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TURKISH JOURNAL of
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Aims and Scopes

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.

Journal's target audience includes academicians, specialists, residents, and general practitioners working in the fields of orthodontics, dentistry, medicine and other related fields.

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TURKISH JOURNAL of ORTHODONTICS

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Abstract: An abstract should be submitted with all submissions except for Letters to the Editor. The abstract of Original Articles should be structured with subheadings (Objective, Methods, Results, and Conclusion). Please check Table 1 below for word count specifications.
Keywords: Each submission must be accompanied by a minimum of three to a maximum of six keywords for subject indexing at the end of the abstract. The keywords should be listed in full without

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Statistical analysis to support conclusions is usually necessary. Statistical analyses must be conducted in accordance with international statistical reporting standards (Altman DG, Gore SM, Gardner MJ, Pocock SJ. Statistical guidelines for contributors to medical journals. Br Med J 1983: 7; 1489-93). Information on statistical analyses should be provided with a separate subheading under the Materials and Methods section and the statistical software that was used during the process must be specified.

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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
ORIGINAL ARTICLE	4500	250 (Structured)	30	6	7 or total of 15 images
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)"

All references, tables, and figures should be referred to within the main text, and they should be numbered consecutively in the order they are referred to within the main text.

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References

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Journal Article: Rankovic A, Rancic N, Jovanovic M, Ivanović M, Gajović O, Lazić Z, et al. Impact of imaging diagnostics on the budget – Are we spending too much? Vojnosanit Pregl 2013; 70: 709-11.

Book Section: Suh KN, Keystone JS. Malaria and babesiosis. Gorbach SL, Barlett JG, Blacklow NR, editors. Infectious Diseases. Philadelphia: Lippincott Williams; 2004.p.2290-308.

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

Editor(s) as Author: Huizing EH, de Groot JAM, editors. Functional reconstructive nasal surgery. Stuttgart-New York: Thieme; 2003.

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.

Manuscripts Accepted for Publication, Not Published Yet: Slots J. The microflora of black stain on human primary teeth. Scand J Dent Res. 1974.

Epub Ahead of Print Articles: Cai L, Yeh BM, Westphalen AC, Roberts JP, Wang ZJ. Adult living donor liver imaging. Diagn Interv Radiol. 2016 Feb 24. doi: 10.5152/dir.2016.15323. [Epub ahead of print].

Manuscripts Published in Electronic Format: Morse SS. Factors in the emergence of infectious diseases. Emerg Infect Dis (serial online) 1995 Jan-Mar (cited 1996 June 5): 1(1): (24 screens). Available from: URL: http:/ www.cdc.gov/ncidodlEID/cid.htm.

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TURKISH JOURNAL of ORTHODONTICS

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TURKISH JOURNAL of ORTHODONTICS

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Original Article

Content and Quality Analysis of Websites as a Patient Resource for Temporomandibular Disorders

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Main points:
- The quality and content of information on TMDs available on the internet are low.
- The readability of websites about TMDs is generally poor or very poor.
- Reliability is a concern, and patients should interpret most of these sites carefully.

ABSTRACT

Objective: The purpose of this study was to evaluate the content and quality of internet information resources in Turkey about temporomandibular disorders (TMDs).

Methods: In July 2020, the keywords "jaw joint disease" (çene eklemi rahatsızlığı) and "jaw joint pain" (çene eklemi ağrısı) were searched on Google, Bing, YAHOO!, and Yandex. The first 20 websites were listed for 2 keywords on the 4 search engines. Scientific articles, product websites, repetitive sites, advertisements, and irrelevant websites were excluded from the list. The remaining 77 websites were assessed using the Quality Criteria for Consumer Health Information (DISCERN), Global Quality Score (GQS) and Journal of American Medical Association (JAMA) benchmarks. The topics related to TMDs that were thought to be important in informing the patient were determined and the Temporomandibular Disorder Content Score (TMDCS) was calculated to evaluate whether these contents were available on the website.

Results: The sources of the 77 websites included dentists in private practice (6.5%, n=5), hospitals/polyclinics (32.5%, n=25), universities (6.5%, n=5), and others (54.5%, n=42). The total DISCERN scores of all websites included were poor (average score 26.96). Mean scores of JAMA, GQS, and TMDCS were 1.75, 2.31, and 8.4, respectively.

Conclusion: The quality and reliability of the information on the websites related to TMDs are poor. Clinicians should be aware that patients may have access to unreliable or incomplete information. There is a need for improvement on websites about TMDs, especially by professionals through imparting more comprehensive and reliable information.

Keywords: Internet, patient resource, temporomandibular joint disorders, temporomandibular joint pain

INTRODUCTION

The use of the internet has increased considerably for general purposes and for accessing health care information (1). Advantages such as ease of accessibility, the desire of patients to have more information without going to a healthcare professional, and being less time-consuming and more economical causes a significant increase in the rate of searching for medical information on the internet (2, 3). The information contained in official and reliable sources provides benefits such as directing individuals to the right healthcare professionals and health institutions regarding their health conditions and helping them understand the truth of misunderstood medical information (4-6).

However, incorrect information on some official and unreliable websites increases the level of anxiety about individuals' health status and negatively affects their decision making. Therefore, concerns about the accura-

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cy and reliability of this information on the internet have led to the development of tools that allow the given information to be evaluated scientifically. To help physicians and patients choose reliable websites providing health-related information, Quality Criteria for Consumer Health Information (DISCERN), Journal of American Medical Association (JAMA) benchmarks, LIDA (Minervation Inc.), and Health on the Verification tools such as Net Code of Conduct (HONcode) have been developed (7-9).

DISCERN, a verification tool, developed by Charnock et al. (9) in 1998 facilitates the production of new, high-quality, evidence-based consumer health information, enabling patients and information providers to evaluate the quality of written information on a subject. Another assessment tool, the JAMA benchmarks, which assess basic quality standards, such as the author, citation, disclosure, and currency of issues for health-related internet information, was published in 1997 by Silberg et al. (10). Similar to the other tools, the Global Quality Score (GQS), which evaluates the content quality of online resources, is a widely used but unconfirmed assessment tool (11).

The temporomandibular joint (TMJ) is one of the most complex joints in the human body. Disorders of the TMJ include problems affecting TMJ components, masticatory muscles, and all masticatory system functions. The first literature on temporomandibular joint disorders (TMDs) was published in 1918 (12). TMDs are defined according to the American Academy of Orofacial Pain as a group of disorders involving masticatory muscles, TMJ, and related structures (13). These disorders may cause symptoms such as tenderness in the masticatory muscles and TMJ, limitation and pain in the mandibular movements, and TMJ sounds, leading people to seek treatment. Trauma, stress, degenerative diseases, overwork of muscles, inflammation, and orthodontic irregularity are among the etiological factors (14-16). Although TMDs are not seen as a social health problem, they affect a significant part of society. An epidemiological study evaluating the prevalence of symptoms of TMJ disorders in the Turkish population, conducted on 1253 individuals, revealed a 31% prevalence of joint pain, an 8.4% prevalence of pain in the opening, and a 27.3% prevalence of joint noise (17). The incidence of TMJ disorders varies between 6% and 93%, depending on the population and clinical criteria (18).

The high rate of TMDs in the population and the wide use of internet sites as the first source for patient health suggests that websites have a critical role in directing patients to the related specialist and/or health institution. In addition, symptoms that are disregarded despite decreasing the quality of life may lead patients to seek answers to their questions on the internet rather than referring them directly to a physician. Therefore, this study aims to evaluate the content and quality of information about TMDs on websites in the Turkish language accessed in Turkey by using up-to-date information evaluation tools.

METHODS

Ethical approval was not required for this study because publicly available data were evaluated. An internet search was made using the 4 of the most popular search engines in Turkey on July 27, 2020: Google (www.google.com), Bing (www.bing.com), Yahoo! (www.yahoo.com), and Yandex (www.yandex.com) (18). The keywords were determined using the Google Trends application. The search setting was based on past "All categories/ Turkey/Google web search" and has been limited in the past 5 years to avoid user restrictions and to expand their search results. Some keywords related to the main topic were analyzed using the app. The search was made in the Turkish language. After a comparative keyword search, "jaw joint disease" (çene eklemi rahatsızlığı) and "jaw joint pain" (çene eklemi ağrısı) were identified as keywords for the web search. The first 20 websites listed for 2 keywords on the 4 search engines, and in total, 160 websites were identified and listed. Exclusion criteria were scientific articles, product websites, repetitive sites, advertisements and irrelevant websites. According to the exclusion criteria, 83 websites were excluded from the study list. Two researchers (B.A. and F.Ç.D.), who received training for assessment tools (DISCERN, JAMA, and GQS), evaluated the remaining 77 websites.

Fourteen contents related to TMDs were determined based on the textbooks and guidelines published on this subject to evaluate the quality and sufficiency of the information (18-20). Each content's presence was scored as 1 point. Then, Temporomandibular Disorder Content Score (TMDCS) was calculated as a total content score for each website with a maximum of 14 points.

DISCERN (Quality Criteria for Consumer Health Information) measurement tool was used for the evaluation of reliability and information quality of written training materials on selected websites (9). The tool consists of 16 questions, each representing a different quality criterion. DISCERN questions are organized into 3 parts. Questions 1 to 8 address the credibility of the publication and help users to decide if they are trustworthy sources on treatment selection. Questions 9 to 15 address specific details of information on treatment alternatives. In this context, Questions 9 to 11 refer to active treatments described in the publication; non-treatment options are addressed separately in Question 12. The scoring made for the 16th question corresponds to the collective quality evaluation of the website. Each question is scored on a scale of 1 to 5.

The information quality of selected websites was also evaluated using criteria known as JAMA benchmarks. The authorship of medical content that should be visible on a website, the display of citations or references, the date of creation and update, and the presence of ownership, sponsorship, advertising policies, or conflicts of interest features were evaluated. For each criterion, "yes" was evaluated as 1 point, and "no" as 0 points.

GQS, which was used to assess the quality of websites, rated using a 5-point scale (Table 1).

Statistical Analysis

IBM SPSS version 22.0 (SPSS Inc, Chicago, IL) was used for statistical analysis. The Shapiro-Wilk test was used to confirm the normal distribution of the data. Frequency and descriptive statistics included the number, percentage, and average values. The data

collection and analysis were re-performed on randomly selected 35 websites by the same examiner after 2 weeks. Intraexaminer and interexaminer reliability were calculated using intraclass correlation coefficients (ICCs). The correlation between JAMA, GQS, DISCERN, and TMDCS was assessed by calculating Spearman correlation coefficients. Statistical significance was set at $p<0.05$.

RESULTS

ICC values indicated good intraexaminer repeatability (0.976-0.988) for both observers. The ICC range for examiners 1 and 2 was 0.969 to 1.000 and 0.984 to 1.000, respectively.

From the 160 websites listed, some were excluded because of duplication (75), irrelevance (1) advertisement (2), and no access (5). The sources of the remaining 77 sites were dentists in private practice (6.5%), hospitals/polyclinics (32.5%), universities (6.5%), and others (54.5%). The total DISCERN score of all websites included was poor (average score 26.96). No website reached an excellent or good score. More of the websites scored as poor or very poor (92.2%) (Table 2).

The average score per DISCERN question among all websites was displayed in Table 3. When using the keywords "Temporomandibular Disorder" and "Temporomandibular pain," most of the websites (n=74) were relevant according to DISCERN Question 3.

None of the websites covered all the JAMA benchmarks at once. Although the "disclosure" was the most achieved score, the attribution was the least. JAMA benchmarks and their distribution on websites are shown in Table 4.

The distribution of TMDCS between the sources was presented in Table 5. The most frequently mentioned subject was "Symptoms-Pain," whereas the least mentioned subject was "Children/Adolescents."

The correlation analysis of JAMA, DISCERN, TMDCS, and GQS values indicated that there was no significant relationship between JAMA and TMDs, and a very weak and weak relationship with the other 2 parameters. (DISCERN: r=0.238; GQS: r=0.318) The highest correlation was found between JAMA and TMDCS values (r=0.711) (Table 6).

Table 1. Global Quality Score (GQS) description

Score	Description
1	Poor quality, poor flow of the 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	Generally good quality and 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

DISCUSSION

Nowadays, with rapidly developing technology, the internet is an important part of our lives. This directly increases the information obtained through the internet. Researchers point out that the use of the internet as an important resource for many issues causes the problems of reliability and/or accuracy of the source quoted or read (6). The absence of any control mechanism for all kinds of information published on the internet, as in printed sources, may cause this information to be spread rapidly and uncontrollability (6, 21). This may mislead patients and/or their relatives researching health problems and treatment alternatives. Moreover, awareness of the physicians about the possible knowledge of the patients about the diseases and their treatment choices may improve physician-patient communication. Therefore, we aimed to evaluate the content and quality of the Turkish information about TMDs which the patients in Turkey obtain. We used Google Trends to obtain the most popular keywords in Turkish. After the keywords were identified, the search for the determined keywords was made by a single researcher

Table 2. Association between the sources and DISCERN, JAMA, GQS, and TMDCS

	Total (n=77)	Dentist (n=5)	Hospital/polyclinics (n=25)	University (n=5)	Others (n=42)
Total DISCERN score (16-80)					
16-26 (very poor)	51	3	17	4	27
27-38 (poor)	20	0	5	1	14
39-50 (fair)	6	2	3	0	1
51-62 (good)	0	0	0	0	0
63-80 (excellent)	0	0	0	0	0
Average DISCERN score	26.96	31.8	26.72	27.2	26.5
Average number of JAMA benchmarks satisfied (0-4)	1.75	2.2	1.48	1.6	1.88
Average GQS (1-5)	2.31	3.2	2.52	2.6	2.1
Avarage TMDCS (0-14)	8.4	9.4	8.28	9	8.29

DISCERN: Quality criteria for consumer health information; GQS: Global quality score; JAMA: Journal of American Medical Association; TMDCS: Temporomandibular disorder content score

