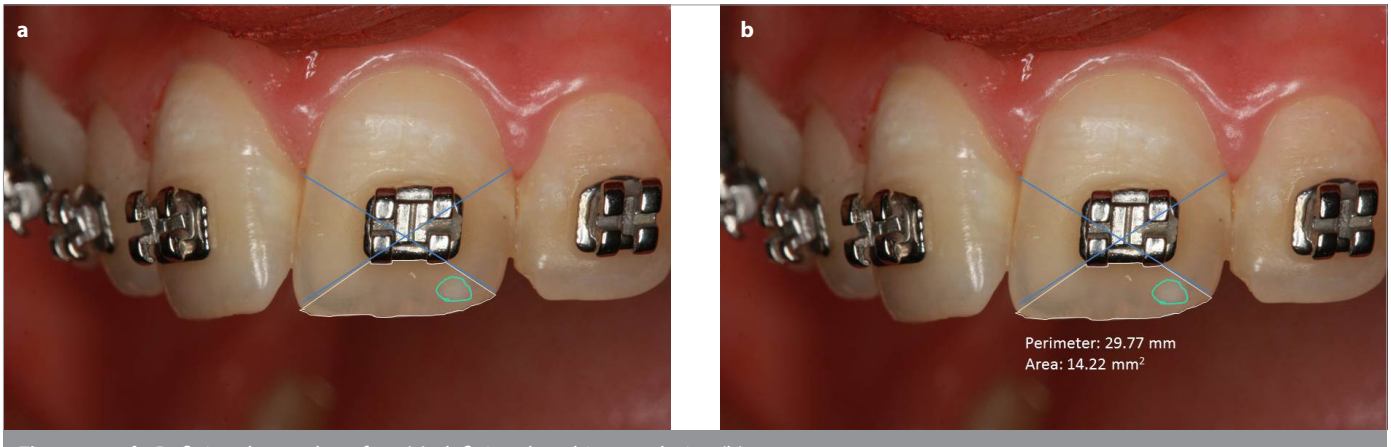

Figure 2. a, b. Defining the tooth surface (a), defining the white spot lesion (b)

- WSLs' severity

Clinical assessment and caries severity was measured by the following scoring index (13):

0: lack of WSL or any surface roughness (lack of demineralization)

1: WSL without any surface irregularity (mild demineralization)

2: WSL with rough surface but no restoration is required (intermediate demineralization)

3: WSL requiring restorative treatment (severe demineralization)

Each tooth was assigned an overall score, and the differences between the baseline and 6-month values were calculated.

Sample Size

To determine the sample size for each group, a priori power analysis was conducted as follows:

$$n = \frac{(z_{\alpha/2} + z_{\beta})^2 (p_1(1-p_1) + p_2(1-p_2))}{(p_1 - p_2)^2}$$

p1: 26% of the lesion incidence in the control group

p2: 16% of the lesion incidence in the test group

The data for this power analysis were obtained from a previous study (14). Significance level was considered as 95% and power was 80%. By inserting the minimum values in the above formula, the sample size was calculated as 548 teeth (274 per group).

Data Analysis

The development of WSLs between two time points was measured by logistic regression (generalize estimating equations, GEE). The inter-group comparison was performed by the Mann–Whitney test. The incidence, severity, and extent of the lesions in two time points in each group were compared by the McNemar analysis. The correlation between each tooth (central, lateral, or canine) and risk of WSL development in every individual overtime was assessed by GEE analysis (generalized estimating equations). All analyses were performed by Statistical Package for Social Sciences version 22.0 (IBM Corp.; Armonk, NY, USA), and significance level was considered <0.05. In addition, the inter-observer reliability and agreement was estimated by Kappa.

RESULTS

No significant difference was observed between the two study groups (p>0.05). The type of teeth had no significant effect on development of WSLs (p>0.05), whereas there were significant differences between two time points (p=0.005).

A significant difference was observed in incidence of WSLs between baseline and 6 months post-irradiation in the control group (p<0.05); however, there was no significant difference in the laser group (p>0.05) (Table 1, 2). Also, the region of tooth surface had a significant effect on WSLs (Table 3). Laser exposure was significantly effective on incisal, mesial, and distal regions (p<0.05), whereas it was not effective in the gingival sites (p>0.05) (Table 3, 4). The inter-observer agreement was estimated almost perfect (Kappa=99%).

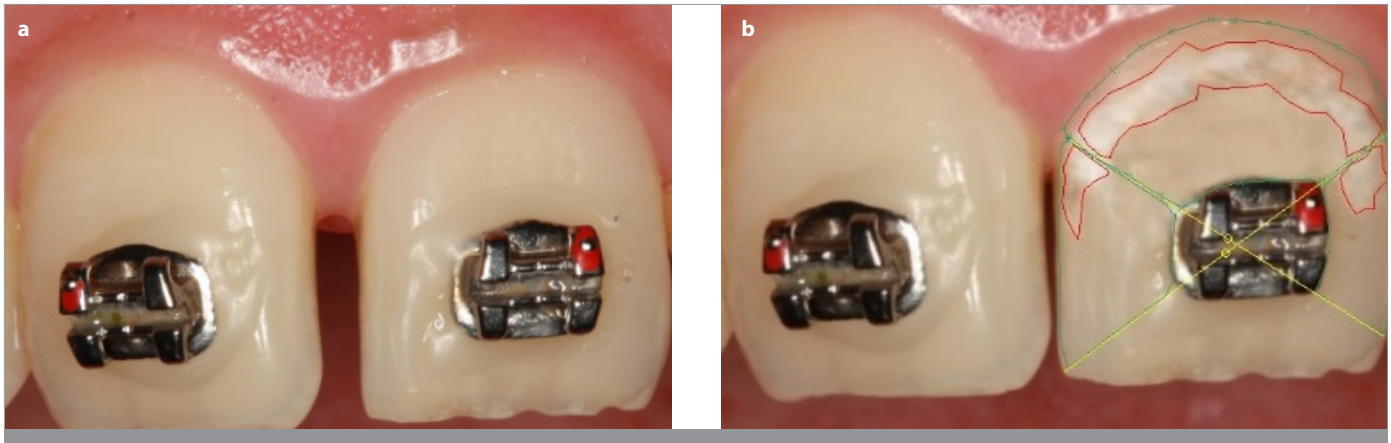

Figure 3. a, b. Without WSL at baseline (a), with WSL at 6 months follow-up (b)

Table 1. Incidence of WSLs in the laser and control groups at baseline and 6 months post-irradiation. Negative values show reduction in the incidence of lesions, and positive values show an increase in the incidence of lesions. The Mann-Whitney U test was used to compare the changes in the groups

Group	6-month baseline	WSL+	WSL–	Total	p
Laser	WSL+	29 (10.4%)	9 (3.2%)	38 (13.7%)	1.00
	WSL–	10 (3.6%)	230 (82.7%)	240 (86.3%)	
	Total	39 (14%)	239 (86%)	278(100%)	
Control	WSL+	18 (6.5%)	0 (0%)	18 (6.5%)	<0.001
	WSL–	24 (8.7%)	234 (84.8%)	258 (93.5%)	
	Total	42 (15.2%)	234 (84.8%)	276 (100%)	

Table 2. Comparison of affected teeth with WSLs in baseline and after 6 months between two study groups

	Change in WSLs' number				
Group	**Negative**	**No change**	**Positive**	**Total**	**p**
Laser	9 (3.24%)	259 (93.16%)	10 (3.6%)	278 (100%)	<0.001
Control	0 (0%)	252 (91.3%)	24 (8.7%)	276 (100%)	
Total	9	511	34	554	

Table 3. Comparison of WSLs' change in different regions of tooth surface between groups

		Change in regions				
Region	**Group**	**Negative**	**No change**	**Positive**	**Total**	**p**
Gingival	Laser	2	269	7	278	0.245
	Control	0	266	10	276	
Incisal	Laser	6	272	0	278	0.003
	Control	3	263	10	276	
Mesial	Laser	5	270	3	278	0.005
	Control	0	266	10	276	
Distal	Laser	3	274	1	278	0.02
	Control	0	271	5	276	

Table 4. Comparison of WSLs' extent change in different regions of tooth surface between groups

		Change in WSLs' extent				
Region	**Group**	**-1**	**No change**	**+1**	**Total**	**p**
Gingival	Laser	5	267	6	278	0.073
	Control	0	267	9	276	
Incisal	Laser	9	269	0	278	<0.001
	Control	0	266	10	276	
Mesial	Laser	5	270	3	278	0.018
	Control	1	266	9	276	
Distal	Laser	3	275	0	278	0.008
	Control	0	272	4	276	

Table 5. Comparison of WSLs' severity change in different regions of tooth surface between groups. The negative values demonstrated a decrease in the severity of WSL and vice versa; +2 and –2 values were not detected in any group.

		Change in WSLs' severity						
Region	**Group**	**–3**	**–1**	**No change**	**+1**	**+3**	**Total**	**P-value**
Gingival	Laser	-	3	268	7	-	278	0.123
	Control	-	0	265	11	-	276	
Incisal	Laser	-	6	272	0	-	278	<0.001
	Control	-	0	266	10	-	276	
Mesial	Laser	1	5	269	1	2	278	0.005
	Control	0	0	267	9	0	276	
Distal	Laser	-	3	273	1	1	278	0.058
	Control	-	0	271	5	0	276	

Analysis of 554 teeth at baseline estimated 22 centrals, 19 laterals, and 15 canines with WSLs. In the other words, the counts of WSLs at baseline were 38 in the laser group and 18 in the control group. After 6 months of laser irradiation, 27 centrals, 31 laterals, and 23 canines were affected. The severity changes of WSLs in different regions of tooth surfaces are shown in Table 5. Accordingly, laser exposure did not have a significant effect on the severity of lesions in the gingival and distal regions (p>0.05); however, it significantly affected the incisal and mesial regions (Table 5).

DISCUSSION

WSLs may develop 6-12 months or even one month after bracket bonding (1). Because the previous studies have shown that there

was no significant difference between the number of lesions in 6 and 12 months post-bonding (13, 15), we set a 6-month time frame to study the incidence and changes of WSLs. In the control group, new WSLs were developed in 8.7% cases during 6 months. Some studies have presented similar results to ours, 10.8% (16) and 7.53% (17) WSLs during the study however; some other studies demonstrated a rate of 30% which is further than ours (18). In addition, this study demonstrated a significant difference between the two study groups in terms of WSLs incidence after 6 months. The CO_2 laser application demonstrated improvement of the baseline lesions and incidence of fewer lesions during 6 months. It is assumed that laser induces the chemical change in the subsurface crystals of enamel and eliminates caries by remineralization (19).