Table 3. JAMA benchmarks and distribution of them between the sources

DISCERN questions	Mean score (1-5)
1. Are the aims clear?	1.92
2. Does it achieve its aims?	1.71
3. Is it relevant?	3.12
4. Is it clear what sources of information were used to compile the publication (other than the author or producer)?	1.18
5. Is it clear when the information used or reported in the publication was produced?	1.39
6. Is it balanced and unbiased?	2.25
7. Does it provide details of additional sources of support and information?	1.23
8. Does it refer to areas of uncertainty?	1.26
9. Does it describe how each treatment works?	1.96
10. Does it describe the benefits of each treatment?	1.84
11. Does it describe the risks of each treatment?	1.14
12. Does it describe what would happen if no treatment is used?	1.65
13. Does it describe how treatment choices affect the overall quality of life?	1.35
14. Is it clear that there may be more than one possible treatment choice?	1.87
15. Does it provide support for shared decision making?	1.27
16. Based on the answers to all of the above questions, rate the overall quality of the publication as a source of information about treatment choices.	1.81

DISCERN: Quality criteria for consumer health information; JAMA: Journal of American Medical Association

Table 4. JAMA benchmarks and distribution of them between the sources

	Dentist	Hospital/ polyclinics	University	Others	Total	
JAMA Benchmarks	n	n	n	n	n	Percentage
Authorship	3	5	2	11	22	28.6
Attribution	2	1	0	9	12	15.6
Disclosure	3	25	5	29	62	80.5
Currency	2	6	1	30	39	50.6

JAMA: Journal of American Medical Association

Table 5. Distribution of TMD contents based on the sources

	Dentist	Hospital/ polyclinics	University	Others	Total	
	(n=5)	(n=25)	(n=5)	(n=42)	n	Percentage
Definition-disorders of joint	4	16	4	23	47	61
Definition-disorders of mastication muscles	3	12	2	9	26	33.8
Anatomy and function of TMJ	2	11	3	17	33	42.9
Etiology-trauma	3	20	5	33	61	79.2
Etiology-Anatomic/systemic/pathologic	3	19	3	33	58	75.3
Etiology-psychologic	3	18	4	31	56	72.7
Diagnosis	3	13	2	20	38	49.4
Symptoms-pain	5	24	5	42	76	98.7
Symptoms-limitation of movement	5	23	5	33	66	85.7
Treatment-education/exercise	5	15	3	32	55	71.4
Treatment-surgical	4	12	4	21	41	53.2
Treatment-non surgical	4	19	4	32	59	76.6
Differential diagnosis	3	5	1	21	30	39
Children/adolescents	0	0	0	1	1	1.3

TMD: Temporomandibular disorder; TMJ: Temporomandibular joint

Table 6. Spearman correlation between DISCERN, JAMA, GQS, and TMDCS

		Total JAMA	GQS	Total DISCERN	Total TMDCS
Total JAMA	r		0.238*	0.318**	0.093
	p		0.038	0.005	0.423
GQS	r	0.238*		0.668**	0.711**
	p	0.038		0.000	0.000
Total DISCERN	r	0.318**	0.668**		0.529**
	p	0.005	0.000		0.000
Total TMDCS	r	0.093	0.711**	0.529**	
	p	0.423	0.000	0.000	

DISCERN: Quality criteria for consumer health information; GQS: Global quality score; JAMA: Journal of American Medical Association; TMDCS: Temporomandibular disorder content score

at the same time, and the links of the listed websites were transferred to a Word document. Thus, algorithms such as localization differences, grammar, and previous search history information have been standardized. As the location of the search may result in a different website list, the reader should keep in mind that the results will change when searching in a different country. Therefore, further studies should be conducted, which are based on the search results of that location.

Aldairy et al. (22) stated that in a regular internet search, patients were less likely to visit more than the first 20 site results displayed on the search engine. Therefore, we evaluated the first 20 websites for each keyword searched in the 4 search engines. Exclusion criteria were determined as scientific articles, product websites, repetitive sites, advertisements, and irrelevant websites. As the present study aims to evaluate the information source that is available for the patients and evaluating the scientific articles requires an almost different study design, we determined the scientific articles as an exclusion criterion. However, no scientific article was found. Moreover, the presentation of the advertisements is variable and independent from the algorithm of the search engine, whereas our purpose was reaching the most visited websites.

Park et al. (23) evaluated the content, quality, accuracy and comprehensiveness of websites related to TMDs. They reported that websites concerning TMDs were poorly organized and maintained. Similarly, Trüp et al. (24) stated that there is a discrepancy between quantity and quality of the available information on TMDs, and in general, there is a lack of evidence-based, high-quality information for patients seeking information related to TMDs on the websites. When we evaluated all the findings of our study in general, we found similar results in our study.

In the present study, we aimed to evaluate the prominent features of 3 different assessment tools. The DISCERN tool was developed to enable patients and information providers to evaluate the quality of written information about treatment options and to facilitate the production of high-quality, evidence-based patient information. DISCERN cannot measure the information accuracy of the content, as the evaluation of accuracy requires acknowledged sources of information. However, matters such as—if conflicting information on the subject is mentioned or not and whether the given references are clear and understandable—provide a detailed scoring (9). In the present study, we determined that the scope of written educational materials provided on the websites evaluated was clear, accessible, relevant, and impartial; however, the sources and the dates of the information were not clearly stated. For the general evaluation of the websites, the total average score of the DISCERN measurement tool, reliability, information quality, and general quality score means revealed moderate scores (9). Universities and hospitals also received poor values. It appeared that the articles on related websites mostly have commercial concerns, away from the academic style. Many websites (66.2%) scored at the lowest level of DISCERN. So, it can be concluded that the content and the quality of information on the websites searched with the keywords "jaw joint disease" and "jaw joint pain" are not sufficient in our country.

Nowadays the prevalence of TMDs is quite high and they affect patients socially and functionally, and it is difficult to differentially diagnose it in terms of localization and symptoms. According to Question 13 (which inquired about the effects of treatment options on the quality of life; the relationship with family, friends, and caregivers; and the effects on daily activities), only 28.6% of the websites mentioned this issue. Kindler et al. (25) reported that depression may be a risk factor in people with joint pain and that depression symptoms were encountered in 49.2% of people with joint pain. It is expected that the improvement and decrease in pain level as a result of TMD treatment will also be effective in reducing depression and somatization of the patients. It should be considered that TMDs have effects on the quality of life and should be mentioned on the websites. However, we observed that the quality of life was not examined adequately on the evaluated websites according to our study.

The JAMA assessment tool aims to critically evaluate the reliability, plausibility, and usefulness of health-related information on the internet. In this context, the authorship of the medical content of the website, citation or reference, date of creation or update, and ownership, sponsorship, advertising policies, or conflict of interest are evaluated comparatively. There was no website meeting all the JAMA benchmarks. It has been found that the biggest deficiency among the criteria evaluating websites was the citation/attribution (15.6%). Similar results have been found in the studies evaluating medical and dental websites using JAMA benchmarks (26-28).

Opinions on the subject evaluated may vary according to different sources of information. Different authors may make different comments on the subjects that are still at the hypothesis stage, or there may be a bias in some cases. To eliminate such problems, reference sources should be specified for the information provided when preparing a website. This issue is questioned with a criterion in both DISCERN and JAMA measurement tools (9, 10). We observed that 84.4% of the websites did not meet the "attribution" criteria of JAMA and the Question 4 of DISCERN. In contrast, websites that gave reference either provided the opin-

ion of a single expert or did not cite the specific sources in the article. Providing reference sources for each new evidence-based information may avoid bias and facilitate access to accurate information.

TMDs were previously assumed to be a condition that only affects adults; however, recent epidemiological studies have reported that the frequency of TMDs' signs and symptoms among the children is similar to the frequency among the adults. Although children and adolescents rarely complain of any symptoms, there is an increase in the frequency of TMD symptoms throughout life among the children and adolescents having symptoms (20). Frequent parafunctional habits such as bruxism in children are effective in the development of TMDs at older ages. The prevalence of TMDs in children has been reported as 16% in the deciduous dentition and 90% in the mixed dentition period. It has been reported that TMJ sounds increase with permanent dentition from deciduous dentition (29). Although the signs and symptoms among children and adolescences are not rare, TMDs in childhood and adolescence were briefly mentioned on only 1 website. It has been observed that the internet cannot be used as a source of information on this subject that families searched for their children.

It has been revealed that 40% to 75% of the cases in the adult population have symptoms of at least 1 joint dysfunction, and 33% of these cases have dysfunction symptoms such as facial pain and articular pain (30). The symptoms are observed between the ages of 17 and 30 years in the general population, while it is more pronounced between the ages of 20 and 40 years (31). In the present study, movement limitation (85.7%) and pain symptoms (98.7%) were found to be among the most frequently mentioned information contents.

TMDs can be divided into 2 groups as pain-related disorders (myalgia, arthralgia, and headache) and TMJ-related disorders (disc displacement and degenerative diseases) (32).

Pain is the most common symptom of temporomandibular disease (13, 33). In patients with TMDs, pain is observed in the TMJ and chewing muscles. Pain can be caused by musculoskeletal, vascular, neurovascular, neuropathic, psychogenic, and infectious diseases. Therefore, the fact that the pain is caused by TMDs should be confirmed by appropriate imaging methods and clinical examination concomitantly (34). Therefore, the information on the websites is an important element in providing information about possible differential diagnoses, raising awareness of the patients, and directing the patient to the right specialist. However, we found that 39% of the websites had provided information about differential diagnosis.

Although 54.5% of the evaluated websites were nonprofessional resources, (health sites, news sites ext.) the most emphasized content (29.3%) of these websites was "treatment: exercise and education." Besides, it was observed that less than half of the websites provide information about TMJ anatomy and function and also a definition of disorders related to mastication muscles. It has been observed that there is a need for reliable, up-to-date, and evidence-based information sources about TMDs. The websites managed by professional organizations without any commercial concerns may help inform patients about TMDs correctly.

CONCLUSION

On the basis of the results of this study, the following conclusions were drawn:

1. None of the websites included all the contents, and most of them could not be considered as a patient resource for TMDs.
2. Because of the insufficiency of information, TMD-related websites cannot be a source of information about TMDs in children and adolescents.
3. It was observed that professionals organized or managed fewer websites about TMDs.
4. Professionals should prepare more comprehensive websites and make improvements on existing websites to improve informational resources for patients with TMDs or they should refer more scientific resources to patients.

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

Informed Consent: Informed consent is not necessary due to the nature of this study.

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Original Article

Relationship between Pathological Occlusal Changes and the Signs and Symptoms of Temporomandibular Dysfunction

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Main points:

- A correlation between pathological occlusal changes and the signs and symptoms of TMD was investigated.
- Among the occlusal factors analyzed in the study, Class II malocclusion was statistically correlated with TMD. The patients with this malocclusion showed signs of crackling and bruxism.
- Class I malocclusion with crowding was the most prevalent in cases of tooth loss.

ABSTRACT

Objective: This study aimed to investigate whether there is a correlation between pathological occlusal changes and the signs and symptoms of temporomandibular dysfunction (TMD).

Methods: This cross-sectional, quantitative, non-randomized clinical trial was conducted on 150 participants. We examined adult patients of both genders with occlusal interference, malocclusion and dental absence in the posterior region of the dental arch that were associated or not associated with painful symptoms. The questionnaire was administered, and the intra- and extra-oral clinical examination was performed on each patient, including the evaluation of the temporomandibular joint (TMJ) to investigate the presence of dysfunction.

Results: The mean age of the participants was 33 years (±2.3), and 103 (68.7%) of them were women and 47 (31.3%) were men. Tooth loss and malocclusion were more prevalent in females. Tooth loss showed a statistically significant association with all the signs and symptoms of TMD (p=0.02). Patients with multiple teeth losses experienced preauricular pain during mandibular opening and closing. There was no association between malocclusion with tooth loss and the signs and symptoms of TMD in 65 patients (p>0.05).

Conclusion: Only in the patients with Class II malocclusion there was a significant association with 2 signs of TMD (crackling and bruxism). There was no association between malocclusion and tooth loss with the signs and symptoms of TMD. The signs and symptoms of TMD were more frequent in the patients who presented multiple teeth loss without malocclusion.

Keywords: Malocclusion, occlusion, temporomandibular joint dysfunction syndrome

INTRODUCTION

Temporomandibular joint dysfunction (TMD) presents clinical, muscular, and articular symptoms related to the stomatognathic system. It has a multifactorial etiology, and it is related to structural, neuromuscular, occlusal factors (dental loss, dental wear, maladaptive dentures, cavities, improper restorations, premature contact of restorations, inclination of teeth toward the space created by tooth loss, bruxism, nail-biting, hand–jaw support, digit or pacifier sucking) and traumatic or degenerative lesions of the temporomandibular joint (TMJ) (1, 2).

Symptoms may occur spontaneously, but in general, they are aggravated by masticatory function. They are usually unilateral and are located close to the ear, the angle of the mandible, or the face and temporal area, with

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restricted muscle movements, tenderness to palpation, and possibly heterotopic pain when trigger points are detected (3).

Pain is the most common symptom, and women are more affected than men. Some possible reasons for this involve psychosocial, psychological, behavioral, hormonal, and structural factors. TMD symptoms appear to be more severe and last longer in women, increasing the chance that they will seek treatment. Symptoms have a negative impact on the quality of life of the patient, impairing work activities, school, sleep, and appetite (4).

Both genders are affected equally between the ages of 20 and 40, with little clinical evidence in children. The signs of TMD in children are mild, from no evidence progressing to more severe dysfunction as adults. The low prevalence in elderly individuals can be explained by the fact that with advancing age, symptoms of other more serious diseases are more salient than those of TMD, and this reduces the likelihood of seeking treatment (5, 6).

The literature is strong and consistent in support of the role of other factors, such as psychosocial and genetic issues, as well as muscle-related overload, in the pathophysiology of TMD. It is worth mentioning that the loss of posterior teeth, a lower number of teeth, and edentulousness have been associated with TMD symptoms. Non-occlusion on at least one side leads to an increased likelihood of developing myofascial pain (7).

Although occlusion is commonly considered to be a major risk factor for TMD, there is limited understanding of the causal relationship between the occurrence of TMD symptoms and occlusion and of the possible role of the different aspects of occlusion in the etiology of TMD (8).

For this reason, it is necessary to follow up on patients by performing occlusal adjustments and orientation to obtain removable dentures as a replacement for permanent teeth that are lost, ensuring an improvement in aesthetics, speech, and chewing, i.e., in the patient's quality of life. The high prevalence of TMD and the negative outcomes that are associated with several other morphofunctional problems justify the development of this research.