Several studies, such as this one, have examined the effect of CO_2 laser with a wavelength of 10.6 µm on preventing demineralization or increasing microhardness (20, 21). Some of them did not detect any significant change in the enamel microhardness after laser irradiation. They showed that the pulsed CO_2 laser irradiation alone was not able to inhibit the surface looseness of dentin and enamel due to erosion (14, 22). On the contrary, other studies showed that CO_2 laser irradiation could prevent caries lesions progression up to about 80%. They explained that this effect depended on the number of pulses used, but there was no correlation between the caries resistance and morphological changes in the enamel surface (21). CO_2 laser irradiation with 10.6 µm wavelength inhibits WSLs' development hypothetically by the prevention of demineralization, increased enamel microhardness, and acid resistance (5, 8, 19, 23, 24). This effect was explained by reduced solubility either by physical melting and fusion or by re-crystallization of the enamel (25). Several studies have also shown the positive effect of CO_2 laser with other wavelengths on the enamel hardness (26, 27). On the other hand, Stangler et al. (28) and Rechmann et al. (24) exhibited that the CO_2 laser irradiation around the orthodontic brackets with or without topical fluoride was effective on inhibiting caries. The controversy between our results and some studies may be explained by the differences in laser parameters, sample size, measurement methods, and inclusion criteria.

The results of this study showed that laser irradiation had no significant effect on the development of gingival lesions, whereas it was effective on the incisal, mesial, and distal regions. The extent of the lesions in the incisal, mesial, and distal regions reduced significantly after CO_2 laser irradiation, whereas laser had no significant effect on the gingival region. In addition, the severity of the lesions did not change in the gingival and distal areas but significantly reduced in the mesial and incisal regions. Probably because of the structural differences and the enamel thickness in the gingival region, laser was not effective in this area (29). Because the WSLs commonly affect the gingival regions (30), the laser parameters should be changed in these areas to have a positive effect on the reduction of these lesions. Also, the oral hygiene improvement could reduce the incidence of the gingival lesions (due to more plaque accumulation).

Some studies have reported that caries susceptibility increased significantly in pre-adolescent (≤16 years) when compared to adolescents (>16 years) (17, 31-33). But in this study, selecting or randomization based on the age was only performed for normal distribution of the patients in both groups. Also, the used CO2 laser parameters in this study were 10.6 µm wavelength, 0.4 mw power, 5 Hz frequency, and 9 s pulse time. In the previous study, laser etching of enamel surface by CO2 laser at 3 We showed an increased temperature of 3.5°C that was within the acceptable physiologically limitations of the pulp (33). Also, in another study, all irradiated samples with pulsed CO_2 laser at 10.6 µm wavelength, and 2, 4, 6, 8, and 10 watts power showed an increased intrapulpal temperature below 3°C (34).

This study was novel in the field of clinical assessment of CO_2 laser effect on the incidence, extent, and severity of WSLs in four regions of the tooth surfaces. Co-application of fluoride with CO_2 laser or irradiation with various laser parameters may be interesting topics for future studies. One limitation of this study was that the demineralization scoring was assessed subjectively. Nowadays, technology offers more objective solutions to caries assessment like diagnodent. But because of the high cost, we did not have access to it.

CONCLUSION

- Incidence of WSLs was significantly different between baseline and 6 months post-irradiation in the control group; however, there was no significant difference in the laser group.
- WSLs changes were affected by the region of tooth surface. Laser exposure was significantly effective on incisal, mesial, and distal regions, whereas it was not effective in the gingival sites.
- Laser exposure did not have a significant effect on the severity of the lesions in the gingival and distal regions; it significantly affected the incisal and mesial areas.

Ethics Committee Approval: Ethics committee approval was received for this study from the Research Ethics Committee of Hamadan University of Medical Sciences, Hamadan, Iran (ID: IR.UMSHA.REC.1396.146)

Informed Consent: Written informed consent was obtained from the patients who participated in this study.

Peer-review: Externally peer-reviewed.

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REFERENCES

1. Gavrilovic I. White Spot Lesions in Orthodontic Patients: Formation. Prevention and Treatment. J Oral Hyg Health 2014; 2: 1-3.
2. Øgaard B, Larsson E, Henriksson T, Birkhed D, Bishara SE. Effects of combined application of antimicrobial and fluoride varnishes in orthodontic patients. Am J Orthod Dentofacial Orthop 2001; 120: 28-35. [CrossRef]
3. Rolla G, Øgaard B. Oral microbiological changes, long-term enamel alterations due to decalcification, and caries prophylactic aspects. Orthodontic Materials: Scientific and Clinical Aspects Stuttgart, Thieme. 2001: 123-42.
4. Øgaard B. Prevalence of white spot lesions in 19-near-olds: A study on untreated and orthodontically treated persons 5 years after treatment. Am J Orthod Dentofacial Orthop 1989; 96: 423-7. [CrossRef]
5. Patel CKN. Selective Excitation Through Vibrational Energy Transfer and Optical Maser Action in N2-CO2. Phys Rev Lett 1964; 13: 617. [CrossRef]
6. Esteves-Oliveira M, Pasaporti C, Heussen N, Eduardo C, Lampert F, Apel C. Rehardening of acid-softened enamel and prevention of enamel softening through CO2 laser irradiation. J Dent 2011; 39: 414-21. [CrossRef]
7. Rodrigues LK, Nobre dos Santos M, Pereira D, Assaf AV, Pardi V. Carbon dioxide laser in dental caries prevention. J Dent 2004; 32: 531-40. [CrossRef]
8. Paulos RS, Seino PY, Fukushima KA, Marques MM, de Almeida FCS, Ramalho KM, et al. Effect of Nd: YAG and CO2 Laser Irradiation on prevention of enamel demineralization in orthodontics: in vitro study. Photomed Laser Surg 2017; 35: 282-6. [CrossRef]
9. Poosti M, Ahrari F, Moosavi H, Najjaran H. The effect of fractional CO2 laser irradiation on remineralization of enamel white spot lesions. Lasers Med Sci 2014; 29: 1349-55. [CrossRef]
10. Ramalho KM, Eduardo Cde P, Heussen N, Rocha RG, Lampert F, Apel C, et al. Protective effect of CO2 laser (10.6 µm) and fluoride on enamel erosion in vitro. Lasers Med Sci 2013; 28: 71-8. [CrossRef]
11. Mathew A, Reddy NV, Sugumaran D, Peter J, Shameer M, Dauravu LM. Acquired acid resistance of human enamel treated with laser (Er: YAG laser and CO2 laser) and acidulated phosphate fluoride treatment: An in vitro atomic emission spectrometry analysis. Contemp Clin Dent 2013; 4: 170-5. [CrossRef]
12. Robertson MA, Kau CH, English JD, Lee RP, Powers J, Nguyen JT. MI Paste Plus to prevent demineralization in orthodontic patients: a prospective randomized controlled trial. Am J Orthod Dentofacial Orthop 2011; 140: 660-8. [CrossRef]
13. Tufekci E, Dixon JS, Gunsolley J, Lindauer SJ. Prevalence of white spot lesions during orthodontic treatment with fixed appliances. Angle Orthod 2011; 81: 206-10. [CrossRef]
14. Steiner-Oliveira C, Nobre-dos-Santos M, Zero DT, Eckert G, Hara AT. Effect of a pulsed CO2 laser and fluoride on the prevention of enamel and dentine erosion. Arch Oral Biol 2010; 55: 127-33. [CrossRef]
15. Lucchese A, Gherlone E. Prevalence of white-spot lesions before and during orthodontic treatment with fixed appliances. Eur J Orthod 2012; 35: 664-8. [CrossRef]
16. Gorelick L, Geiger AM, Gwinnett AJ. Incidence of white spot formation after bonding and banding. Am J Orthod 1982; 81: 93-8. [CrossRef]
17. Julien KC, Buschang PH, Campbell PM. Prevalence of white spot lesion formation during orthodontic treatment. Angle Orthod 2013; 83: 641-7. [CrossRef]
18. Boersma J, Van der Veen MH, Lagerweij MD, Bokhout B, Prahl-Andersen B. Caries prevalence measured with QLF after treatment with fixed orthodontic appliances: influencing factors. Caries Res 2005; 39: 41-7. [CrossRef]
19. Fried D, Ragadio JN, Akrivou M, Featherstone JD, Murray MW, Dickenson KM. Dental hard tissue modification and removal using sealed transverse excited atmospheric-pressure lasers operating at lambda=9.6 and 10.6 microm. J Biomed Opt 2001; 6: 231-9. [CrossRef]
20. Lakshmi A, Shobha D, Lakshminarayanan L. Prevention of caries by pulsed CO2 laser pre-treatment of enamel: an in-vitro study. J Indian Soc Pedod Prev Dent 2001; 19: 152-6.
21. Kantorowitz Z, Featherstone JD, Fried D. Caries prevention by CO2 laser treatment: dependency on the number of pulses used. J Am Dent Assoc 1998; 129: 585-91. [CrossRef]
22. Mirhashemi AH, Hakimi S, Ahmad Akhoundi MS, Chiniforush N. Prevention of enamel adjacent to bracket demineralization following carbon dioxide laser radiation and titanium tetra fluoride solution treatment: an in vitro study. J Lasers Med Sci 2016; 7: 192-6. [CrossRef]
23. Tepper SA, Zehnder M, Pajarola GF, Schmidlin PR. Increased fluoride uptake and acid resistance by CO2 laser-irradiation through topically applied fluoride on human enamel in vitro. J Dent 2004; 32: 635-41. [CrossRef]
24. Rechmann P, Charland DA, Rechmann BM, Le CQ, Featherstone JD. In-vivo occlusal caries prevention by pulsed CO2-laser and fluoride varnish treatment-A clinical pilot study. Lasers Surg Med 2013; 45: 302-10. [CrossRef]
25. Nelson DG, Wefel JS, Jongebloed WL, Featherstone JD. Morphology, histology and crystallography of human dental enamel treated with pulsed low-energy infrared laser radiation. Caries Res 1987; 21: 411-26. [CrossRef]
26. Miresmaeili A, Farhadian N, Rezaei-Soufi L, Saharkhizan M, Veisi M. Effect of carbon dioxide laser irradiation on enamel surface microhardness around orthodontic brackets. Am J Orthod Dentofacial Orthop 2014; 146: 161-5. [CrossRef]
27. Rodrigues L, Dos Santos MN, Featherstone J. In situ mineral loss inhibition by CO2 laser and fluoride. J Dent Res 2006; 85: 617-21. [CrossRef]
28. Stangler LP, Romano FL, Shirozaki MU, Galo R, Afonso AM, Borsatto MC, et al. Microhardness of enamel adjacent to orthodontic brackets after CO2 laser irradiation and fluoride application. Braz Dent J 2013; 24: 508-12. [CrossRef]
29. Whittaker D. Structural variations in the surface zone of human tooth enamel observed by scanning electron microscopy. Arch Oral Biol 1982; 27: 383-92. [CrossRef]
30. Årtun J, Brobakken BO. Prevalence of carious white spots after orthodontic treatment with multibonded appliances. Eur J Orthod 1986; 8: 229-34. [CrossRef]
31. Chapman JA, Roberts WE, Eckert GJ, Kula KS, González-Cabezas C. Risk factors for incidence and severity of white spot lesions during treatment with fixed orthodontic appliances. Am J Orthod Dentofacial Orthop 2010; 138: 188-94. [CrossRef]
32. Al Maaitah EF, Adeyemi AA, Higham SM, Pender N, Harrison JE. Factors affecting demineralization during orthodontic treatment: a post-hoc analysis of RCT recruits. Am J Orthod Dentofacial Orthop 2011; 139: 181-91. [CrossRef]
33. Knösel M, Klang E, Helms H-J, Wiechmann D. Occurrence and severity of enamel decalcification adjacent to bracket bases and sub-bracket lesions during orthodontic treatment with two different lingual appliances. Eur J Orthod 2015; 38: 485-92. [CrossRef]
34. Steiner-Oliveira C, Rodrigues LK, Soares LE, Martin AA, Zezell DM, Nobre-Dos-Santos M. Chemical, morphological and thermal effects of 10.6-µm CO2 laser on the inhibition of enamel demineralization. Dent Mater J 2006; 25: 455-62. [CrossRef]

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Review

Orthodontic Approach to Patients with Autism: A Review

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ABSTRACT

Autism is a complex neurobehavioral disorder that causes problems in thinking, feeling, language, and the ability to communicate with other people. Over the past two decades, there has been a great deal of interest in autism disorder. This problem is recognized worldwide, and various measures are taken both nationally and internationally to improve the lives of affected individuals and families.

The oral health care of such patients can be complicated since they cannot express their problems and can show unpredictable behaviors during treatment. The aim of the literature review was to collect information about the general oral health status of patients with autism, the difficulties that may be encountered during treatment, and the precautions that can be taken and the treatment approaches. This article reviews the dental literature from 1943 to the present.

Keywords: Behaviour modification, autism, orthodontic approach

INTRODUCTION

Autism disorder (AD) was first identified by Leo Kanner, an American child psychologist, in 1943. He examined 11 children whose behaviors were clearly different from other children and suspected that there was an innate trait that impeded children's social relationships (1). AD was classified as infantile autism, childhood autism, and Kanner autism. Autism is a lifelong neurodevelopmental disorder, affecting children while they are young. Children with autism often exhibit multiple and complex deficiencies in their social, emotional, and communicative skills and repetitive behaviors (2).

Genetic and environmental factors are thought to be effective in the development of autism. Factors, such as *CNTNAP2* gene, de novo mutations, mitochondrial defects (3), increased level of inflammatory cytokines, maternal bleeding during pregnancy, metabolic syndromes, and advanced maternal age (4), are thought to be effective. Some patients with AD showed abnormal levels of serotonin or other neurotransmitters that can affect brain development. Prenatal factors, such as intrauterine viral infections or metabolic disorders and intrauterine exposures to teratogenic drugs, thalidomide, and valproate (5), may all play important roles in the pathogenesis of AD.

Oral Health and Oral Health Behavior

Various results have been found in studies on children with autism with regard to caries and periodontal status. In a population-based study, parents reported that their children's teeth were in worse condition than other children (6). On the other hand, some other studies have shown that there was no significant difference between individuals with autism and without autism with regard to the prevalence of cavity (7, 8). In some studies, low cavity frequency and severity were determined (9, 10). Some drugs used for patients with autism may affect the flow of saliva, and this may lead to an increased risk of cavity (11).

Blomqvist et al. (12) found that the risk of cavity increases in patients with autism due to less frequent brushing and reduction in saliva flow rate. In the same patient group, gingivitis was found to be low despite less teeth

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brushing frequency. Several factors can explain these findings; they had significantly more buccal surfaces with gingival recessions that indicate a persistent, intensive teeth brushing technique (possibly related to pervasive behaviors), and they also reported less frequent snacking, which generates lower levels of dental plaque (12).

In the study conducted by Jaber (13), it has been determined that patients with autism had a high risk of cavity, poor oral hygiene, and unmet treatment. Therefore, it was recommended to focus on protective practices (13). In another study, similar to the control group in individuals with autism, high gingival inflammation, poor oral hygiene, and low pH value in saliva were determined (14). Since children with autism have poor language coordination, they prefer soft and sugary foods and keep them in the mouth for long periods instead of swallowing. The risk of caries can be high due to the preference of this type of food, keeping foods in the oral cavity for a long time, lack of motor coordination, and high sensitivity to the taste of toothpaste, as well as difficulties in teeth brushing (15).

Oral Habits and Malocclusion

In addition to self-injurious behaviors, such as hitting with bare hands, banging their heads on walls and furniture, and pricking or pinching (16), oral habits, including bruxism, tongue thrusting, lip biting, and pica (eating objects and substances, such as gravel or pens), have been reported among children with autism (17). In a previous study, oral habits were higher in individuals with autism than in individuals without autism. The most common oral habit was found to be bruxism. Bruxism, tongue biting, object biting, and thumb sucking were significantly higher in children with autism than in the control group (18). These habits may contribute to significant dental problems, such as soft tissue injury, tooth loss, tooth wear, increased overjet, anterior open bite, and posterior crossbite (19). Deformation of the skeletal and dentoalveolar systems may occur due to the frequency and severity of the habit. Individuals with autism did not show a specific malocclusion, but a tendency to deep palate and anterior open bite was observed (20).

Difficulties Experienced During Dental Treatment

The hypersensitivity and sensory inputs of individuals with autism are difficult to predict and cause difficulties in dentistry because dentistry services are usually performed under bright light and include high sounds, strong flavors, or smells (21). There may be difficulties during treatment sessions due to the lack of communication and bonding abilities in children with autism. Failure of controlling emotions, recurrent body movements, and hyperactivity associated with attention deficit may also cause difficulties during treatment (22). In addition to these difficulties, the insufficient number of trained specialists and the low number of appropriate treatment environments make treatment difficult. In a previous study, it was found that individuals with autism who do not have a medical home and exhibit severe autistic features need a high level of treatment (23). In a study conducted in Riyadh, it was found that individuals serving in autism centers do not have sufficient knowledge and equipment about dental care (24).

Preventive Dental Care

Early and routine preventive dental care visits are crucial with regard to caries-risk assessment. Nevertheless, many people are unaware of the importance of primary teeth and do not perceive a need for preventive dental care for young children (25). Preventive practices are of particular importance for individuals with autism due to the high risk of cavities and difficult access to treatment services (26). Children with autism who have special health care needs had more dental visits involving restorative/surgical needs but were less likely to have preventive dental care visits than children who did not have special health care needs (27). Concurrently, it was determined that access to preventive practices was restricted due to unemployment and financial reasons (25). Obstacles in front of the preventive practices should be evaluated with regard to our community, and competent authorities should be informed.

Behavioral Management Approaches

The aim of the behavior management techniques is to reduce anxiety, to make a successful treatment by increasing compliance, and to establish a successful relationship between the specialist and the patient (28).

Communication

Communication guidance helps to establish trust and builds necessary cooperation. It is a technique that can be applied also to individuals with autism as it is applied to individuals without autism. It includes the following procedures: telling, showing, and doing immediate, frequent positive and negative reinforcements (29). "Tell–show–do" is a basic and effective exposure therapy and a way to introduce dental instruments, equipment, or procedures to a patient (30). The aim of the process is explained by using pictures and objects.

Desired behaviors are rewarded with positive empowerment. In this way, repetition of these behaviors is provided. Positive reinforcement can be done by verbal appreciation of a behavior and thanking. It is also a good way for the parent to be with the patient during the procedure (31).

Visual Pedagogy

In a study conducted in 1999, it was observed that patients with autism were treated with visual support technique (32). A picture book was used, and each session of the treatment was depicted in the book. Results showed that children were fully cooperative compared with controls. The expert can develop some exercises that can be performed at home by the individual with autism to be familiar with the instruments and the statements used during treatment (33).

Pharmacological Behavior Management Approaches

The effect of conscious sedation on children with autism may be variable. Conscious sedation can be selected as a treatment plan if the patient needs two surgery appointments or a minimum of dental treatment needs. Patients with autism can also be treated under general anesthesia (31).

Applied Orthodontic Treatments

In individuals with autism (PubMed, between 1979 and 2017), some treatments have been found, such as the use of removable

appliances containing nickel titanium (Ni Ti) spring to position the upper incisors behind, anterior crossbite correction, orthognathic surgery, and four premolar extractions.

Ozsoy and Bingöl (34) have successfully performed four premolar extraction treatments for a 17-year-old individual with autism who had Class I malocclusion, increased vertical growth angles, protruded upper and lower incisors, and inconsistent lip closure.

Methods, such as tell-show-do, voice control, positive reinforcement, and behavior modification, were used to increase patient's compliance during treatment. When the patient was afraid, he started to murmur his favorite song. The treatment was completed within 13 months (34). In a previous study, lower bone mineral density was detected in male patients with autism (35). The shortened treatment duration may be related to decreased bone mineral density levels, resulting in faster tooth movement. Gingival inflammation was observed due to poor oral hygiene during treatment (34).

The rates of angle Class II malocclusion characterized by increased overjet among patients with autism can be high (10). In many studies, it has been reported that the frequency of dental trauma is high in these patients due to increased overjet. When the overjet is >3 mm, the risk of dental trauma is doubled (36). Therefore, treatment of increased overjet is important. Saito et al. used Ni Ti spring with a removable orthodontic appliance to position the upper incisors behind.

Saito et al. (37) have made some suggestions for the success of such treatments as follows:

1. Appliances should be as small as possible because hyperesthesia can be seen in patients with autism.
2. Appliances should be reinforced with the help of wires.
3. Ni Ti wire must not come into contact with opposite teeth because occlusal forces can break the wire.

As a result of the study, it has been found that removable orthodontic appliances with reinforced resin infrastructure and Ni Ti wire can be used for such patients (37). In another study, it was observed that a patient with anterior crossbite could tete-a-tete position the incisors when he is given a muscle relaxant under general anesthesia. At the second session of general anesthesia, the upper central teeth were placed on the acrylic bite plane. And at the next stage, the lower incisors were placed on the acrylic bite plane under general anesthesia. As a result of 12-month treatment, 3 mm overbite and 1 mm overjet were obtained (38).