As a hypothesis, it is believed that occlusal factors should not be considered the most important factors in the etiology of TMD. It is necessary to take a broad view of its etiological factors and to recognize occlusion as just one of these factors, which may or may not have an influence on TMD, depending on the patient's characteristics. Therefore, the aim of the study was to investigate whether there was a correlation between pathological occlusal changes and the signs and symptoms of TMD.

METHODS

A cross-sectional, quantitative, non-randomized clinical intervention study was carried out after approval by Committee Research Ethics at the State University of Piauí - CEP / UESPI with the decision number 1.978.081. The number of patients attended to per month in the Clinical School of Dentistry (CSD) of the State University of Piauí in the city of Parnaíba-PI was considered as the target population. For that, an arithmetic average of the number of visits was calculated for the period between August 2017 and June 2018, resulting in 310 patients per month. Based on the proposed data and considering a sampling error of 5% in addition to a 95% confidence level, the minimum sample size needed to represent the assisted population was 160 participants (9).

Adult patients of both genders with occlusal interferences, such as premature dental contact points or any type of malocclusion (biprotrusion, crowding, crossbite, open bite, Angle Class I, Class II, and Class III), associated or not associated with dental absence in the posterior region (of one tooth or teeth in any posterior hemi-arch of both arches), with or without painful symptomatology, were included in the study. We excluded patients who had already used orthodontic appliances or had a history of TMD treatment, patients with cognitive deficiency, and those who did not wish to participate in the study.

During the experiment, some of the patients did not continue treatment and finally a total of 150 participants, were included for further analysis, of whom 97 were women and 53 were men. Convenience sampling was used, which consisted of selecting the participants consecutively as the individuals arrived at the data collection site.

The team, made up of 2 researchers, had a workload of 36 hours, divided between theoretical discussion of the variables and codes used, the criteria of examination, and practical discussion. The experiment simulated the different conditions and situations that the professionals would encounter during their practical work in the diagnosis of occlusal interferences, dental losses, malocclusion, pain, and TMD in 30 patients who received routine care at the CSD, according to the methodology described in another publication (10).

Between December 2017 and May 2018, the patients were selected as they sought dental treatment on Mondays, Wednesdays, and Fridays, during both shifts at the CSD. After the signing and authorization of the informed consent form, the questionnaire that had been developed for the study of each case was applied. The physical examination for the intra- and extra-oral evaluation of each patient was then performed, including an analysis to investigate the presence of TMD. Dental signs, malocclusions, and TMD were recorded in the clinical file (the 3 symptoms of muscle fatigue, preauricular pain and TMJ pain), along with 7 dental indicators, including click (a clear, strong, and short sound), crackling (a long and rough sound), mandibular displacement, limited mouth opening, mandibular locking, tightening, and bruxism. The presence of these symptoms and signs is suggestive of TMD because they can be associated with occlusal conditions, trauma, emotional distress, and parafunctional activities.

Mandibular displacement was considered as the deviation from the dental midline during opening the mouth. Mouth-opening limitation was measured by the distance between the incisal edges of the upper and lower central incisors, 52.85±7.41 mm for men and 48.34±5.64 mm for women.

Clinically, mandibular locking was measured by the partial or total interruption of mandibular movement. As the mandible is a rigid arch, a lock on one side produces chin deviation toward the homologous side, creating a rotational movement. In total locking, the mouth opens up to the limit of the lock.

Tightening and bruxism were detected by the wear on the incisors and canines and were associated with pain in the TMJ.

To detect joint noise, manual palpation, and bilateral auscultation of the TMJ were done using a stethoscope. The patients opened and closed their mouth several times, following the verbal prompt of the examiner, so that it was possible to determine the presence or absence of noise and the type of noise. The manual palpation of the masticatory muscles and the TMJ evaluation followed the recommendations of Santos et al. (11). This palpation was performed as a complement to the clinical evaluation to analyze the muscle condition.

The patients received follow-up at the CSD for 1 year. During the study, the researchers gave educational lectures on the subject. The importance of maintaining oral hygiene was emphasized to prevent tooth loss and TMD.

The sample of patients with malocclusion was referred to the specialization clinic in the city of Parnaíba for orthodontic treatment. When necessary, in situations of occlusion interference, occlusal adjustment was performed at the end of orthodontic treatment in patients who presented "spots" after an occlusal test with carbon paper. Those with tooth loss who needed removable dental prostheses were referred to the CSD for oral rehabilitation.

Statistical Analysis

The data were tabulated using The Statistical Package for Social Sciences version 21.0 software (SPSS Inc., Chicago, IL, USA), and descriptive statistics (frequency and distribution) were measured. Chi-square tests were used to verify the association between symptoms, sex, and causes. A pilot study was performed on 20 patients. The patients who did not fit the sample to test the proposed methodology were also assisted by the CSD. As a result, its viability was observed, with no need for adjustments. To assess intra- and inter-examiner reproducibility, 10% of the total sample was double examined by each of the examiners, and the Kappa coefficients for the agreement of intra- and inter-examiners were 0.88 and 0.87, respectively.

RESULTS

The mean age of the participants was 33±2.3 years, and 103 (68.7%) of them were women and 47 (31.3%) were men. The results were showed in tables 1-3 with their respective descriptions. In patients who had malocclusion associated or not associated with tooth loss, dental interference was present, and occlusal adjustment was performed in 90 patients after orthodontic treatment. The distribution of tooth loss and malocclusion in

Table 1. Distribution of tooth loss, multiple teeth loss, and malocclusion in relation to gender tested by chi-square test

Variables	N	Women	Men	Chi-square value and p value	Superior arch	Inferior arch	Both arches
Tooth loss	20	11	9	χ^2=0.20 p=0.65	Women: 8 Men: 2	Women: 3 Men: 7	
Multiple teeth loss	40	29	11	χ^2=12.81 p=0.01**	Women: 4 Men: 1	Women: 9 Men: 3	Women: 16 Men: 7
Malocclusion	25	19	6	χ^2=5.40 p=0.02*			
Malocclusion+multiple teeth loss	65	44	21	χ^2=7.23 p=0.01**			

*p< 0.05; **p≤0.01

Table 2. Frequency of the sample distribution based on the questionnaire

Signals/ symptoms	Total n=150	Women	Men	Tooth loss n=20	Multiple teeth loss n=40	Malocclusion n=25	Malocclusion+multiple teeth loss n=65
Click	60	47	13	11	39	8	2
Crackling	26	20	6	5	17	3	1
Muscle fatigue	44	35	9	6	24	9	5
Mandibular displacement	50	34	16	10	20	7	13
Mouth-opening limitation	26	21	5	2	13	6	5
Mandibular locking	16	10	6	3	8	3	2
Tooth tightening	64	45	19	13	23	8	20
Bruxism	50	32	18	10	22	3	15
Preauricular pain	48	36	12	7	21	8	12
TMJ pain (opening and closing)	42	30	12	5	20	8	9

TMJ: Temporomandibular joint

Table 3. The results of Chi-square test regarding the signs/symptoms and the variables

Signs/ symptoms	Test	Tooth loss n=20	Multiple teeth loss n=40	Malocclusion n=25	Malocclusion+multiple teeth loss n=65
Click	χ^2=19.27 p<0.001***	χ^2=0.20 p=0.65	χ^2=5.40 p=0.02*	χ^2=0.07 p=0.79	χ^2=0.60 p=0.44
Crackling	χ^2=7.54 p=0.01**	χ^2=5.01 p=0.02*	χ^2=7.54 p=0.01**	χ^2=5.40 p=0.02*	χ^2=0.15 p=0.69
Muscle fatigue	χ^2=15.36 p<0.001***	χ^2=3.20 p=0.07	χ^2=5.82 p=0.02*	χ^2=0.60 p=0.44	χ^2=0.09 p=0.76
Mandibular displacement	χ^2=6.48 p=0.01**	χ^2=0.01 p=0.99	χ^2=5.12 p=0.02*	χ^2=0.07 p=0.79	χ^2=0.32 p=0.57
Mouth-opening limitation	χ^2=9.85 p=0.01**	χ^2=12.80 p<0.001***	χ^2=9.85 p=0.01**	χ^2=0.60 p=0.44	χ^2=0.15 p=0.70
Mandibular locking	χ^2=1.00 p=0.32	χ^2=6.25 p=0.01**	χ^2=0.01 p=0.99	χ^2=0.60 p=0.44	χ^2=2.25 p=0.13
Tooth tightening	χ^2=10.56 p=0.01**	χ^2=1.80 p=0.18	χ^2=9.00 p=0.01**	χ^2=0.07 p=0.80	χ^2=0.02 p=0.89
Bruxism	χ^2=3.92 p=0.04*	χ^2=0.01 p=0.99	χ^2=11.52 p=0.01**	χ^2=5.40 p=0.02*	χ^2=0.01 p=0.99
Preauricular pain	χ^2=12.00 p=0.01**	χ^2=1.80 p=0.18	χ^2=5.33 p=0.02*	χ^2=0.07 p=0.79	χ^2=0.33 p=0.56
TMJ pain (opening and closing)	χ^2=7.72 p=0.01**	χ^2=5.00 p=0.02*	χ^2=6.09 p=0.01**	χ^2=0.67 p=0.79	χ^2=0.95 p=0.76

TMJ: Temporomandibular joint; *p < 0.05; **p≤0.01; ***p≤ 0.001

relation to gender and chi-square test was showed in Table 1. Among 29 women, there were multiple teeth loss in the posterior region, ranging from 4 to 6 teeth. In 16 women, there was a teeth loss in both arches. Table 2 shows the frequency of the sample distribution. Table 3 shows the chi-square test results for the signs, symptoms, and variables. There was a significant predominance of women in relation to tooth loss and malocclusions (Table 1).

It was found that there were differences in the association between gender and dental absence or malocclusion in the 7 signs and 3 symptoms of TMD (p<0.05). This scenario indicates the rejection of the null hypothesis because of significant differences between the observed and expected frequencies (Table 2). There was a greater association of the female gender with the signs and symptoms of TMD. Tooth loss showed a statistically significant association with all the signs and symptoms of TMD. All the patients with multiple teeth loss experienced preauricular TMJ pain and pain during mandibular opening and closing (Table 2). However, in tooth loss, only crackling, limited mouth opening, and mandibular locking were observed (Tables 1-3).

In the patients who presented only malocclusion, 16 cases of Class II, 7 of Class I with anterior crowding, and 2 of Class III with posterior crossbite were observed. No patient had an anterior open bite. There was a significant association (p=0.02) with 2 signs of TMD (crackling and bruxism) only in the patients who presented Class II malocclusion. There was no association between the 65 cases of malocclusion with tooth loss and the signs and symptoms of statistically significant TMD (Table 3). There were 42 patients with Class I malocclusion with anterior crowding (17 with tooth loss and 25 with multiple teeth loss), 21 patients with Class II (7 with tooth loss and 14 with multiple teeth loss), and 2 patients with Class III malocclusion associated with multiple teeth loss.

DISCUSSION

Functional, structural, and psychological factors characterize the complex multifactorial etiology of TMD. Occlusion is treated not only as the contact relationship between the teeth but also as a dynamic, morphological, and functional relationship between all the components of the stomatognathic system that has a great influence on chewing, swallowing, and speech. The authors believe that occlusion plays a limited role; however, it cannot be underestimated (12-15).

In this study, there was an association between muscular pain and TMJ, click, and crackling in some clinical situations, such as dental loss and malocclusions (Tables 2 and 3), corroborating Costa et al. (16). They observed that 80% of the patients with TMD presented positive responses to TMJ sounds, muscle fatigue, or pain during chewing, headache and pain in the cervical region, occlusal interference, and associated malocclusions.

Although other authors have stated that joint noises are frequent, the absence of joint noise cannot be a determining factor of joint normality. There is a relationship between TMD and occlusal factors that may predispose, trigger, or perpetuate this dysfunction, and the occlusal analysis of the patients should not be neglected (16).

In particular, the multiple loss of posterior teeth was quite expressive (Tables 1-3), suggesting an association with the signs and symptoms of TMD. The loss of posterior support is considered to be one of the few dental factors that had some consisten-

cy of evidence in the literature as a cause of TMJ pain and TMD. This was observed by Landi et al. (17) when they stated that the most prevalent occlusal factor in TMD patients was the absence of 5 or more posterior teeth. This kind of tooth loss could lead to joint problems, particularly the risk of cracking and dislocation of the articular disc. Some authors have reported that the patients with greater tooth loss in support areas were more affected by myofascitis of the lateral pterygoid muscle, capsulitis, and partial anterolateral disc displacement, which may accelerate the development of TMJ degenerative diseases (17-19).

In this study, it was observed that the patients who presented multiple tooth loss without malocclusion showed significant signs and symptoms of TMD, such as click, crackling, muscle fatigue, mandibular displacement, limited mouth opening, mandibular locking, tooth tightening, bruxism, preauricular pain, and TMJ pain (opening and closing). It is worth mentioning that the patients with tooth loss associated with malocclusion did not show any significant correlation with TMD signs and symptoms. This suggests that orthodontic treatment alone will not treat this dysfunction. Oral rehabilitation is indicated to restore the correct masticatory function and muscle balance. Such observations have been made by other authors who concluded that invasive dental therapy, such as orthodontic treatment, is not recommended for the management or prevention of TMD, and its need should be analyzed with caution by practitioners (17, 18).

In the study by Lemos et al. (20) and Teixeira et al. (21), the malocclusion was not associated with the presence of TMD or the appearance of clinical signs. Among the occlusal factors analyzed in the study, Class II malocclusion was statistically correlated with the need for treatment and TMD, which corroborates our studies because Class II showed significant signs of TMJ crackling and tooth creaking. When malocclusion was associated with multiple teeth loss, Class I with dental crowding was more prevalent, but the signs and symptoms of TMD were not statistically significant, although they were observed in all the malocclusions studied (Tables 2, 3).

In a prospective longitudinal study, an increase in the prevalence of TMD symptoms was found in a group of patients with Class II malocclusion. According to these authors, the type of occlusion may play a role as a contributing factor in the development of TMD signs and symptoms, although this influence is difficult to quantify and predict (22).

In a systematic review of the association between malocclusion and the signs and symptoms of TMD, significant evidence to suggest that functional or static occlusal factors cause TMD is lacking. TMD cannot be correlated with any specific type of malocclusion (23).

Studies indicate that the contribution of occlusal factors to the appearance of TMDs is mild. Only a few factors of static occlusion were significantly correlated with the signs of TMD (23). However, the study by Motta et al. (24) found that there was a statistically significant association between parafunctional habits and sinuses and/or TMD symptoms in adolescents. It should be noted that the study by Lemos et al. (20) showed that Class II malocclusion, overbite, and rotated teeth were correlated with the presence of clinical signs of joint TMD or the need for treatment, but that in general, occlusion may play a role as a cofactor in predisposing or perpetuating the different forms of TMD and should not be considered to be the main factor.

The absence of a disease-specific association between the features of dental occlusion and TMD has been observed, and there is no ground to hypothesize a major role of dental occlusion in the pathophysiology of TMDs. Thus, longitudinal studies should be performed to prove that there is a correlation between malocclusion and TMD (25-27).

CONCLUSION

There was a significant association between the 2 signs of TMD (crackling and bruxism) and Class II malocclusion. The signs and symptoms of TMD were more frequent in the patients who presented multiple teeth loss without malocclusion.

Ethics Committee Approval: This study was approved by Ethics committee of State University of Piauí (Approval No: 1.978.081).

Informed Consent: Written informed consent was obtained from the patients who agreed to take part in the study.

Peer-review: Externally peer-reviewed.

Author Contributions: Supervision – A.L.; Design – A.L., M.F.; Resources – A.L., M.F.; Materials – A.L., M.F.; Data Collection and/or Processing – A.L., M.F.; Analysis and/or Interpretation – A.L., M.F.; Literature Search – M.F.; Writing Manuscript – A.L., M.F.; Critical Review – A.L., M.F.

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Original Article

Effect of Strontium Ranelate on Condylar Growth during Mandibular Advancement in Rats

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Main points:

- Strontium ranelate (SR), an anti-osteoporotic agent, is composed of one ranelic acid and two non-radioactive strontium atoms. Unlike its counterpart, SR increases bone formation as well as reducing bone destruction.
- Increase in the condylar ossification after mandibular advancement with systemic SR application was evaluated.
- As a result, SR was found to increase condylar ossification at the histological level, but it was determined that SR had no effect on the total size of the mandible.

ABSTRACT

Objective: Strontium ranelate (SR), unlike other anti-osteoporotic agents, might not only prevent bone resorption but also might induce bone formation. The aim of this experimental study was to evaluate the effects of systemic SR on condylar growth during mandibular advancement (MA) in growing rats.

Methods: Fifty-six, 8-week-old Wistar male rats weighting 160-190 g were randomly divided into four groups; one control (n=14) and three experimental (n=14). Group 1: Control group, Group 2: SR (900mg/kg daily dose), Group 3: MA, Group 4: SR +MA. The amount and direction of mandibular growth were assessed by linear measurements on the computed tomography (CT) images taken on days 1, 15, and 30. For immunohistochemical evaluation, half of the subjects in the groups were sacrificed on the 15th day (early phase) and the rest of them on the 30th day (late phase). New cartilage and bone formation areas on the condyle were analyzed by using Sox9 and Osteopontin antibodies.

Results: Early and late CT images measurements showed no significant difference between the groups ($p<0.05$). However, there were significant differences between the control and experimental groups in the immunohistochemical assessment. Severe immunolocalization of SOX9 and Osteopontin was observed in Group 4, while the immunolocalization scores were moderate in Group 2 and Group 3. In addition, early histological findings were similar to late results in all groups.

Conclusion: In mandibular advancement therapy, Strontium ranelate could be therapeutically effective in avoiding relapse and reducing the duration of retention.

Keywords: Mandibular advancement, Strontium ranelate, Computed tomography, Immunohistochemistry

INTRODUCTION

Class II malocclusions are commonly seen in orthodontic practice. This malocclusion might adversely affect facial aesthetics and mastication. Mandibular retrognathia is the primary factor for skeletal Class II malocclusions and a wide range of functional orthopedic appliances are used to correct this anomaly (1). Mandibular retrognathia correction and retention period have an average duration of one year (2). Long treatment periods can weaken patient compliance. In recent studies researchers have tested whether condylar growth can be stimulated during mandibular advancement by different treatment modalities (low-level laser, chemical agents, etc.) (3). These applications were intended both to improve treatment efficiency and to decrease the total treatment duration of mandibular advancement (MA).

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Table 1. Definition of the groups

Groups	Experimental Procedure	Total number of the rats
Group 1(Control)	No application was made.	
	7 rats were sacrificed on the 15th day.	14
	7 rats were sacrificed on the 30th day.	
Group 2 (SR)	Only systemic SR application (900 mg / kg), but no mandibular advancement	
	7 rats were sacrificed on the 15th day.	14
	7 rats were sacrificed on the 30th day.	
Group 3 (MA)	Only mandibular advancement, but no SR application.	
	7 rats were sacrificed on the 15th day.	14
	7 rats were sacrificed on the 30th day.	
Group 4 (SR+MA)	Both mandibular advancement and systemic SR (900 mg / kg) application	
	7 rats were sacrificed on the 15th day.	14
	7 rats were sacrificed on the 30th day.	

SR: Strontium ranelate; MA: Mandibular advancement

One of the major subjects in orthodontics is bone turnover experienced during growth and development periods or orthodontic tooth movements. Anti-osteoporotic agents that affect bone turnover have therefore been the subject of previous orthodontic research (4, 5). Strontium ranelate (SR) is a promising new anti-osteoporotic agent consisting of one ranelic acid and two non-radioactive strontium atoms and has a unique dual-action in bone formation and resorption. It has a good safety profile with tolerability and compliance so it has begun to be used as an alternative to other bisphosphonates for initial osteoporosis treatment. SR is therapeutically indicated for the treatment of severe osteoporosis in both postmenopausal women and adult men at high risk of fractures. Basically, bisphosphonates only prevent the loss of bone density. However, unlike its equivalents, SR increases bone formation, and also reduces bone resorption. SR is the first anti-osteoporotic agent that has dual-effect (6-8). Numerous studies investigating the SR mechanism have shown that it stimulates osteoblast proliferation and inhibits osteoclast formation (9, 10). SR affects bone turnover by stimulating the expression of Osteoprotegerin (OPG), activating the Calcium-sensing receptor (CaSR), and suppressing the Osteoclast differentiation factor (RANKL) (8, 11). Since it enhances osteoblastic activity, previous orthodontic studies have investigated the impact of SR on anchorage and its influence on ossification in the mid-palatal suture (12, 13).

SOX9 is a transcription factor that is expressed in chondrocytes. It is found in both cartilage and primordial cartilage tissues during embryo development and is recognized as the determinant factor for a lineage of chondrocyte (14). Osteopontin regulates the biomineralization of bone tissue. It plays an important role in the osteoblastic activity and is found in bone mineralization regions due to its affinity to calcium (15).

The objective of this experimental study was to investigate the effects of systemic SR on condylar growth during mandibular advancement. In the future, we believe that these kinds of experimental studies might allow clinicians to shorten the retention period of MA treatment and prevent possible relapses.

METHODS

Experimental protocols of this study were approved (17.03.2017-25) by Cumhuriyet University Animal Research Ethics Committee. In the power analysis to determine sample size, it revealed that minimum 14 rats were required for each group in order to obtain sufficient statistical power (n=14, α=0.05, and 1-β=0.80). During the study, all instructions determined by the ethics committee were followed. A total of fifty-six, 8-week-old (160-190 g body weight) Wistar male were used (16, 17). In the selection of experimental animals, attention was paid to conditions such as good general health and ideal anterior teeth. Rats in each group were fed with soft diet and water in a separate cage under the same conditions as 12 hours daily / night, 21±1°C temperature and 40-60% humidity.

Definition of the Groups

Fifty-six growing rats were randomly divided into 4 groups. Half of the animals in each group were sacrificed on the 15th day and the rest of them were sacrificed on the 30th day in order to evaluate the early and late-term effects of SR. The groups were as follows (Table 1):

Group 1 (Control, n=14): This group was included in the study to determine the morphology and normal histological characteristics of condyles and to compare them with experimental groups.

Group 2 (SR, n=14): Daily systemic SR (900 mg/kg) was applied during the experimental period. No mandibular advancement was performed. The group was designed to determine whether or not SR affects condylar growth on its own without MA.

Group 3 (MA, n=14): Mandibular advancement was performed without systemic SR application. This group has allowed us to analyze the nominative effect of the MA on condylar growth.

Group 4 (SR+MA, n=14): First, the placement of mandibular advancement devices was performed, and then the daily systemic SR (900 mg/kg) was given during the experimental period.

Figure 1. Intraoral view of the acrylic bite-jumping appliance

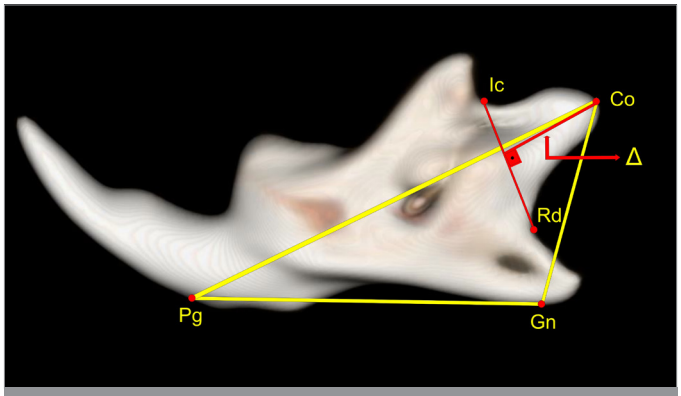

Figure 2. Co: The most posterior-superior point of the condyle, Pg: The lowest point of the mandible near the incisor, Gn: The lowest point of the lower boundary of the angular process, Ic: Deepest point between condyle head and coronoid process, Rd: Deepest point of convexity of mandibular ramus, Co-Gn: Ramus length, Co-Pg: Mandibular length, Pg-Gn: Mandibular base length, Δ: Length of condyle head

Bite-jumping Appliance and SR Application

The animals were anesthetized intraperitoneally to provide immobilization during the appliance placement. After examining the dentoalveolar structure of the subjects, impressions were taken from the lower incisors of the subjects by using silicone impression material. Composite models (Transbond XT, EP7SF, 3 M, Monrovia-CA / US) were produced from the impression and acrylic bite-jumping devices were made to move the lower jaw forward. The appliances were applied to the lower teeth as defined by Owtad et al. (18). Self etch primer (Transbond Plus Self Etching Primer, 359651, 3M, Monrovia-CA / USA) was used to bond the appliances (Figure 1). Through daily checks, the damaged appliances were renewed, and mandibular advancement was obtained again. The food and water intake of subjects were monitored and weight measurements were carried out periodically. The weight of each animal in Group 2 and Group 4 was individually identified and recorded for the preparation of SR (PROTELOS, Servier, France) suspension concentrations. Daily prepared SR (900mg/kg daily dose) suspensions in distilled water were given orally as 1 cc per dose.

Radiological Analysis

The section collimation was set to 0.5 mm and the images were obtained using A Toshiba Aquilino Helical 64-slice tomography device (Canon Group Company, Japan). Computed tomography (CT) images were obtained on the 1st, 15th, and 30th days of the study for the analysis of mandibular dimensional changes. The acquisition of images was performed under intraperitoneal anesthesia in order to prevent motion artifacts. Five reference points were identified and four linear measurements were carried out to evaluate dimensional changes of the condyle and the mandible (Figure 2) (19),(20). Aquarius Intuition Edition Version 4.4 software was used for the analysis.

Histological Evaluations

Immunolocalization is a histological technique in which specific antibodies are used to localize macromolecules (proteins, polysaccharides) within biological material (tissues, cells, biofilms). Before the histological evaluation, the rats were killed by injection of high-dose intraperitoneal anesthesia, and their lower jaws were dissected as a whole. Osteopontin and SOX9 immunolocalizations were assessed to analyze new cartilage and bone formation on the condyle. The following steps were performed during the preparation of the tissues:

- The right condyle heads were fixed in 10% neutral formalin for 30-36 hours
- Decalcification, dehydration, and transparency processes were followed.
- The tissues were embedded in paraffin and 6 µm thick sections were prepared in the sagittal plane.
- Sections were deparaffinized and hydrated in distilled water.
- Anti-SOX9 antibody (Rabbit polyclonal, Bioss) and anti-Osteopontin antibody (Rabbit Mab, Cell Signaling) were used for immunohistochemical staining of the sections. In each section, only the middle part of the condyle was evaluated by a histologist. The selected sections were photographed and digitized. The immunolocalization level of SOX9 and Osteopontin in the new cartilage and bone formation areas were evaluated semi-quantitatively for each subject. The samples were scored as mild (+), moderate (++), and severe (+++).

Statistical Analysis

Statistical analysis were performed by the Statistical Package for Social Sciences, version 15.0 software (SPSS Inc.; Chicago, IL, USA). In the assessment of the CT and histological data non-parametric Kruskal Wallis test was performed to determine the differences between the groups. Mann Whitney U test was also used to determine which group was responsible for the difference. For all statistical comparisons in the study, p values less than 0.05 were considered statistically significant. In addition, Ten randomly selected CT images were re-analyzed 10 days later by the same researcher (H.C.) to assess the error rate. Repeated measurements were compared with the intraclass correlation coefficient (ICCs).

Table 2. Comparison of the body weight measurements (Kruskal-Wallis Test)

	Group 1 (n=14) Mean±SD	Group 2 (n=14) Mean±SD	Group 3 (n=14) Mean±SD	Group 4 (n=14) Mean±SD	p
1st week	160.0±5.4	161.3±7.9	162.0±5.6	161.4±3.5	0.992
2nd week	174.1±7.0	175.0± 12.9	174.1±4.6	173.2±2.9	0.849
3rd week	184.3±7.8	182.0±14.5	184.2±6.0	181.1±4.1	0.936
4th week	194.7±8.0	195.0±12.8	194.6±5.5	193.4±3.8	0.916

SD: Standard deviation, Body weight measurement in gr.