In the literature, the treatment of a 12-year-old patient with autism is described in a case report. The patient had increased overjet, anterior open bite, vertical growth pattern, and tongue thrusting. Although the ideal treatment method was orthognathic surgery, an alternative method was applied because of the neurological problem of the patient. The treatment of the patient was successfully completed within 3 years by using Hyrax, high pull headgear, transpalatal arch, and elastics. Tongue thrusting was controlled by using a wrap around the appliance in the patient. The treatment was reported to be successful because treatment was performed with appropriate behavioral guidance techniques (39).

CONCLUSION

As each patient is an individual, a thorough understanding about each patient is necessary. The dental management of a child with AD requires in-depth understanding of the autistic behavioral profile. A treatment approach based on the correct behavior orientation will provide successful results.

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REFERENCES

1. Kanner L. Autistic disturbances of affective contact. Nervous child 1943; 2(3): 217-250.
2. Association AP, Diagnostic and statistical manual of mental disorders (DSM-5®)edn. American Psychiatric Pub 2013.
3. Dhillon S, Hellings JA, Butler MG. Genetics and mitochondrial abnormalities in autism spectrum disorders: a review. Curr Genomics 2011; 12: 322-32. [CrossRef]
4. Sandin S, Hultman CM, Kolevzon A, Gross R, MacCabe JH, Reichenberg A. Advancing maternal age is associated with increasing risk for autism: a review and meta-analysis. J Am Acad Child Adolesc Psychiatry 2012; 51: 477-86. [CrossRef]
5. Williams G, King J, Cunningham M, Stephan M, Kerr B, Hersh JH. Fetal valproate syndrome and autism: additional evidence of an association. Dev Med Child Neurol 2001; 43: 202-6. [CrossRef]
6. Kopycka-Kedzierawski DT, Auinger P. Dental needs and status of autistic children: results from the National Survey of Children's Health. Pediatric Dentistry 2008; 30: 54-8.
7. Bassoukou IH, Nicolau J, dos Santos MT. Saliva flow rate, buffer capacity, and pH of autistic individuals. Clin Oral Investig 2009; 13: 23-7. [CrossRef]
8. Rai K, Hegde AM, Jose N. Salivary antioxidants and oral health in children with autism. Arch Oral Biol 2012; 57: 1116-20. [CrossRef]
9. Loo CY, Graham RM, Hughes CV. The caries experience and behavior of dental patients with autism spectrum disorder. J Am Dent Assoc 2008; 139: 1518-24. [CrossRef]
10. Orellana LM, Silvestre FJ, Martínez-Sanchis S, Martínez-Mihi V, Bautista D. Oral manifestations in a group of adults with autism spectrum disorder. Med Oral Patol Oral Cir Bucal 2012; 17: 415-9. [CrossRef]
11. Hsia Y, Wong AY, Murphy DG, Simonoff E, Buitelaar JK, Wong IC. Psychopharmacological prescriptions for people with autism spectrum disorder (ASD): a multinational study. Psychopharmacology 2014; 231: 999-1009. [CrossRef]

12. Blomqvist MS, Bejerot S, Dahllöf G. A cross-sectional study on oral health and dental care in intellectually able adults with autism spectrum disorder. BMC Oral Health 2015; 15: 81. [CrossRef]
13. Jaber MA. Dental caries experience, oral health status and treatment needs of dental patients with autism. J Appl Oral Sci 2011; 19: 212-7. [CrossRef]
14. Diab HM, Motlaq SS, Alsharare A, Alshamery A, Alshammery N, Khawja SG, et al. Comparison of gingival health and salivary parameters among autistic and non-autistic school children in Riyadh. J Clin Diagn Res 2016; 10: 110-3. [CrossRef]
15. Mc Donald R, Avery D. Dentistry for the child and adolescent. St. Louis: Mosby-Year Book. Inc. 1994.p.601-11.
16. Weddell JA, Sanders BJ, Jones JE. Dental problems of children with special health care needs. In: McDonald and Avery's Dentistry for the Child and Adolescent (Tenth Edition). Editon edn: Elsevier 2016: 513-9. [CrossRef]
17. Medina AC, Sogbe R, Rey AMG, Mata M. Factitial oral lesions in an autistic paediatric patient. Int J Paediatr Dent 2003; 13: 130-7. [CrossRef]
18. Al-Sehaibany FS. Occurrence of oral habits among preschool children with Autism Spectrum Disorder. Pak J Med Sci 2017; 33: 1156-60. [CrossRef]
19. Bell RA. Management of the developing occlusion. McDonald and Avery's Dentistry for the Child and Adolescent. 9th ed. Maryland Heights, Mo: Mosby Elsevier: 2011.p.550-613. [CrossRef]
20. Ozgen H, Hellemann GS, Stellato RK, Lahuis B, Daalen EV, Stall WG, et al. Morphological features in children with Autism spectrum disorders: A matched case-control study. J Autism Dev Disord 2011; 41: 23-31. [CrossRef]
21. Stein LI, Polido JC, Mailloux Z, Coleman GG, Cermak SA. Oral care and sensory sensitivities in children with autism spectrum disorders. Spec Care Dentist 2011; 31: 102-10. [CrossRef]
22. Klein U, Nowak A. Autistic disorder: a review for the pediatric dentist. Pediatric Dentist 1998; 20: 312-7.
23. McKinney CM, Nelson T, Scott JM, Heaton LJ, Vaughn MG, Lewis CW. Predictors of unmet dental need in children with autism spectrum disorder: results from a national sample. Acad Pediatr 2014; 14: 624-31. [CrossRef]
24. Murshid EZ. Dental knowledge of educators and healthcare providers working with children with autism spectrum disorders. Saudi Med J 2015; 36: 1477-85. [CrossRef]
25. Wiener RC, Vohra R, Sambamoorthi U, Madhavan SS. Caregiver Burdens and Preventive Dental Care for Children with Autism Spectrum Disorder, Developmental Disability and/or Mental Health Conditions: National Survey of CSHCN, 2009-2010. Matern Child Health J 2016; 20: 2573-80. [CrossRef]
26. Lewis C, Robertson AS, Phelps S. Unmet dental care needs among children with special health care needs: implications for the medical home. Pediatrics 2005; 116: 426-31. [CrossRef]
27. Iida H, Lewis C, Zhou C, Novak L, Grembowski D. Dental care needs, use and expenditures among US children with and without special health care needs. J Am Dent Assoc 2010; 141: 79-88. [CrossRef]
28. Clinical A.C.-B.M.S. and A.A.o.P. Dentistry. Guideline on Behavior Guidance for the Pediatric Dental Patient. Pediatric Dentistry 2015; 37: 57.
29. Lowe O, Lindemann R. Assessment of the autistic patient's dental needs and ability to undergo dental examination. ASDC J Dent Child 1985; 52: 29-35.
30. Klingberg G. Behavior management-children and adolescents. Disability and Oral Care 2000.
31. Chandrashekhar S, Bommangoudar JS. Management of Autistic Patients in Dental Office: A Clinical Update. Int J Clin Pediatr Dent 2018; 11: 219-27. [CrossRef]
32. Bäckman B, Pilebro C. Visual pedagogy in dentistry for children with autism. ASDC J Dent Child 1999; 66: 325-31.
33. Hernandez P, Ikkanda Z. Applied behavior analysis: behavior management of children with autism spectrum disorders in dental environments. J Am Dent Assoc 2011; 142: 281-7. [CrossRef]
34. Özsoy ÖP, Bingöl Sİ. Extraction Orthodontic Treatment in an Autistic Patient. Turk J Orthod 2017; 30: 28-32. [CrossRef]
35. Neumeyer AM, Gates A, Ferrone C, Lee H, Misra M. Bone density in peripubertal boys with autism spectrum disorders. J Autism Dev Disord 2013; 43: 1623-9. [CrossRef]
36. Nguyen QV, Bezemer PD, Habets L, Andersen BP. A systematic review of the relationship between overjet size and traumatic dental injuries. Eur J Orthod 1999; 21: 503-15. [CrossRef]
37. Saito K, Jang I, Kubota K, Hoshino T, Hotokezaka H, Yoshida N, et al. Removable orthodontic appliance with nickel-titanium spring to reposition the upper incisors in an autistic patient. Spec Care Dentist 2013; 33: 35-9. [CrossRef]
38. Olsen CB. Anterior crossbite correction in uncooperative or disabled children. Case reports. Aust Dent J 1996; 41: 304-9. [CrossRef]
39. Linares TSM, Ruiz DR, Uribe-Querol E. Camouflage orthodontic treatment in an autistic class II patient with anterior open bite: Case report. Revista Mexicana de Ortodoncia 2015; 3: 47-55. [CrossRef]

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Case Report

Interdisciplinary Management of an Adult Bilateral Cleft Lip and Palate Patient with Excessive Incisor Display - A Case Report

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ABSTRACT

This case report shows a successful orthodontic treatment of an operated adult bilateral cleft lip and palate subject with short upper lip and excessive incisor display. The patient underwent cleft lip repair at an early age of 2.5 years, followed by palatoplasty at the age of 21 years. She presented with malaligned teeth, inability to close the lips, excessive upper incisor display, and difficulty in speech.

She was treated with upper and lower arch alignment and intrusion of the upper incisors, followed by prosthetic replacement of the missing right lateral incisor and left lateral incisor and canine. Normal dental occlusion was achieved using orthodontic procedures, followed by prosthodontic rehabilitation that resulted in significant improvement in facial aesthetics and psychosocial benefit to the individual.

Keywords: Cleft lip and palate, orthodontic treatment, incisor intrusion

INTRODUCTION

Bilateral cleft lip and palate deformity has a wide degree of variability with regard to the severity of the cleft (incomplete vs. complete) and, most importantly, the premaxilla. The deformity is characterized by a protruding premaxilla, prolabium lacking muscle fibers with a blunted white roll, vertically long lateral lip elements widely spaced due to discontinuity of the orbicularis oris, short columella, flattened nose, and abnormally positioned alar cartilages (1).

Cephalometric studies of the bilateral cleft lip and palate showed that in complete bilateral clefts of the lip and alveolus with intact palates, the premaxilla was protrusive, but the palatal size was well within normal limits (2).

Adult patients with bilateral cleft lip and/or palate display malocclusion characterized by anterior deep bite, protruded maxilla, and a bilateral collapse of the buccal maxillary segments (3). The extrusion of upper incisors and/or short upper lip causes serious aesthetic problems.

The amount of incisor display greatly influences the facial aesthetic at rest and during smile (4). Three-quarters of upper incisors' crown height to 2 mm of gingival display is considered a normal/ideal exposure during smile (5).

The static and dynamic smile is severely compromised in bilateral cleft lip and palate patients. The maxillary incisors should be moved toward the alveolus in the vertical direction that improves their relationship to the normal lip position. In addition, the premaxilla gets repositioned during orthodontic intrusion of the maxillary incisors. A greater Morley's ratio in bilateral cleft lip and palate patients is a significant problem as the lip shrinks due to surgical scarring (6).

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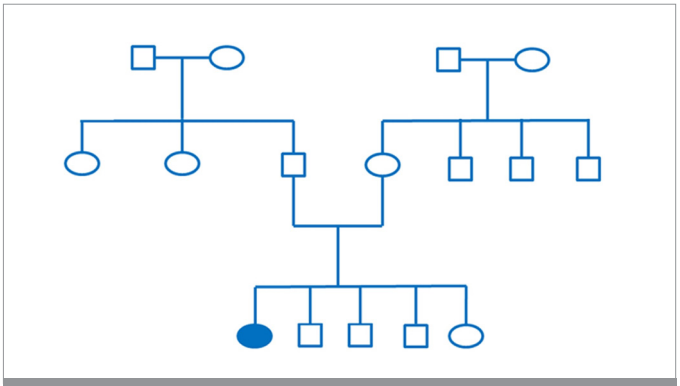

Figure 1. Pedigree chart, showing non-familiar, sporadic occurrence of BCLP

An intrusion of maxillary incisors is a difficult tooth movement to perform in an adult. We report a case of a successful treatment of a 23-year-old female patient with operated bilateral cleft lip and palate with excessive incisor display.

CASE PRESENTATION

A 23-year-old female patient with operated bilateral cleft lip and palate with complaints of an inability to close the lips, irregular teeth, and difficulty in speech reported to us for improvement in her aesthetic and function. The patient was the first child of a non-consanguineous marriage with a non-relevant history of cleft deformity in her family (Figure 1). The child was delivered at term, and pregnancy was healthy except for congenital bilateral cleft lip.

Figure 2. Pre-treatment extraoral and intraoral photographs and radiographs showing malaligned mandibular incisors and extrusion of maxillary incisors

Figure 3. Mid treatment intraoral photographs showing rigid rectangular wire in the mandibular arch and intrusion cum retraction horizontal loops in the maxillary arch

Figure 4. Post-treatment extraoral and intraoral photographs and radiographs showing removable partial denture serving as a retainer and obturator plate

The patient underwent a bilateral cleft lip repair at an early age of 2.5 years, followed by palatoplasty at the age of 21 years. The patient had a mesoprosopic face, an orthognathic profile, and incompetent lips with an asymmetrical nose and a bilateral scar extending from the vermillion border of the lip to the base of the nose with an excessive incisor display at rest and during smile.

Intraorally, the upper arch was narrow in the anterior region and asymmetric with a protruding premaxilla. Two oronasal fistulae were present distal to the right and left central incisors. Maxillary right lateral incisor and left lateral incisors and canine were missing. A supernumerary tooth was present in the left cleft area. Spacing in the lower anterior teeth was present. The maxillary central incisors and maxillary left first premolar were rotated. Maxillary right canine and left supernumerary tooth were in crossbite. The mandibular right and left third molars were horizontally impacted. An overjet of 10 mm with an overbite of 5 mm was present (Figure 2).

The patient had a nasal twang in her voice, oronasal breathing, and a typical swallowing pattern. Cephalometric analysis showed Class II skeletal base and average growth pattern with proclined upper and lower incisors.

Ideally, distraction histogenesis would be the best option to close the maxillary defects, followed by alveolar bone grafts to receive the implant prosthesis to replace the missing teeth. However, the patient declined any more surgery. Therefore, alignment of the mandibular arch and maxillary arch together

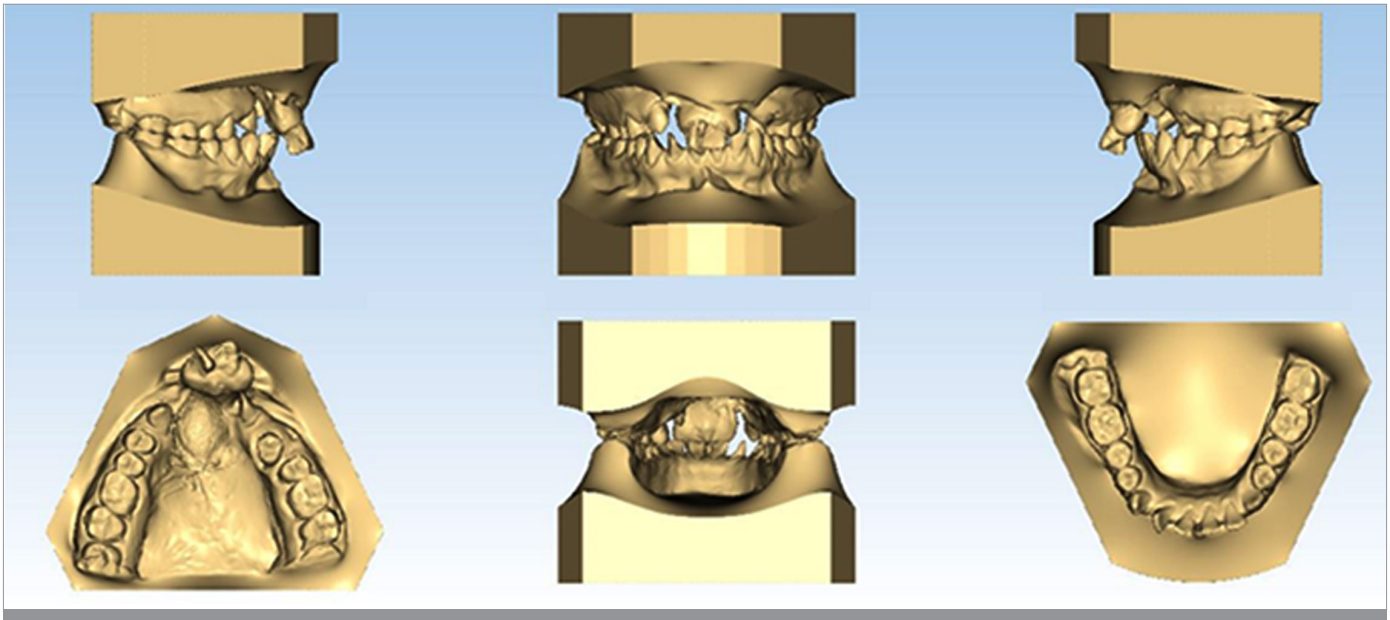

Figure 5. Pre-treatment digital models

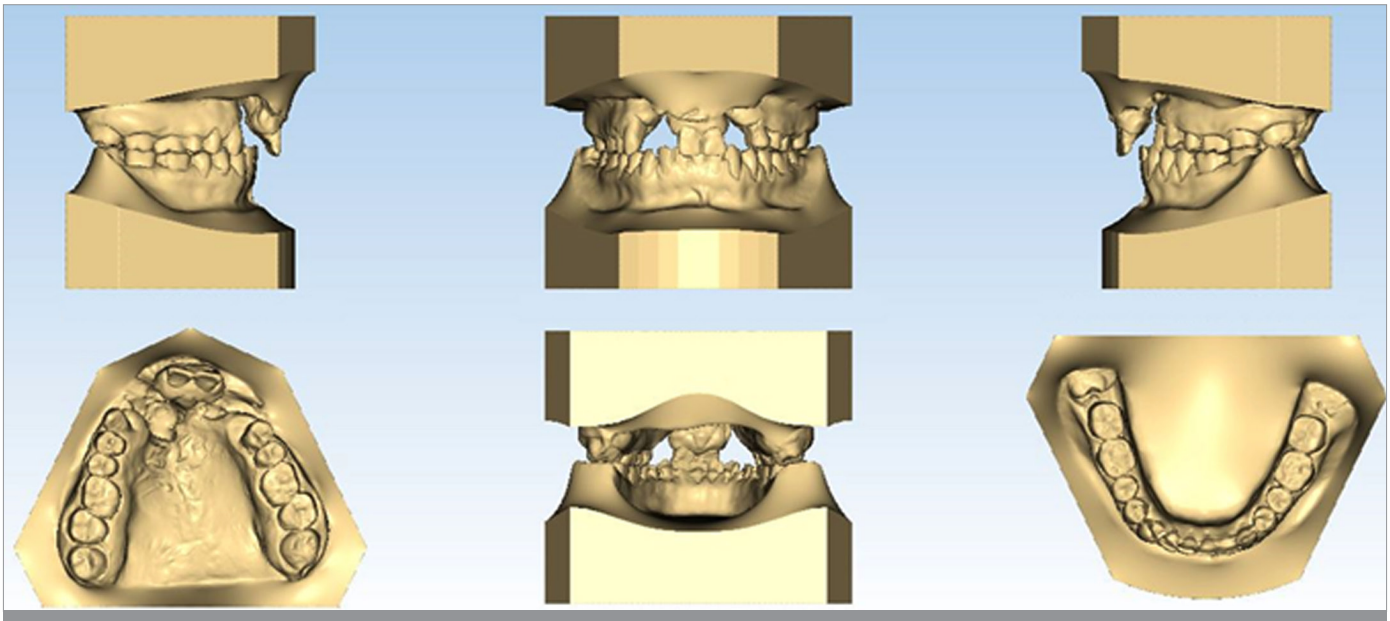

Figure 6. Post-treatment digital models

with an intrusion of maxillary incisors and replacement of the missing teeth with a removable prosthesis were performed. The treatment plan and outcome were explained in detail to the patient. Written consent was obtained from the patient. Before starting the orthodontic treatment, the supernumerary tooth with respect to the left maxillary canine region was extracted as it had a short root and poor bone support, indicating a poor prognosis. After the initial oral prophylaxis and restorative procedures were performed, banding and bonding were completed using a preadjusted Roth 0.022-inch×0.028-inch prescription appliance. A sectional 0.014-inch NiTi wire was ligated in the maxillary incisors, and sectional 0.016-inch NiTi wires were ligated in the maxillary right and left posterior regions for alignment. Following the initial alignment, intrusion cum retraction horizontal loops were ligated with respect to the maxillary central incisors using a 0.016-inch stainless steel wire. In the lower arch, initial leveling and alignment was performed using 0.016-inch NiTi wires, and the archwires were sequentially changed to higher dimensions (Figure 3).

After intrusion of the maxillary incisors, a 0.018-inch stainless steel wire was ligated in the upper arch with a step-up bend with respect to the central incisors. After debonding, a removable partial denture in relation to the maxillary right and left lateral incisors was placed, which in addition to prosthesis also served as a retainer and obturator. Retention was provided by a flexible spiral wire retainer in the mandibular arch (Figure 4, 5 and 6).

DISCUSSION

Patients with cleft lip and palate often suffer from aesthetic, morphological, and functional problems in the dentofacial region (7). A large number of patients suffer from poor self-esteem due to an unaesthetic facial appearance and unintelligible speech (8).