Table 3. Pearson correlation coefficient of the CT measurements

Lengths	Co-Gn	Co-Pg	Pg-Gn	Δ
Correlation coefficient	0.958	0.898	0.937	0.910

Table 4. Comparison of linear CT measurements at T0, T1, T2

1st day (T0)	Group 1 (n=14)	Group 2 (n=14)	Group 3 (n=14)	Group 4 (n=14)	p
Co-Gn	9.1±0.3	9.2±0.2	9.3±0.3	9.2±0.4	0.745
Co-Pg	18.6±0.3	18.8±0.6	18.9±0.4	18.8±0.6	0.669
Pg-Gn	13.4±0.3	13.5±0.7	13.3±0.3	13.2±0.7	0.871
Δ	4.2±0.1	4.2±0.3	4.6±0.3	4.2±0.4	0.590
15th day (T1)	**Group 1 (n=14)**	**Group 2 (n=14)**	**Group 3 (n=14)**	**Group 4 (n=14)**	**p**
Co-Gn	9.6±0.3	9.9±0.4	9.8±0.3	9.8±0.4	0.687
Co-Pg	19.4±0.4	19.9±0.5	20.0±0.5	19.7±0.6	0.506
Pg-Gn	14.1±0.6	14.4±0.5	14.1±0.5	14.0±0.4	0.461
Δ	4.2±0.2	4.3±0.3	4.8±0.3	4.3±0.4	0.550
30th day (T2)	**Group 1 (n=7)**	**Group 2 (n=7)**	**Group 3 (n=7)**	**Group 4 (n=7)**	**p**
Co-Gn	10.2±0.4	10.4 ±0.4	10.5±0.2	10.4±0.4	0.669
Co-Pg	20.5±0.4	20.8±0.6	20.9±0.4	20.8±0.5	0.962
Pg-Gn	14.7±0.6	14.7±0.6	14.3±0.5	14.2±0.5	0.770
Δ	4.3±0.2	4.3±0.3	4.9±0.3	4.6±0.5	0.161

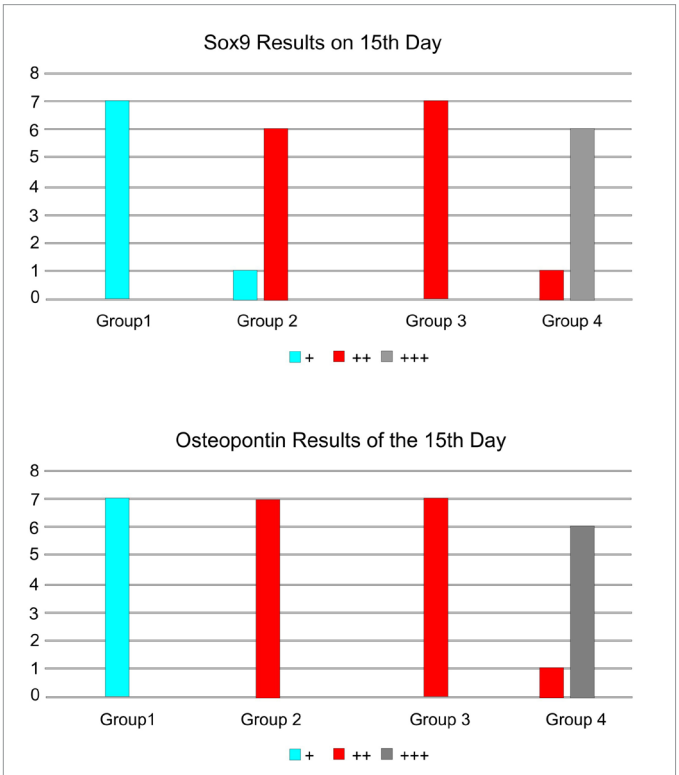

Figure 3. Early term SOX9 ve Osteopontin scores were shown with number of the rats

RESULTS

Body Weight Measurements

In order to ensure the accuracy of the study, the initial body weights of the rats were adjusted to be quite similar for all groups. No statistically significant differences were observed between the groups in the first, second, third, and fourth-week measurements (p values 0.992, 0.849; 0.936 and 0.916, respectively), (Table 2).

CT Measurements

Ten randomly selected CT measurements were repeated by the same researcher after 15 days to evaluate inter-examiner variability. No difference was seen in Pearson correlation coefficient (Table 3).

15th (T1) and 30th (T2) day measurements of Co-Gn, Co-Pg, Pg-Gn and Δ showed a significant increase compared to 1st day (T0). The dimensional changes in mandible showed no significant difference between the groups (Table 4).

SOX9 and Osteopontin

Early-term (15th day) SOX9 immunolocalization was higher in the experimental group than in the control group ($p<0.001$). Among the experimental groups, the most intensive immunolocalization was observed in Group 4 ($p<0.001$). There was no significant difference between Group 2 and Group 3 ($p>0.05$). Early-term (15th day) Osteopontin immunolocalization of experimental groups was more intensive than the control group ($p<0.001$). Similarly, the most intensive Osteopontin immunolocalization was observed in Group 4 ($p<0.001$). There was no significant difference between Group 2 and Group 3 ($p>0.05$) (Figure 3).

Late-term (30th day) SOX9 immunolocalization was significantly higher in the experimental group compared to the control group ($p<0.001$) (Figures 4 and 5). Among the experimental groups,

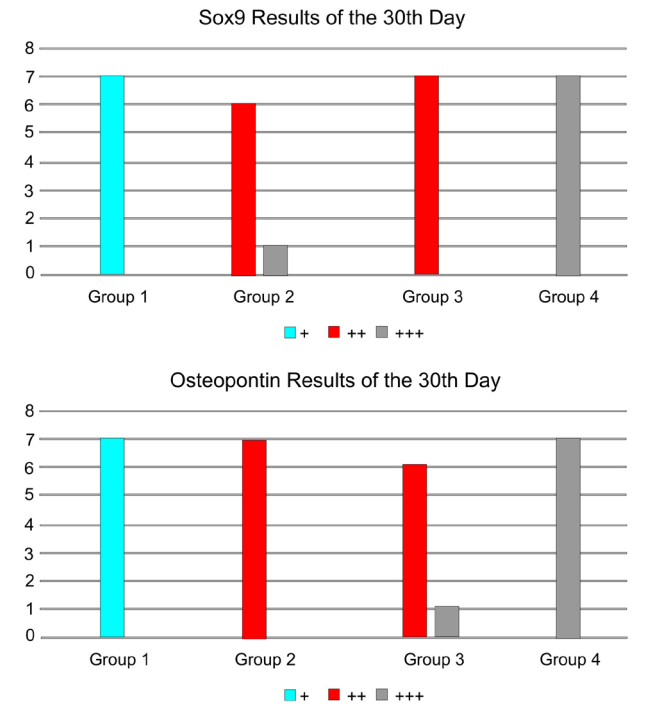

Figure 4. Late term SOX9 ve Osteopontin scores were shown with number of the rats

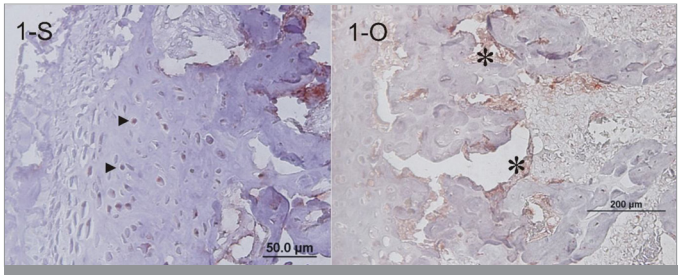

Figure 5. Histological images of Group 1 (control) S: SOX9, O: Osteopontin, *: new cartilage formation, *: new bone formation (mild level)

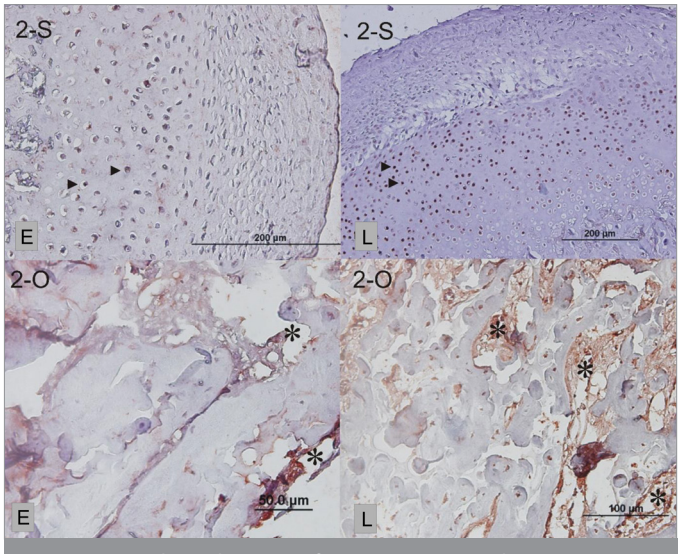

Figure 6. Histological images of Group 2 (SR). E: Early, L: Late, S: SOX9, O: Ostepontin, *: new cartilage formation, *: new bone formation (moderate level)

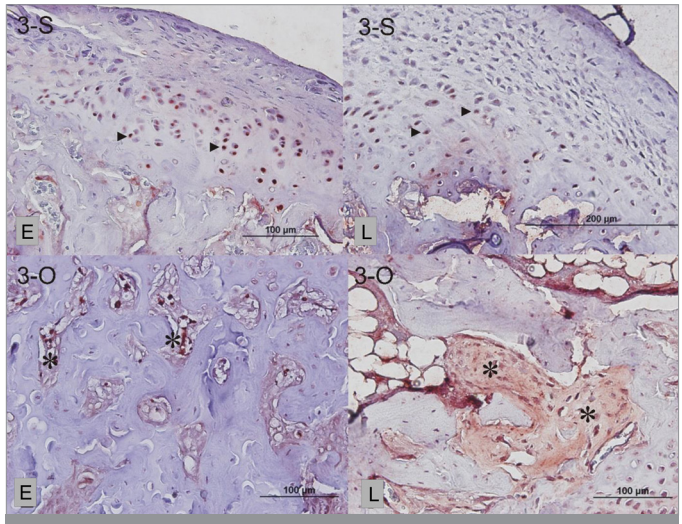

Figure 7. Histological images of Group 3 (MA). E: Early, L: Late, S: SOX9, O: Ostepontin, *: new cartilage formation, *: new bone formation (moderate level)

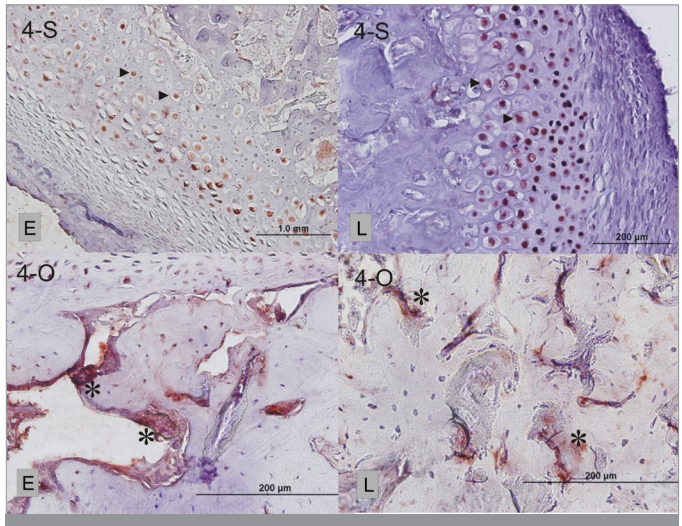

Figure 8. Histological images of Group 4 (SR+MA). E: Early, L: Late, S: SOX9, O: Ostepontin, 9: new cartilage formation, *: new bone formation (severe level)

the most intensive immunolocalization was observed in Group 4 ($p<0.001$). Group 2 and Group 3 immunolocalization levels were quite similar ($p>0.05$) (Figure 6 and 7). Late-term Osteopontin immunolocalization of experimental groups was more intensive than the control group ($p<0.001$). Similarly, the most intensive Osteopontin immunolocalization was observed in Group 4 ($p<0.001$) (Figure 8). There was no significant difference between Group 2 and Group 3 ($p>0.05$).

DISCUSSION

The main purpose of our experimental research was to evaluate the effect of systemic SR on condylar growth during mandibular advancement and to test whether it can be used therapeutically in the treatment of MA.

The age of the rats is crucial in such studies. Researchers selected 4-week or 8-week-old rats for similar experimental procedures

(16, 17, 21, 22) . However, in our opinion, 4-week old rats might not be strong enough to live with a bite jump appliance. Therefore we preferred to use 8-week-old rats. In another study mandibular advancement showed that condylar growth may occur even in 12-month or 18-month-old rats due to persistent chondrogenic cells (23).

Bite jumping appliance could be designed for rats using three methods: (1) two-piece appliance in both the lower and upper jaws, such a twin block; (2) a device only in the upper jaw; or (3) a device only in the lower jaw (18, 21, 24). Rat incisors are highly specialized for gnawing. They are open-rooted, which means they grow throughout life. The single lower jaw appliance was used in our study to ensure the success of the mandibular advancement and proper feeding of the animals.

Unlike other bisphosphonates, SR reduces bone resorption and simultaneously increases bone formation (25). SR improves the biomechanical properties and micro-architectural structure of the bones (26). However, other bisphosphonates have even been reported to reduce bone formation by up to 50% (27). The effective dose is very critical to accomplish the dual-effect of SR. Fuchs et al. (28) reported that the daily intake of SR at doses of 25 mg/kg or 150 mg/kg for 90 days was inadequate to prevent bone resorption and increase bone formation. The recommended daily effective human dose of SR is 2 grams. Bain et al. (29) stated that this dose corresponds to 625 mg/kg for rats. The discrepancy in dose among humans and rats is associated with low SR absorption in the gastrointestinal system of rats. In order to have antiresorptive effects, the daily SR intake of rats should be at least 308 mg / kg (25). SR was used in the previous two orthodontic studies at doses of 600 mg/kg and 900 mg/kg (12, 13). In our study a dose of 900 mg/kg was used to achieve a clear bone-building effect.