Management of protruded premaxilla and excessive incisor display can be a confounding problem in adult bilateral cleft lip and palate cases. Many techniques have been proposed to deal with this problem. These techniques include extraoral traction, premaxillary surgical setback, premaxillary excision, and incisor intrusion (6). Excessive incisor display may be due to the scarring, shrinkage, and shortening of the upper lip after surgery and/or due to the extrusion of upper incisors (6). The facial appearance of the patient with short upper lip improved due to the intrusion of upper front teeth.

Generally, adult patients undergoing orthodontic intrusion are more likely to have apical root resorption (9). Treatment duration, magnitude of applied force, method of force application, roots with developmental abnormalities, alveolar bone density, patient age, and sex are risk factors for root resorption (9).

The gingival recession evident in the upper right canine was present before initiation of fixed orthodontic treatment and was exaggerated by the orthodontic tooth movement and poor bone support.

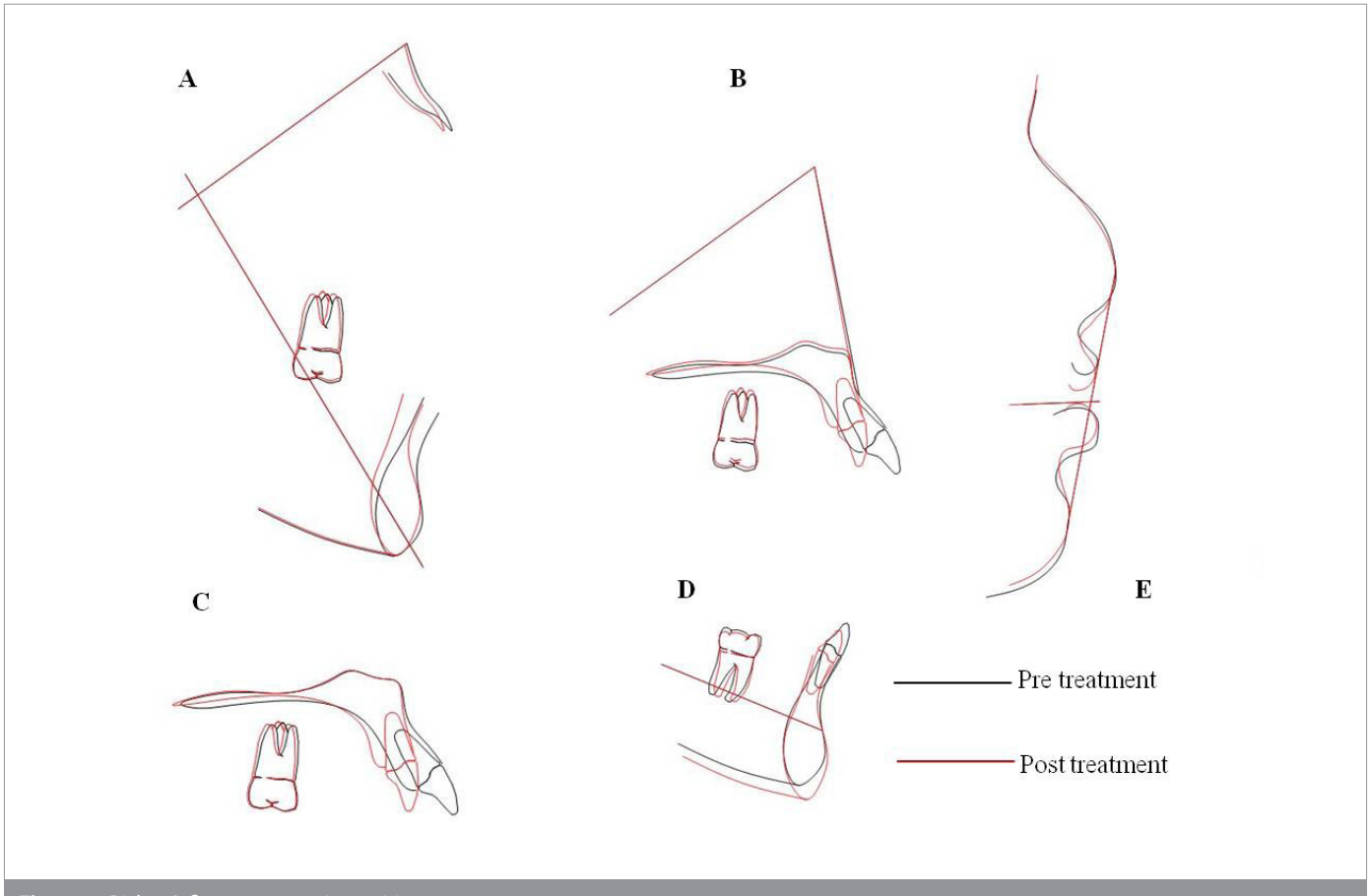

Figure 7. Rickett's five-step superimposition

Incisor intrusion was performed with mild activation of horizontal loops in a 0.016-inch stainless steel wire that provided lighter force for a longer duration to prevent root resorption in this adult patient. The orthodontic procedures and prosthetic rehabilitation resulted in a near normal dental occlusion with significant improvement in aesthetics and psychosocial benefits to the individual.

Surgical repair of the oronasal fistulas was avoided because the patient did not provide consent as she had already undergone multiple surgeries.

The removable denture poses a problem to hygiene, leading to the initiation of caries in contact areas. A slight problem with clarity of speech that usually lasts for a few days can be seen. The removable denture is also a cause of social embarrassment. In our clinical practice, we have seen that the patients very well manage with the appliance, serving as a removable partial denture, an obturator, and a retainer and also providing support to the nasal flange (Figure 7).

CONCLUSION

This case report shows a successful interdisciplinary treatment of an adult bilateral cleft lip and palate patient.

Informed Consent: Written informed consent was obtained from the patient who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - O.P.K., A.P. ; Design - O.P.K.; Data Collection and/or Processing - A.P.; Analysis and/or Interpretation - A.P., O.P.K.; Literature Search - O.P.K., A.P.; Writing Manuscript - A.P., O.P.K.; Critical Review - O.P.K.

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REFERENCES

1. Khosla KR, McGregor J, Kelly PK, Gruss JS. Contemporary Concepts for the Bilateral Cleft Lip and Nasal Repair. Semin Plast Surg 2012; 26: 156-63. [CrossRef]
2. Berkowitz S. Complete Bilateral Cleft Lip and Palate. In: Berkowitz S, editor. Cleft Lip and Palate, Diagnosis and Management. 2nd edition. Florida: Springer; 2006. P. 99-102. [CrossRef]
3. Aburezq H, Daskalogiannakis J, Forrest C. Management of the prominent Premaxilla in Bilateral Cleft Lip and Palate. Cleft Palate Craniofac J 2006; 43: 92-5. [CrossRef]
4. Sarver DM, Ackerman MB. Dynamic smile visualisation and quantification: Part 1. Evolution of the concept and dynamic records for smile capture. Am J Orthod Dentofacial Orthop 2003; 124: 4-12. [CrossRef]
5. Kharbanda OP. Clinical evaluation. In: Kharbanda OP, editor. Diagnosis and Management of Malocclusion and Dentofacial Deformities. 2nd edition. New Delhi: Elsevier India; 2013. p.159
6. Phadkule SS, Shivaprakash G, Kumar GA, Shamnur N. Customised Appliance for Intrusion and Retraction of Premaxilla in Bilateral Cleft Palate Patient. J Indian Orthod Soc 2014; 48: 561-5.
7. Fukunaga T, Honjo T, Sakai Y, Sasaki K, Yamamoto TT, Yamashiro T. A Case Report of Multidisciplinary Treatment of an Adult Patient with Bilateral Cleft Lip and Palate. Cleft Palate Craniofac J 2014; 51: 711-21. [CrossRef]
8. Ferrari Júnior FM, Ayub PV, Capelozza Filho L, Pereira Lauris JR, Garib DG. Esthetic Evaluation of the Facial Profile in Rehabilitated Adults with Complete Bilateral Cleft Lip and Palate. J Oral and Maxillofac Surg 2015; 73: 169.e1-6. [CrossRef]
9. Weltman B, Vig KW, Fields HW, Shanker S, Kaizar EE. Root Resorption associated with orthodontic tooth movement: A systematic review. Am J Orthod Dentofacial Orthop 2010; 137: 462-76. [CrossRef]

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Case Report

Mini-Implant-Assisted En Masse Protraction of Maxillary Posterior Segment

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ABSTRACT

Protraction of posterior teeth to close the spaces in patients with congenitally missing maxillary lateral incisors is challenging. Mini-implants are a reliable source of anchorage for this purpose. This case report demonstrates the application of a T-bar protraction appliance with a palatal mini-implant for en masse protraction of posterior teeth into the lateral incisor space in an adolescent patient. The patient's occlusion and esthetics were significantly improved, and ideal overjet and overbite were obtained after 30 months of treatment. Follow-up records six months after the completion of the treatment displayed stable results.

Keywords: Mini-Implant , 'en masse' protraction, T-bar

INTRODUCTION

Congenitally missing maxillary lateral incisors can be treated either by space closure with canine substitution or by creating additional space for prosthetic restoration (1-4). In young patients, canine substitution can be visualized as a long-term treatment option for missing lateral incisors. However, depending on the type of occlusion, achieving anchorage control can be critical. Mini-implants can provide a reliable source of anchorage for protraction of canine and posterior teeth. The case report presented here demonstrates the application of a T-bar protraction appliance with a palatal mini-implant for en masse protraction of posterior teeth into the lateral incisor space in an adolescent patient.

Diagnosis and Etiology

The patient was a 13.5-year-old boy with a chief complaint of spacing and missing upper front tooth. The extraoral examination showed a convex soft tissue profile with optimal nasolabial angle and coincident facial midline (Figure 1). The maxillary dental midline was deviated 1.5 mm to the left, while the mandibular dental midline was coincident with the facial midline. Intraoral examination showed a Class I molar and Class II canine relationship bilaterally, with 5 mm spacing localized in the maxillary anterior region (Figure 1). The overbite was 1 mm and overjet was 2.5 mm. The maxillary arch was skewed to the left, while the mandibular arch had a symmetric U-shaped arch form. There were no signs or symptoms of temporomandibular joint dysfunction. The upper left lateral incisor was noted to be congenitally missing on the panoramic radiograph (Figure 2). The cephalometric analysis indicated a skeletal Class I jaw relationship with normal mandibular plane angle (Figure 3 and Table 1). The maxillary and mandibular incisors showed mild proclination.

Treatment Objectives

Based on the patient's chief complaint and the problem list, the treatment objectives were as follows: (1) achieve a Class I canine relationship; (2) close the maxillary anterior spaces; (3) establish an ideal overjet and overbite; (4)

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correct the maxillary dental midline deviation; and (5) maintain the facial profile.