SR was used for experimental purposes in our study, but like any drug, SR has undesirable side effects. The most common side effects in clinical researches are (30): diarrhea, nausea, headache, and skin irritation. For patients with ischemic heart disease, uncontrolled hypertension, and cardiovascular system disorders, it has been stated that SR should not be used (31). As another side effect, the reduction of osteoclastic activity by SR may impair condylar growth. However, no such effects were observed in the histological findings. In further studies, this can be researched by the measurement of osteoclast activity markers.

The effect of mandibular advancement on condylar growth is still controversial. Some authors reported a minimal increase in condylar growth or total mandibular length (32, 33). However, other researchers have seen a significant increase in the mandibular dimension (34). McNamara et al. (35) found that mandibular advancement increased the mandibular length by 5-6 mm in monkeys. A rat mandible is much smaller than a monkey, so it is quite difficult to detect the condylar or mandibular dimensional change by CT measurement. The use of micro-CT instead of normal CT could have been more efficient. This could be the reason that in both early and late-term CT measurements, no difference was observed between all groups.

Condylar growth could be evaluated histologically using two methods: histomorphometric measurement or immunohistochemistry (36, 37). In the previous researches, the thickness of the condylar cartilage maturation, and proliferation layers was measured at three locations (anterior, middle, posterior) for histomorphometric evaluation (38). However, we only evaluated the ossification by a semi-quantitative scoring system in the middle of the condyle. The lack of histomorphometric measurements and lack of cell counts for quantitative assessment of the immunolocalization were limitations of our study.

Histological findings have shown that Osteopontin and SOX9 immunolocalization in Group 4 were significantly higher than in the other groups. Thus, we could say that a synergistic effect has occurred in the combination of mandibular growth and SR. Abtahi et al. (39) achieved the same synergistic effect by applying low-level laser (LLL) during mandibular advancement in rabbits. However, El-Bialy et al. (40) reported that there was no synergistic effect when LLL or light-emitting diode (LED) and MA were applied together. Furthermore, the use of a single LED or single LLL resulted in more bone formation than LED+MA or LLL+MA combinations. The mismatch between the findings of the two studies may have been related to testing different stimulating factors (SR and LLL or LED).

The bone and cartilage formation levels in Group 2 and Group 3 were similar. SR or MA protocol had the same cellular stimulation effect on the condylar cartilage. The results suggest that SR could stimulate condylar growth by itself or in combination with MA.

Early and late term results of ossification in condyle might be evaluated with a wide range of time intervals such as 3rd, 14th, 21st, and 30th days (18, 36). Our early-term histological findings were similar to the late-term findings of all groups. In the literature, there are different opinions that reported bone formation decreased or increased during the late period (18, 36, 41). We believe that the variety of evaluation methods leads to this disagreement.

CONCLUSION

SR is capable of stimulating condylar growth by itself. The stimulation effect could be further increased in combination with mandibular advancement. SR, which we used for experimental purposes, can not be used in orthodontic practice. However, in further studies, applications with little or no side effects could be tested.

Ethics Committee Approval: This study was approved by Ethics committee of Cumhuriyet University, (Approval No:17.03.2017- 25).

Informed Consent: N/A.

Peer-review: Externally peer-reviewed.

Author Contributions: Supervision - H.C., C.D.; Design - H.C., C.D., S.S.; Supervision - H.C., C.D.; Resources - H.C.; Materials - H.C., C.D.; Data Collection and/or Processing - H.C.; Analysis and/or Interpretation - H.C., C.D., S.S. ; Literature Search - H.C.; Writing Manuscript - H.C., C.D.; Critical Review - H.C., C.D.

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

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Original Article

The Assessment of Knowledge, Behaviors, and Anxiety Levels of the Orthodontists about COVID-19 Pandemic

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Main points:

- Most of the orthodontists were aware of COVID-19 symptoms and transmission routes and avoided aerosol generating procedures.
- Because the standard precautions were not sufficient; the orthodontists adopted transmission-based precautions.
- Anxiety levels of orthodontists did not show a statistically significant increase during the COVID-19 pandemic.

ABSTRACT

Objective: A new viral disease called Coronavirus disease-19 (COVID-19) affected the whole world because of its characteristics of spreading rapidly via respiratory droplets and aerosol. As one of the most aerosol-generating occupations, dentists are at high risk and are recommended to treat emergency cases only. We aimed to assess the general knowledge, emergencies, personal precautions, and avoided behaviors among the orthodontists and also their anxiety levels, during COVID-19.

Methods: A survey research, including demographic information, general knowledge about COVID-19, treatment strategies, protective measures, and Generalized Anxiety Disorder (GAD) 7 test, was conducted via a web-based questionnaire (1 open-ended and 26 closed-ended questions). A total of 215 orthodontists older than 20 years of age and practicing in different regions of Turkey were included in this study. The answers received within the first 10 days were included.

Results: Most of the orthodontists were aware of COVID-19 symptoms and transmission routes (n=159 and n=183, respectively). Almost all of them treated only emergency cases (n=209). Orthodontic emergencies were reported mostly as injury due to band/bracket failure, soft/hard tissue trauma, and problems in retention appliances (n=197, n=186, and n=81, respectively). The participants also avoided aerosol-generating procedures and used transmission-based protective equipment. The prevalence of GAD was 16.7% during COVID-19, and there was no statistically significant difference when it was stratified by gender, age, city, and COVID-19 related questions ($p>0.05$).

Conclusion: The orthodontists followed the guidelines and took protective measures during COVID-19, and the majority had subthreshold anxiety levels.

Keywords: Anxiety, COVID-19, emergencies, orthodontists, personal protective equipment

INTRODUCTION

Last December, a new pandemic caused by Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2) had started and affected people all around the world (1-3). The World Health Organization named the disease as Coronavirus disease-19 (COVID-19) (4). Most of the patients present symptoms such as fever, dry cough, and shortness of breath or they might be asymptomatic; furthermore, a small percentage of the cases show more severe complications such as acute respiratory distress syndrome or even death (5).

Main transmission routes of SARS-CoV-2 were reported to be contact transmission, droplets transmission, and airborne transmission (2, 6). Furthermore, saliva contains the virus due to the pathway which uses to invade the

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cells (6, 7). Recent studies suggest that asymptomatic patients, patients in their incubation period, and mildly symptomatic patients can spread the virus (8, 9).

Taking into consideration the routes of transmission, it is obvious that dentists, dental staff, and patients are at high risk during dental treatment (6). An article published in the *New York Times* reported that dentists have a greater risk to be affected by COVID-19 than the general physicians and nurses (10). In dental procedures, an increased number of droplets and aerosol can be generated. Although large droplets usually fall to the ground or surrounding objects, small droplets or aerosol remain in the air and even travel further (11). After landing on surfaces, SARS-CoV-2 can survive on the surfaces from hours to several days and in aerosol for up to 3 hours (6,12). It was suggested to postpone routine dental treatments and provide treatment just for dental emergencies because of the aerosol-generating procedures, close contact with the patient's oropharyngeal region, and the cross-contamination risk because of the infected surfaces/objects in the clinic (6, 13). Because even the asymptomatic patients can spread the virus, every patient in the dental clinic should be considered as a potential COVID-19 carrier, and the dentists should avoid aerosol-generating procedures, use personal protective equipment (PPE), and follow disinfection procedures as recommended in the guidelines (6, 14, 15).

Orthodontic treatment is a continuous, long-term treatment and usually needs to be followed-up every 2-6 weeks. During the COVID-19 pandemic, appointments have been interrupted and thus might affect the psychology of both the patients and the orthodontists. In most countries, dental emergencies have been regulated by the government, but there is a lack of information about orthodontic management. Although most of the orthodontic patients do not show urgent situations, we still need more detailed guidelines and consensus to understand what constitutes a real emergency for orthodontic patients, which will ensure the safety of both the patients and the orthodontists. There are few studies in literature that report orthodontic emergencies, how the orthodontist can manage their patients remotely, whether there is a need for treatment in the clinic, and what the protective measures should be (16-18). In this study, with the help of a survey, we aimed to assess the general knowledge about COVID-19, what is seen as an orthodontic emergency, which protective equipment or methods are preferred, and what the preferred communication methods with the patients are because the studies on this subject are not many. In addition, a test was added at the end of the questionnaire to measure the anxiety level of orthodontists because studies are showing mental health problems and anxiety among healthcare workers after Severe Acute Respiratory Syndrome and Middle East Respiratory Syndrome (19).

METHODS

The survey research was conducted in Marmara University, Faculty of Dentistry, Department of Orthodontics, and the study was approved by The Republic of Turkey, Ministry of Health, COVID-19 Scientific Research Evaluation Commission (02.05.2020, T11_25_26), and Marmara University, Faculty of Dentistry, the Ethical Committee of Clinical Research (15.05.2020, 2020/14, Istanbul, Turkey). A web-based questionnaire was prepared by using Google form (Google Inc., Mountain View, CA, USA), which is an online survey tool and sent through e-mail to the registered orthodontist in Turkey. Informed consents were not taken from the participants because it was a web-based questionnaire and the participation was voluntary. The questionnaire comprised four sections. In the first section, demographic information such as age, gender, city, and the working place was collected. The second section comprised general questions about COVID-19, such as questions related to source of the information, whether the orthodontists themselves or people around them have sufficient information about the symptoms and transmission routes of COVID-19, whether adequate precautions have been taken in the orthodontists' working area, and whether the orthodontists consider themselves to be in a high-risk position with regard to the transmission. The third section comprised the orthodontic treatment strategies and the protective measures, which the orthodontists have taken during the COVID-19 outbreak. Orthodontists were asked whether they work during the COVID-19 outbreak; whether they avoid bonding/debonding procedures or using high-speed or low-speed handpieces and 3-way syringe; whether they apply preprocedural mouth rinse; and whether their patients want to continue routine orthodontic treatment. The questionnaire also included questions about the treatment type (all treatments or emergencies), communication methods, orthodontic interventions considered as emergencies, the types of PPE used, and the highest impact of the COVID-19 outbreak on them. In the last section, to measure the orthodontists' anxiety level, the Turkish version of the 7-item Generalized Anxiety Disorder (GAD) test was applied. It was used to evaluate how often the participants were bothered by each related item in the questionnaire during the last 2 weeks. Response options were "not at all," "several days," "more than half the days," and "nearly every day," scored as 0, 1, 2, and 3, respectively. In the GAD-7, the score of 10 or above was used as the cutoff point for the diagnosis of anxiety as was reported in the original article (20).

The data received within the first 10 days after the questions were sent via e-mail were included in this study. A total of 220 orthodontists attended the survey; however, only 215 of them were included in this study. Five people who left unanswered questions were excluded from the study.

Statistical Analysis

The data were analyzed using The Statistical Package for Social Sciences version 25.0 software (IBM Corp.; Armonk, NY, USA). Descriptive analyses were conducted to describe the demographic characteristics and COVID-19-related answers. The results were shown as frequency and percentage for categorical variables. To analyze the distribution difference between categorical variables, Chi-square test or Fisher exact probability test was performed. Logistic regression analysis was performed to determine which factors affect anxiety together, and the forward conditional method was used. The suitability of the model was evaluated with the Hosmer-Lemeshow test. The odds ratio for risk factors was expressed with 95% confidence intervals. The significance level was set at $p<0.05$.

RESULTS

Demographic Characteristics

The participants tended to be mostly female (70.2%), aged 20-34 years (52.1%), living in Istanbul (52.5%), and working mostly in private practice (57.2%) (Table 1).

COVID-19 Related Questions

The sources of information about COVID-19 were reported mostly as websites and social media (n=182 and n=169, respectively); 51.2% of the orthodontists changed their working situation to a short-time working model (Table 2). Most of the orthodontists reported having sufficient information about the COVID-19 symptoms and transmission routes (n=159 and n=183, respectively), as illustrated in Figure 1. In contrast, the number of orthodontists who reported taking adequate precautions against COVID-19 at their working place was equal to those who reported taking only partial precautions (n=88). In addition, 120 orthodontists stated that people around them did not have sufficient information about COVID-19 and did not comply with hygiene rules. Of all the participants, 187 orthodontists thought that they were at a high-risk position with regard to contamination (Figure 1). Restricted social life, decreased income, and negatively affected psychology were among the most marked items in the questionnaire because COVID-19 has an impact on them (Table 2).

Table 1. Demographic characteristics of the study sample

Variables	n (%)
Total	215(100)
Gender	
Female	151 (70.2)
Male	64 (29.8)
Age	
20-34	112 (52.1)
35-44	60 (27.9)
45-54	25 (11.6)
55-64	16 (7.4)
>65	2 (1)
City	
Istanbul	113 (52.5)
Ankara	24 (11.2)
Izmir	10 (4.7)
Other	68 (31.6)
Working place	
Private Practice	123 (57.2)
University Hospital	98 (45.6)
Public Institutions and Organizations	7 (3.3)
GAD‡	
No	179 (83.3)
Yes	36 (16.7)

GAD: Generalized Anxiety Disorder
GAD‡ was defined as individuals who scored ≥10 points

Orthodontic Treatment and Precautions

Almost all the orthodontists reported that they treated only emergency cases from 15th of March to 15th of June which was the end of the survey participation period (n=209) (Figure 2). Injury due to the band or bracket failure and soft and hard tissue

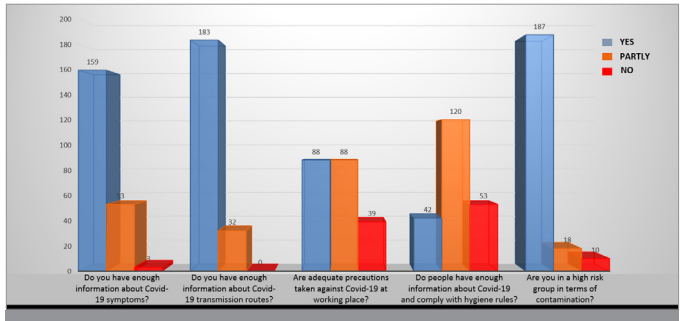

Figure 1. COVID-19 related questions

Table 2. Numbers and percentages of the given answers regarding COVID-19 related questions