Treatment Options and Alternatives

Two treatment options were considered and presented to the patient. The first option was non-extraction orthodontic treatment. In this method, the maxillary anterior spaces would be consolidated and redistributed primarily to the left lateral incisor area. Once the orthodontic treatment was completed, this space would be utilized for replacement of the missing tooth with a prosthesis. The second option was to close the maxillary spaces by protraction of the left posterior teeth with skeletal anchorage. This would require the substitution of the missing lateral incisor and canine with the maxillary left canine and maxillary first premolar, respectively. The occlusion would be finished as Class I molar on the right and Class II molar on the left. After discussion with the patient and the parents, it was decided to protract the posterior segment.

Table 1. Cephalometric analysis

Measurement	Norm	Pretreatment	Posttreatment
SNA (°)	82.0±3.5	79	79
SNB (°)	80.9±3.4	78	78
ANB (°)	1.6±1.5	1	1
FMA (°)	24.4±4.5	24	24
IMPA (°)	95.0±7	93	90
U1-NA (mm)	4.3±2.7	5	6
L1-NB (mm)	4.0±1.8	5	4
Interincisal angle (°)	130.0±6.0	127	132
Upper lip to E-line (mm)	-8.0±2.0	-2.5	-6
Lower lip to E-line (mm)	-2.0±2.0	-1	-4

SNA: Sella, Nasion, A-point; SNB: Sella, Nasion, B-point; ANB: A-point, Nasion, B-point; FMA: frankfor mandibular angle; IMPA: Inter-incisor mandibular plane angle

Treatment Progress

The treatment objectives and alternatives were explained to the patient, and informed consent was obtained. A 0.022×0.028-inch pre-adjusted edgewise appliance was used. The upper arch was leveled with continuous archwires, starting with a 0.016-inch nickel-titanium wire and working up to a 0.019×0.025-inch stainless steel wire in 6 months. A power chain was placed connecting the upper left central incisor to right first molar to shift the dental midline to the right and to consolidate the spaces.

Two mini-implants (2×8 mm) were placed in the palatal area at the premolar level and the impression was taken for construction of a T-Bar protraction appliance. After two weeks, the ap-

Figure 1. Pretreatment facial and intraoral photographs

pliance was delivered and cemented on the incisors and palatal mini-implants (Figure 4). Palatal and buccal power chains were applied for posterior teeth protraction. Grinding and reshaping of upper left canine were performed gradually such that it mimics a lateral incisor during the protraction process. The lower arch was also bonded and banded for some minor corrections. It took approximately 10 months to completely close the space.

At the finishing stage, 0.017×0.025-inch, CNA (Connecticut New Archwire) was used for both arches and inter-arch elastics were worn for occlusal settling. The total treatment duration was 30 months. After the treatment, maxillary and mandibular modified Hawley retainers were delivered.

Treatment Results

At the end of treatment, all the posterior teeth displayed good occlusion and tight interdental contacts. The upper left posterior teeth were protracted by more than 7 mm. The occlusion was finished as Class I canine relationship, with the molar relationship being Class I on the right and Class II on the left side. Normal overjet and overbite were obtained. Posttreatment extraoral photographs showed that dental and facial midlines were coincident (Figure 5).

The posttreatment panoramic radiograph showed good root parallelism with no significant root resorption or bone loss (Figure 6). Superimposition on the cranial base of cephalometric tracings (Figure 7) showed maxillary and mandibular growth changes in the anteroposterior and vertical directions as well as changes in the soft tissue facial profile (Figure 8). Local superimposition of the maxilla and mandible revealed a systematic extrusion of all teeth into the inter-maxillary space created by vertical skeletal growth. The esthetic outcomes of upper anterior teeth were appealing and satisfactory. The patient exhibited a pleasant smile and was happy with the final outcome. Follow-up records six months after the treatment displayed a stable occlusion (Figure 9).

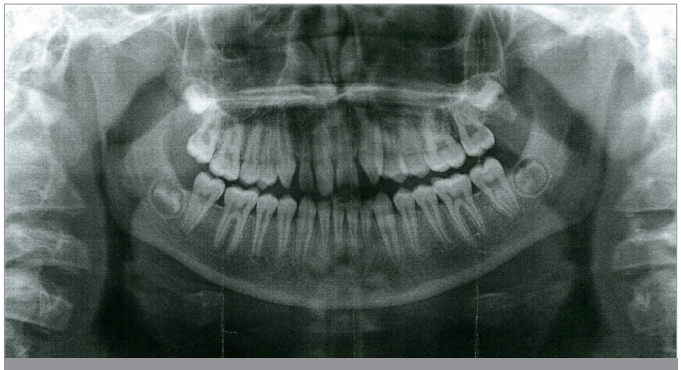

Figure 2. Pretreatment panoramic radiograph

Figure 3. Pretreatment lateral cephalometric radiograph

Figure 4. a, b. Progress intraoral photographs; A: T-Bar was delivered; B: The protraction was completed

Figure 5. Posttreatment facial and intraoral photographs

Figure 6. Posttreatment panoramic radiograph

DISCUSSION

The two primary methods for managing patients with congenitally missing maxillary lateral incisors are orthodontic space closure with canine substitution or creation of additional space for prosthetic restoration of the missing teeth. The factors influencing the choice of treatment include patient age, dental health, buccal occlusion, amount of crowding, and tooth morphology (2-5). An ideal treatment plan should satisfy the patient's aesthetic appearance and functional needs, and at the same time provide a long-term solution to the existing dental and skeletal problems.

Posterior teeth protraction with a canine substitution was therefore the choice of treatment for our patient. Canine substitution has shown better esthetic results and periodontal support (6, 7). De Marchi et al. (8) reported that implant-supported dental prostheses showed less filling by interdental papillae in the spaces between the central and lateral incisors as compared to regular space closure for missing laterals. Canine substitution could be an excellent treatment option for replacing missing lateral incisors with long-term stability and good periodontal health. However, this in no way undermines the fact that treatment decisions have to be made considering several other factors, such as malocclusion, facial profile, and morphology of the canine. Therefore, it does not come as a surprise that opening a space for prosthetic replacement of missing lateral incisors is not a popular choice of treatment. At the same time, this option can lead to a shorter treatment time since midline correction and space opening can be accomplished simultaneously. However, the prevention of alveolar bone resorption and soft tissue shrinkage in the edentulous area should be taken into consideration when an implant-supported dental prosthesis is planned.

Osseointegrated dental implants are unsuitable for adolescent patients because of the active vertical eruption of teeth as ob-

served in this patient. An implant should only be inserted once growth is complete (4, 9, 10). Due to the time lag between orthodontic treatment completion and prosthetic replacement, bone and soft tissue augmentations might be required before implant placement.

Several locations for temporary anchorage devices (TADs), both intra- and extra-dental, have been suggested (11-13). The interdental areas are sometimes unsuitable for TAD placement to protract an entire quadrant because the TADs can themselves interfere with the direction of tooth movement. The anterior palate, at the level between first and second premolars, is a good anatomical site for TAD placement with minimal chances of root perforations (14-16). This site has good bone quality and attached mucosa providing a much higher success rate than most other anatomic locations.

Esthetic Considerations of Canine Substitution

When it comes to replacing congenitally missing lateral incisors, multiple factors should be considered in choosing the appropriate option that satisfies the functional and esthetic demands of the patient. Usually, the options are a canine substitution, implant-supported prostheses, and/or tooth-supported prostheses. The selection of one of these options relies upon different criteria. Considering canine substitution, Kokich et al. (17) have described some criteria that drive the orthodontist more toward choosing such an option. First, the shape and color of the canine must be evaluated carefully. The canine morphology is usually more bulbous, convex, and wider than the lateral incisor when viewed facially. Therefore, a canine with a narrow width, a blunted cusp, and/or less convexity would be more suitable, otherwise extensive restorative workup would be needed. The restorative intervention could be as little as mesial and distal composite build-ups to a full coverage ceramic crown to establish nicely contoured lateral incisors. The color should be also considered because canines are usually 1-2 shades darker than incisors. To manage the color, bleaching is the most conservative option otherwise composite or ceramic veneers can also be considered for more permanent correction. The width of the canine should also be carefully examined mesiodistally at the level of the cementoenamel junction (CEJ). The narrower the canine at the level of the CEJ, the better the emergence profile of the tooth when it mimics the lateral incisor. The second criterion concerns the gingival margin of the canine in relation to both the adjacent teeth and the lip level. Usually, canines have their gingival margins at or slightly incisal to the central incisors. While this usually favors the camouflage of the premolar that is replacing the canine by performing gingivectomy/crown lengthening procedure, it sometimes makes it difficult to manage the canine itself when it replaces a missing lateral since the latter has its own gingival margin about 0.5 mm below the central incisor. Bracket positioning is therefore very critical as placing it based on the gingival margin level will aid the canine to erupt into a better vertical position for a better esthetic gingival outcome.

Figure 7. Posttreatment lateral cephalometric radiograph

In fact, Elaine et al. (18) have found that the morphology, shade, and gingival margin of the canine play a detrimental role in the attractiveness of the treatment outcome. Brighter and narrower canines are more attractive as per the evaluation by orthodontists, dentists, and laypersons. Having a canine gingival margin greater than 0.5 mm above the level of the adjacent central gingival margin was perceived as unattractive.

Kokich et al. (17) also discussed other criteria, such as malocclusion and patient profile. It was mentioned that a straight profile and Class II malocclusion without lower crowding and missing upper lateral incisors were preferred for canine substitution.