Variables	n (%)
Source of information about COVID-19	
Websites	182 (84.6)
Social media	169 (78.6)
Television	153 (71.2)
Academic publications	116 (53.9)
Family and friends	90 (41.8)
Newspaper	30 (13.9)
Radio	12 (5.6)
Changes in working situation	
Short-time working	110 (51.2)
Vacation	76 (35.3)
Home office	44 (20.5)
Left work	3 (1.4)
No change	3 (1.4)
Effects of COVID-19 on lifestyle	
Restricted social life	184 (85.6)
Decreased income	146 (67.9)
Negatively affected psychology	110 (51.2)
Being far from family	86 (40)
Increased housework	85 (39.5)
Lost health	4 (1.9)
Lost work	0 (0)
Use of preprocedural mouth rinse	
No need	55 (25.6)
0.2% povidone-iodine	50 (23.3)
Chlorhexidine	37 (17.2)
1% hydrogen peroxide	32 (14.9)
2% povidone-iodine	31 (14.4)
0.1% hydrogen peroxide	21 (9.8)
Mouthwash	16 (7.4)
Salt water	7 (3.3)

COVID-19: Coronavirus disease-19

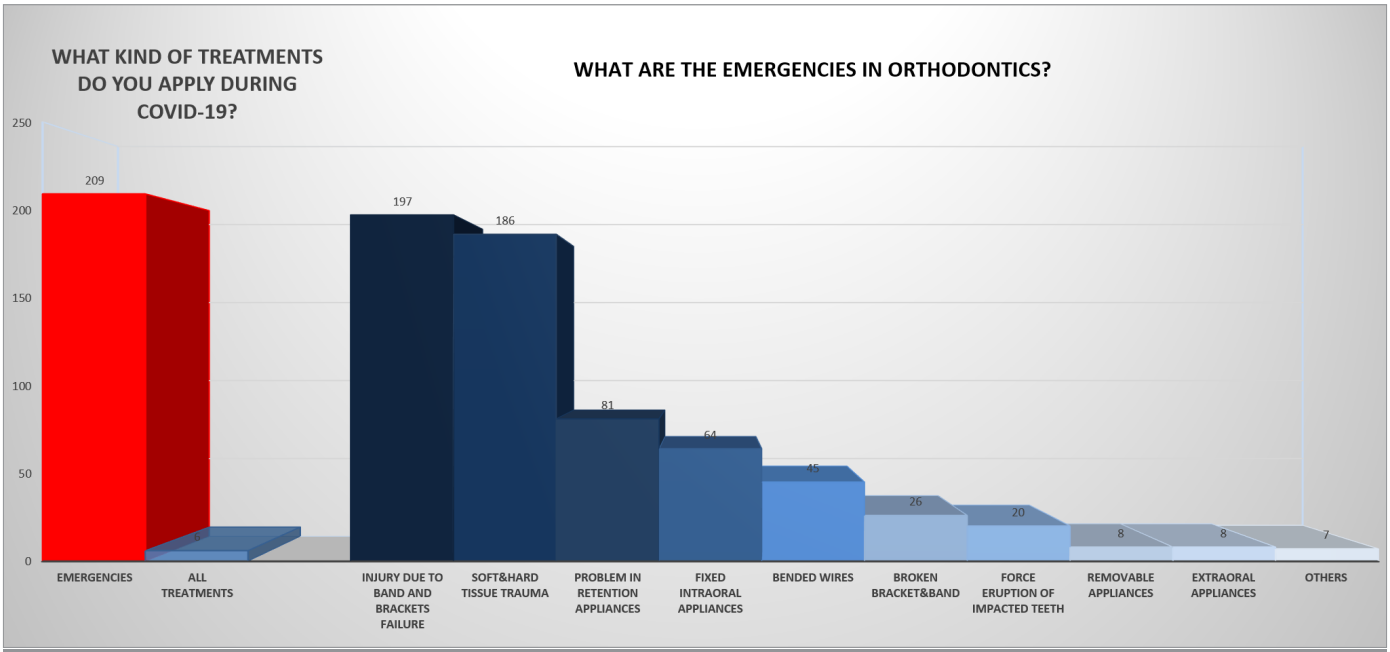

Figure 2. Treatment types and orthodontic emergencies during the COVID-19 outbreak

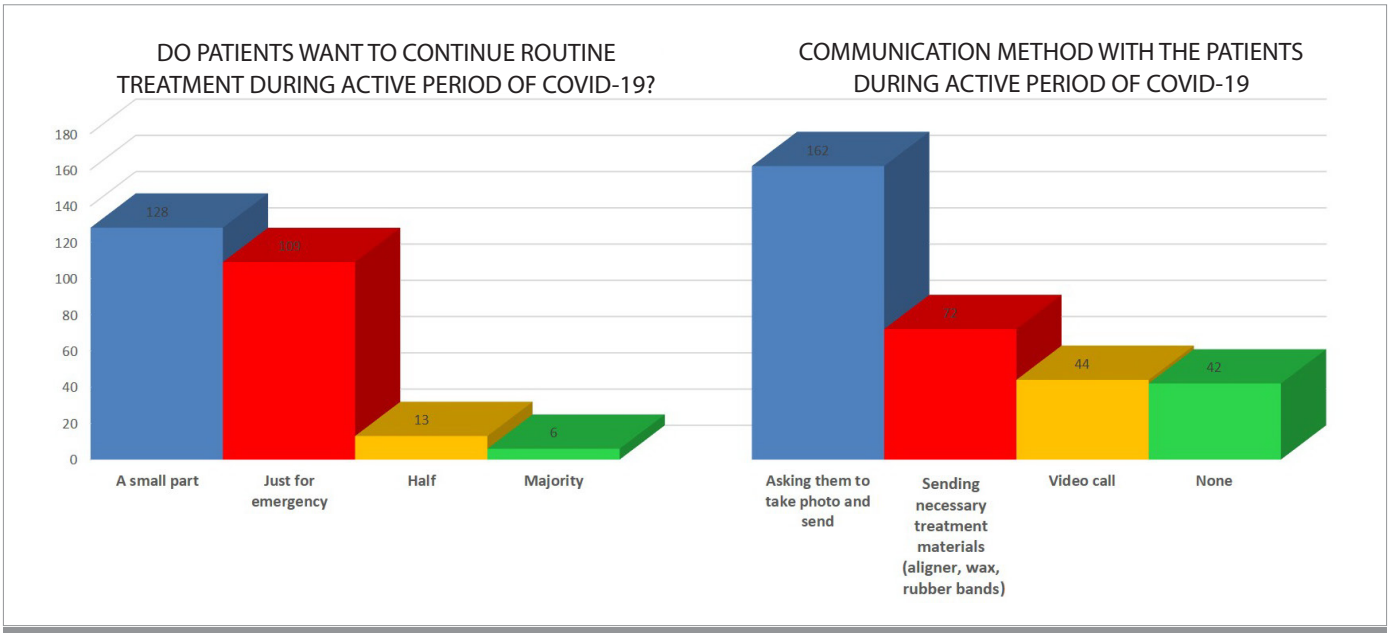

Figure 3. Patient preferences and communication methods during the COVID-19 outbreak

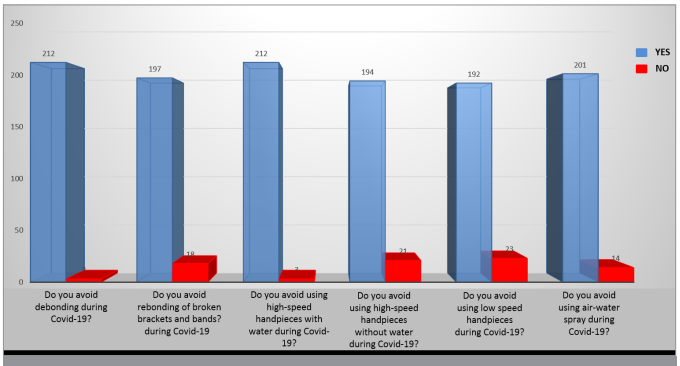

Figure 4. Patient treatment and precautions during the COVID-19 outbreak

trauma along with the problems in retention appliances were among the most marked items as an orthodontic emergency (n=197, n=186, and n=81, respectively) (Figure 2).

A total of 128 orthodontists stated that a small group of their patients wanted to continue routine orthodontic treatment, whereas 109 orthodontists reported that their patients wanted to come only for emergency treatments during the COVID-19 outbreak (Figure 3). Regarding the communication method, the orthodontists mostly asked the patients to send photos (n=162). It was followed by sending necessary treatment materials such as rubber bands, wax, aligners, and others (n=72) to the patients and having video calls (n=44) (Figure 3).

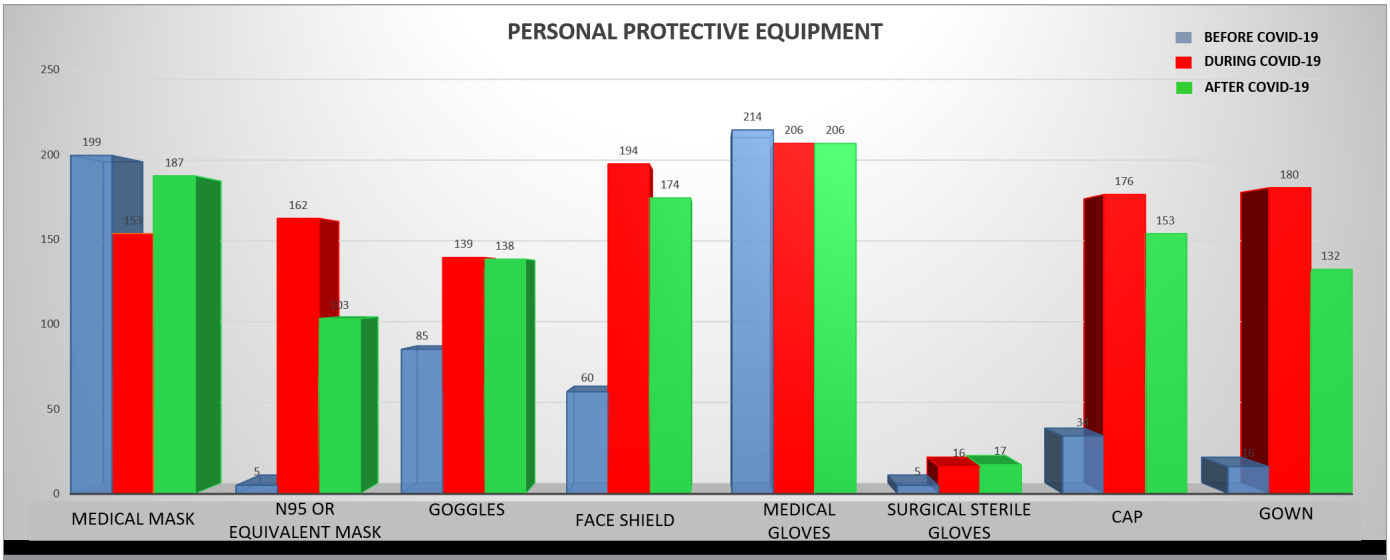

Figure 5. Personal protective equipment preferred before, during, and after the COVID-19 outbreak

Most of the participants avoided the debonding procedure and bonding of broken attachments (n=212 and n=197, respectively), using high-speed handpieces with or without water (n=212 and n=194, respectively), and using low-speed handpieces and 3-way syringe (n=192 and n=201, respectively) during the COVID-19 outbreak (Figure 4).

Regarding PPE, medical mask and medical gloves were reported to be used mostly before the COVID-19 outbreak by the orthodontists (n=199 and n=214, respectively); however, N95 or equivalent mask (n=162), goggles (n=139), face shield (n=194), cap (n=176), and gown (n=180) were reported to be used additionally during the COVID-19 outbreak (Figure 5). Furthermore, most of the participants also stated that they would continue to use additional PPE such as N95, face shield, and others after the outbreak as a routine procedure, but the ratio would be lower than the ratio reported during the COVID-19 outbreak. In addition, 23.3% of the participants reported using 0.2% povidone-iodine, 17.2% of them reported using chlorhexidine, and 14.9% of them reported using 1% hydrogen peroxide as a preprocedural mouth rinse solution, whereas 25.6% reported not needing mouth rinse (Table 2).

GAD-7 Test

The prevalence of GAD was 16.7% among the orthodontists during the COVID-19 outbreak (Table 1). There was no statistically significant difference when the prevalence of GAD was stratified by gender, age, city, and COVID-19-related questions (Table 3). However, there was a statistically significant difference between the working place and the anxiety levels. The ratio of having anxiety above the threshold (GAD-7[3]≥10 points) among the orthodontists working in public institutions and organizations was higher (60%) (Table 3).

Although there was no statistically significant difference between the answers and anxiety presence distributions, the ratio of having anxiety above the threshold was statistically higher (38.9%) among those who reported surrounding people as having inadequate knowledge and not complying with hygiene rules (*z*-test for comparing proportions).

Logistic regression analysis was performed to determine which factors affect anxiety; however, none of them were statistically significant.