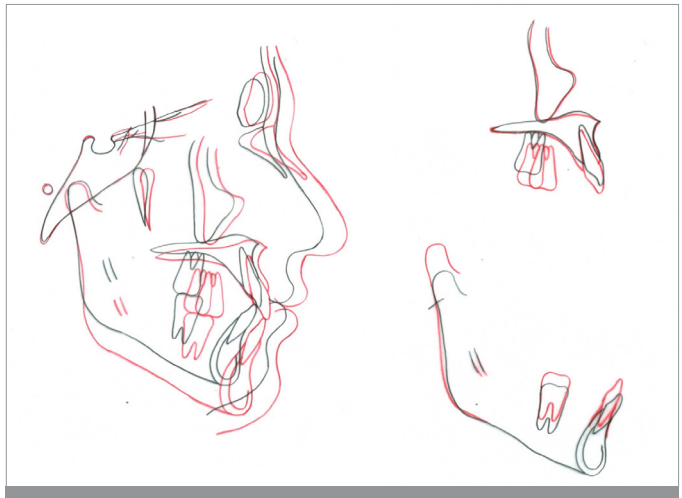

Figure 8. Superimpositions of pretreatment (black line) and posttreatment (red line) cephalometric tracings

Figure 9. Facial and intraoral photographs 6 months after the completion of treatment

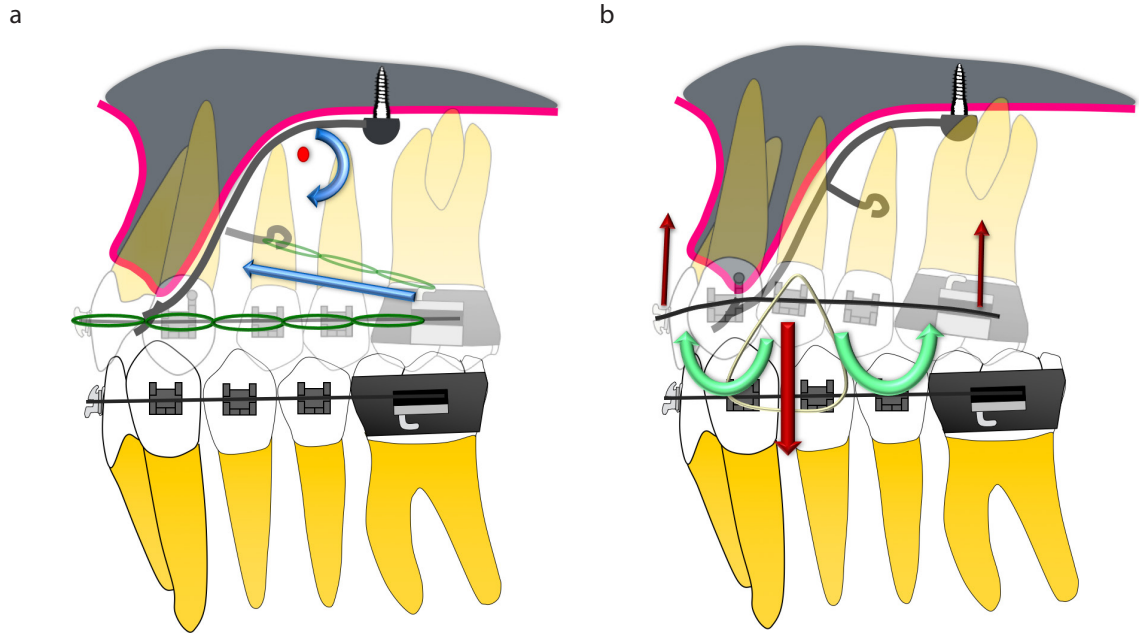

Figure 10. a, b. The protraction force created a clockwise rotation moment causing mesial tipping of posterior segment and lateral open bite (a); The use of vertical seating elastics corrected lateral open bite (b)

Other acceptable indications were a Class I malocclusion with lower crowding that required extractions. The introduction of mini-screws into orthodontics may however allow canine substitution in different malocclusions.

Zachrisson et al. (19) have also pointed out the age of the patient as a critical factor in the selection of the canine substitution option. In a young patient, the orthodontist should provide treatment with very long-term functional and esthetic stability. Provided the shape, color, and the other factors are favorable, early canine substitution will eliminate the need for long-term retention with fixed retainers or semi-permanent bonded bridges before placing an implant at the right age. This will also allow the supporting soft and hard tissue to adapt naturally as the patient grows up.

Rayner et al. (20) stated that unilateral canine substitution cases were found not to be significantly less attractive as compared to bilateral canine substitution cases when smile pictures were evaluated among orthodontists, dentists, and laypersons.

Silveira et al. (21) conducted a systematic review study to compare canine substitution with prosthetic replacement and found that space closure had better scores when evaluated by all the periodontal indices than prosthetic replacement. They further concluded that prosthetic interventions arouse greater criticism in dentists, patients, and laypersons. It was also concluded that canine guidance, whether present or absent in treating such cases, had no relationship with TMDs.

In our opinion, given that most if not all factors are favorable for our patient, canine substitution was the preferred method of treatment

Appliance Biomechanics

A T-Bar protraction appliance helped in securing dual support. A primary direct anchorage was obtained from the palatal side via an extension. This was used for applying a force parallel to the archwire to minimize arch deviations during protraction. A secondary indirect anchorage was derived from the palatal surfaces of incisors by bonding an anterior extension of the main body of the device. This helped in stabilizing the maxillary incisors, which could be used as indirect anchorage to apply protraction force from the buccal side. This type of dual (buccal and lingual) force application helped minimize the transverse rotation of the posterior segment. It also helped in preventing side effects from unilateral forces to the rest of the arch.

From a buccal perspective, both the lingual and buccal forces were significantly away from the assumed center of resistance (Cres) of the posterior segment resulting in a mesial tip during protraction (Figure 10a). To offset this undesirable side effect, a 0.019×0.025-inch stainless steel archwire was used. This archwire helped in generating an uprighting moment on the segment; however, it was not sufficient enough to prevent a mesial moment to cause flexion of the main archwire during protraction. It is critical to remember that the posterior terminal portion of an orthodontic archwire has high flexibility because it is an unsupported cantilever. This complicates the protraction of the entire segment. Mechanically speaking, the load created by the simultaneous tipping of the entire posterior segment resulted in archwire deformation.

Once the space was closed, the second molars were bonded and seating elastics were used to create specific moments in the posterior segment for complete leveling of the teeth with root correction (Figure 10b).

CONCLUSION

This case demonstrated that a T-Bar protraction appliance, when combined with sound biomechanical principles, is an effective modality for protraction of maxillary posterior teeth. Palatal mini-implants exhibited good stability throughout the treatment with no reported patient discomfort.

Informed Consent: Written informed consent was obtained from the patient who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - H.A., M.U., J.F., P.C., S.Y.; Design - H.A., M.U., J.F., P.C., S.Y.; Supervision - J.F., M.U., S.Y.; Fundings - N.A.; Materials - N.A.; Data Collection and/or Processing - H.A., P.C., S.Y.; Analysis and/or Interpretation - H.A., P.C., M.U., S.Y.; Literature Search - H.A., P.C., M.U., S.Y.; Writing Manuscript - H.A., M.U., J.F., P.C., S.Y.; Critical Review - O H.A., M.U., J.F., P.C., S.Y.

Conflict of Interest: The authors have no conflict of interest to declare.

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REFERENCES

1. Silveira GS, de Almeida NV, Pereira DM, Mattos CT, Mucha JN. Prosthetic replacement vs space closure for maxillary lateral incisor agenesis: a systematic review. Am J Orthod Dentofac Orthop 2016; 150: 228-37. [CrossRef]
2. Kokich VO, Kinzer GA. Managing congenitally missing lateral incisors. Part I: Canine substitution. J Esthet Restor Dent 2005; 17: 5-10. [CrossRef]
3. Kinzer GA, Kokich VO. Managing congenitally missing lateral incisors. Part II: tooth-supported restorations. J Esthet Restor Dent 2005; 17: 76-84. [CrossRef]
4. Kinzer GA, Kokich VO. Managing congenitally missing lateral incisors. Part III: single-tooth implants. J Esthet Restor Dent 2005; 17: 202-10. [CrossRef]
5. Rosa M, Zachrisson BU. Integrating esthetic dentistry and space closure in patients with missing maxillary lateral incisors. J Clin Orthod 2001; 35: 221-34.
6. Nordquist GG, McNeill RW. Orthodontic vs. restorative treatment of the congenitally absent lateral incisors-long-term periodontal and occlusal evaluation. J Periodontol 1975; 46: 139-43. [CrossRef]
7. Robertsson S, Mohlin B. The congenitally missing upper lateral incisor. A retrospective study of orthodontic space closure versus restorative treatment. Eur J Orthod 2000; 22: 697-710. [CrossRef]
8. De Marchi LM, Pini NI, Hayacibara RM, Silva RS, Pascotto RC. Congenitally missing maxillary lateral incisors: functional and periodontal aspects in patients treated with implants or space closure and tooth re-contouring. Open Dent J 2012; 6: 248-54. [CrossRef]

9. Biggerstaff RH. The orthodontic management of congenitally absent maxillary lateral incisors and second premolars: a case report. Am J Orthod Dentofacial Orthop 1992; 102: 537-45. [CrossRef]
10. Percinoto C, Vieira AE, Barbieri CM, Melhado FL, Moreira KS. Use of dental implants in children: A literature review. Quintess Int 2001; 32: 381-3.
11. Park HS. The skeletal cortical anchorage using titanium miniscrew implants. Kor J Orthod 1999; 29: 699-706.
12. Costa A, Raffaini M, Melsen B. Miniscrews as orthodontic anchorage: a preliminary report. Int J Adult Orthodon Orthognath Surg 1998; 13: 201-9.
13. Papadopoulos MA. Tarawneh F. The use of miniscrew implants for temporary skeletal anchorage in orthodontics: a comprehensive review. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2007; 103: e6-15. [CrossRef]
14. Kang S, Lee SJ, Ahn SJ, Heo MS, Kim TW. Bone thickness of the palate for orthodontic mini-implant anchorage in adults. Am J Orthod Dentofacial Orthop 2007; 131(4Suppl): 74-81. [CrossRef]
15. Kim HJ, Yun HS, Park HD, Kim DH, Park YC. Soft-tissue and cortical-bone thickness at orthodontic implant sites. Am J Orthod Dentofacial Orthop 2006; 130: 177-82. [CrossRef]
16. Baumgaertel S. Quantitative investigation of palatal bone depth and cortical bone thickness for mini-implant placement in adults. Am J Orthod Dentofacial Orthop 2009; 136: 104-8. [CrossRef]
17. Kokich VO, Kinzer GA. Managing congenitally missing lateral incisors. Part I: Canine substitution. J Esthet Restor Dent 2005; 17: 5-10. [CrossRef]
18. Brough E, Donaldson AN, Naini FB. Canine substitution for missing maxillary lateral incisors : the influence of canine morphology, size, and shade on perceptions of smile attractiveness. Am J Orthod Dentofacial Orthop 2010; 138: 705-9. [CrossRef]
19. Zachrisson BU, Rosa M, Toreskog S. Cogenitally missing maxillary lateral inicsors : canine substitution. Point. Am J Orthod Dentofacial Orthop 2011; 139: 434-8. [CrossRef]
20. Rayner WJ, Barber SK, Spencer RJ. The effect of canine characteristics and symmetry on perceived smile attractiveness when canine teeth are substituted for lateral incisors. J Orthod 2015; 42: 22-32. [CrossRef]
21. Silveira GS, de Almeida NV, Pereira DM, Mattos CT, Mucha JN. Prosthetic replacement vs space closure for maxillary lateral incisor agenesis: A systematic review. Am J Orthod Dentofacial Orthop 2016; 150: 228-37. [CrossRef]