DISCUSSION

This study was one of the first studies that assessed orthodontists' general knowledge about COVID-19, orthodontic emergencies, and behavioral and protective measures taken during the outbreak and was also the first study that measured the anxiety level of orthodontists. Because of the transmission routes of SARS-CoV-2 (6, 15) and the knowledge of asymptomatic people and people in their incubation period who can infect others (9), it is obvious that all dentists, including orthodontists, can be exposed to the virus easily (6, 10, 13, 17). Although the orthodontic practice generates less aerosol than some other dental specialties, insertion of bands and brackets, attachments of clear aligners, and removal of residual adhesive create aerosol, and also saliva droplets which contain SARS-CoV-2 might splash while removing or inserting orthodontic wires and ligatures (7). Most of the guidelines do not have adequate information about orthodontic management during the COVID-19 outbreak. Because the orthodontic treatment is a continuous treatment and needs follow-up every 2-6 weeks, it should be clarified what constitutes a real emergency in orthodontics and how to manage it with specific protocols during this outbreak. In this study, together with the general knowledge about COVID-19, we tried to evaluate what constituted orthodontic emergency according to the orthodontists, about the changes in their working situations, and about the personal protective measures used. In this study, mostly websites and social media were reported as

Table 2. Numbers and percentages of the answers to COVID-19 related questions

	GAD‡		
Variables	**No, n (%)**	**Yes, n (%)**	**p**
Gender[1]			
Female	122_a (80.8)	29_a (19.2)	0.138
Male	57_a (89.1)	7_a (10.9)	
Age[2] (years)			
20-34	92_a (82.1)	20_a (17.9)	0.953
35-44	51_a (85)	9_a (15)	
45-54	21_a (84)	4_a (16)	
55-64	13_a (81.3)	3_a (18.8)	
>65	2_a (100)	0_a (0)	
City[2]			
Istanbul	99_a (87.6)	14_a (12.4)	0.220
Ankara	18_a (75)	6_a (25)	
Izmir	9_a (90)	1_a (10)	
Other	53_a (77.9)	15_a (22.1)	
Working place[2]			
Public institutions and organizations	2_a (40)	3_b (60)	0.034*
Private practice	97_a (87.4)	14_a (12.6)	
University hospital	69_a (80.2)	17_a (19.8)	
More than one place	11_a (84.6)	2_a (15.4)	
Do you have enough information about symptoms of COVID-19?[2]			
No	3_a (100)	0_a (0)	0.174
Partially	40_a (75.5)	13_a (24.5)	
Yes	136_a (85.5)	23_a (14.5)	
Do you have enough information about transmission routes of COVID-19?[2]			
Partially	29_a (90.6)	3_a (9.4)	0.308
Yes	150_a (82)	33_a (18)	
Are adequate precautions taken against COVID-19 at your working place?[1]			
No	32_a (82.1)	7_a (17.9)	0.956
Partially	74_a (84.1)	14_a (15.9)	
Yes	73_a (83)	15_a (17)	
Do people have enough information about COVID-19 and comply with hygiene rules?[1]			
No	39^a (73.6)	14^b (26.4)	0.094
Partially	104^a (86.7)	16^a (13.3)	
Yes	36^a (85.7)	6^a (14.3)	
Are you in a high-risk group in terms of contamination?[1]			
No	7_a (70)	3_a (30)	0.235
Partially	17_a (94.4)	1_a (5.6)	
Yes	155_a (82.9)	32_a (17.1)	

GAD: Generalized Anxiety Disorder; COVID-19: Coronavirus disease-19
[1]Chi-square tests; [2]Fisher exact test. Each subscript letter denotes a subset of GAD categories whose column proportions do not differ significantly from each other at the 0.05 level.
GAD‡ was defined as individuals who scored ≥10 points

the source of information about COVID-19, which coincided with the results of Lim et al. 's study (21). The participants in our study stated that as healthcare workers they had sufficient information about COVID-19 symptoms and transmission routes, which was also in accordance with the literature (21, 22). Most of the participants were considered to be in a high-risk group because it was reported in the literature that healthcare workers were at substantial risk owing to pernicious characteristics of COVID-19 (10, 23). In addition, the number of orthodontists who notified that adequate precautions were taken against COVID-19 at their working place was equal to those who reported that only partial precautions were taken. This statement might be related to feeling insecure about working at a high-risk position, the shortage of protective equipment, or not trusting the application of protective measures by the employees. The participants did not trust people around them about their COVID-19 related knowledge and hygiene rules. However, in one of the studies, authors reported that respondents carried out precautionary behaviors owing to the outbreak (78.6% in Wuhan and 63.9% in Shanghai); the duration and frequency of handwashing and wearing a mask when going out increased significantly. They added that no evidence was found about the associations between sex, age, education, working status, and behavioral responses during the COVID-19 outbreak (24). In contrast, Lim et al. (21) stated according to their respondents' mask-wearing intentions that better messaging was necessary for infection prevention within the household.

In the guidelines and the scientific papers, it was recommended to reschedule patient appointments and treat emergency cases only during the COVID-19 outbreak (6, 13, 15). In this study, most of the orthodontists reported treating only emergency cases as was suggested. However, they also reported that a small part of their patients wanted to continue routine orthodontic treatment even if it was not recommended. This might be related to insufficient information given to the patients about the progress of their treatments during the COVID-19 outbreak, which might have worried them that the quality of the treatment would deteriorate. This might also be related to the fact that the patients did not understand the severity of the outbreak.

In the literature, the functional or extraoral appliances, problems in the aligners and the retainers, loose brackets and bands, pocking wires, abscess around the molar band, irritation of lip and cheek, and loose elastic chain were reported as orthodontic emergencies (16, 17). Although broken brackets and bands, fixed intraoral appliances used for expansion or functional treatment, bent wires, forced eruption, and removable or extraoral appliances were also reported as emergencies in our study; injury due to the band or bracket failure, soft and hard tissue trauma, and the problems in retention appliances were considered as emergencies with a higher ratio. In an emergency, first, it was suggested to try to manage the situation remotely (16, 17). In some cases, even patients or parents can solve the problems at home with guidance. For this purpose, orthodontists can send informative photographs and videos that are either prepared by themselves or available on websites (17). In this study, virtual communication methods such as asking patients to send their photographs or making video calls were most preferred. Furthermore, the participants also provided necessary treatment materials such as aligners, rubber bands, wax, and others, in order not to disrupt the treatment.

When there is a real emergency and the patient should be seen in the clinic, strict protective measures have to be taken. Aerosol- or droplet-generating procedures should be minimized or avoided if possible (6, 15). In this study, the participants mostly avoided debonding procedure, bonding of broken attachments, and using high-speed and low-speed handpieces and a 3-way syringe in order not to generate aerosol, as was recommended in the guidelines. Besides deferring routine dental treatments and avoiding aerosol-generating procedures, it is also important to use proper PPE and decrease the cross-contamination risk while treating emergency cases. For instance, preprocedural mouth rinse was recommended in the literature because SARS-CoV-2 was also reported in the saliva (7). The studies showed that mouth rinse with 0.2% povidone-iodine and 1% hydrogen peroxide decreased the viral load because of oxidation; however, chlorhexidine did not affect the virus (6, 13). In this study, 25.6% of the participants reported not needing mouth rinse, and 17.2% of them reported the use of chlorhexidine, which did not coincide with the guidelines and literature findings. Those findings may imply that the participants who stated that they did not need mouth rinse or who used chlorhexidine did not have sufficient information regarding the mouth rinse. However, 23.3% of them were reported using 0.2% povidone-iodine, and 14.9% of them preferred 1% hydrogen peroxide as was suggested.

Particulate respirators (N-95 masks or equivalent masks such as FFP2-standard masks or superior) are recommended because the standard medical mask is not effective against SARS-CoV-2-loaded aerosol (14, 15). Disposable gowns and caps, goggles, or face shields are also suggested together with standard precautions during the outbreak (14, 15). In this study, medical mask and gloves were mostly reported to be used before the COVID-19 outbreak. However, during the outbreak, N95 or equivalent mask, goggles, face shield, disposable gowns, and caps together with the standard protective equipment were used by the participants. Furthermore, they claimed that they would continue to use the additional PPE even after the outbreak. It is evident that the standard protective equipment will go out of the ordinary and require more equipment. Hence, how this extra cost can be dealt with by the clinicians or whether this will be reflected in the treatment fees is a question for now.

Regarding the effects of the COVID-19 outbreak, the participants mostly marked the items of restricted social life, decreased income, and negatively affected psychology. It was previously reported in the literature that being isolated and working at high-risk positions might adversely affect the psychology of healthcare workers (19). Healthcare workers suffering from mental health disturbances has also been advocated in some of the previous studies about COVID-19 (22, 23). In the last part of this questionnaire, to assess the anxiety level during the outbreak, the Turkish version of the GAD-7 test, which has high validity and reliability similar to the original form, was used (25). The prevalence of GAD was 16.7%, and there was no statistically significant difference when stratified by gender, age, city, and COVID-19-related questions. Qian et al. (24) reported that 32.7% of Wuhan and 20.4% of Shanghai participants reported moderate or severe anxiety, which was higher than the results in this study. Huang and Zhao (22) observed higher percentages (37.4%) in the healthcare workers; however, there was no statistically significant difference when compared with other occupations. Other studies evaluating the mental health disturbances with the help of different scales reported that mostly subthreshold and mild disturbances were seen in the population (23, 26). In the literature, there are conflicting results about associations between GAD and age and gender. Although some of the literature findings reported that females are more vulnerable to stress, the other studies reported no difference between the genders as in the results of this study (22, 24, 26, 27). With regard to the age, Qui et al. (26) reported young adults (18-30 years) as having high-stress levels, and Huang and Zhao (22) observed that people younger than 35 years showed more anxiety symptoms, whereas Qian et al. (24) reported no difference between the age groups in accordance with our study. The only statistically significant difference was between the working place and anxiety presence distributions in this study. The orthodontists working in public institutions and organizations reported higher anxiety levels; however, the number of those was low (n=5), which may not reflect the general results. In addition, the anxiety level was found to be higher among those who reported the surrounding people as having inadequate knowledge about COVID-19 and not complying with hygiene rules. This might imply that the level of anxiety may increase when people feel insecure about protecting themselves and cannot control the people around them; however, the number of the participants was also low in this group.

Because of the restrictions during COVID-19, a web-based questionnaire was used in this study and thus made the participants voluntary. Although it was sent to all registered orthodontists in the country, it should be considered that there is a possibility of selection bias. Furthermore, because the number of participants was relatively small, surveys with larger sample sizes and long-term follow-up for the anxiety might create more generalized results.

As the information about the virus is updated every day, we recommend the orthodontists to update their knowledge. Because people mostly prefer digital platforms such as websites and social media to obtain information, updating the information about the virus on these platforms will provide up-to-date information that will reach more people.

CONCLUSION

- Most of the orthodontists are aware of COVID-19 symptoms and transmission routes.
- They treat only emergency cases and take recommended transmission-based precautions according to the current guidelines and research.
- By most of the orthodontists, injury due to band bracket failure, soft and hard tissue trauma, and problems in retention appliances were seen as real emergencies.
- During COVID-19, 16.7% of the participants had been diagnosed with GAD; however, there was no statistically significant difference when the prevalence of GAD was stratified by gender, age, city, and COVID-19-related questions.

Ethics Committee Approval: This study was approved by Ethics committee of Marmara University, Istanbul, Turkey (Approval No: 15.05.2020, 2020/14).

Informed Consent: Informed consent is not necessary due to the nature of this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Supervision – H.N.Y.; Design – H.N.Y.; , E.O.O.; Resources – H.N.Y., E.O.O.; Materials – H.N.Y., E.O.O.; Data Collection and/or Processing – H.N.Y., E.O.O.; Analysis and/or Interpretation – H.N.Y.; , E.O.O.; Literature Search – E.O.O.; Writing Manuscript – H.N.Y., E.O.O.; Critical Review – H.N.Y., E.O.O.

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

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Original Article

Comparative Study between the Overall Production Time of Digitally Versus Conventionally Produced Indirect Orthodontic Bonding Trays

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Main points:

- The total production time of indirect bonding trays was significantly higher in digital indirect bonding tray technique (DIBT) than in laboratory indirect bonding tray technique (LIBT).
- Although the total working and non-working time for DIBTs was longer, the active working time was significantly shorter, when compared to LIBT.
- The digital planning and production of 3D-printed indirect bracket transfer trays can be represented as a time-efficient production method.

ABSTRACT

Objective: The purpose of this study was to compare the production time for indirect digitally and laboratory-produced orthodontic bonding trays.

Methods: Orthodontic study casts were used in this study (n=40). The specimens were equally and randomly divided. In the digitally produced indirect bonding tray (DIBT) group (n=20), the brackets were set virtually using the Orthoanalyzer program (3Shape, Copenhagen, Denmark) to produce an indirect bonding tray that was virtually designed and 3D printed using VarseoWax® Splint material with a Varseo S 3D printer (Bego, Bremen, Germany). In the laboratory-produced indirect bonding tray (LIBT) group, the brackets were adhesively bonded to the study casts in the dental laboratory (Danube Private University, Krems, Austria), and a transfer bonding silicone tray was manufactured.

Results: The t-test results showed a significant difference between the passive time during the production of DIBTs (153.8±32.8 min) and LIBTs (7 min). However, the active production time was 13.6±0.8 min for DIBTs and 17.7±1.9 min for LIBTs. Every individual process step in both groups was measured in minutes, and statistical analysis was performed.

Conclusion: The total production time, including active working and passive non-working time, was higher for DIBTs than for LIBTs. However, the actual active production time for DIBTs was shorter than that for LIBTs. Within the study limitations, the digital planning and production of indirect orthodontic trays can be considered a time-efficient production method.

Keywords: 3D printing, bonding trays, digital orthodontics, indirect bonding, production time

INTRODUCTION

Patient demand for an esthetic smile has increased the need for orthodontic treatment. Minimizing the indirect bracket bonding duration is considered the main clinical challenge. In orthodontics, digital indirect bonding is considered a new era in daily practice.

Precise bracket placement is considered one of the main keys for successful orthodontic treatment, along with orthodontic diagnosis and treatment planning, which should fulfill the treatment goals (1). In indirect bonding,

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the brackets are transferred clinically using a bonding tray (2). The indirect bonding technique can reduce the chairside time by 50%, according to several studies (3-5). Certain studies found that indirect positioning is more accurate and precise than direct bracket bonding because of accessibility, especially in the molar region (6, 7). The thin layer of orthodontic resin used in indirect bonding eliminates the excessive adhesive residues in addition to reducing plaque accumulation, caries risk, and white spot occurrence (8). The indirect bonding technique is preferred by patients and orthodontists (9). Since 1972, the instructions for indirect bonding tray (IBT) production have been published and were continually improved by numerous advancements in terms of materials (10, 11). Generally, IBTs are made of silicone-based polymers or thermoplastic materials (12, 13). The time taken for the indirect bonding technique is influenced by the method of manufacturing.

Digital indirect bonding using additive manufacturing technology offers a new alternative method to the plaster model of the patient's teeth. A special printable resin is used for 3-dimensional (3D) printing using the additive technique and is polymerized layer by layer (14).

The laboratory indirect bonding technique involves a dental technician stage in which the selected brackets are positioned and attached to the plaster model of the patient; silicone or thermoplastic materials can be used to fabricate the transfer trays, followed by clinical bonding of the bracket on the etched enamel using these transfer trays. The digital indirect bonding technique involves virtual positioning of the brackets using either a digitally scanned plaster model or a digital intraoral impression, followed by exporting the designed bonding transfer tray and printing it using a 3D printer.

Several studies evaluating the precision of indirect laboratory bracket positioning have been examined. In fact, IBTs using digital technology should be compared with conventional methods. Accordingly, the purpose of this experimental study is to compare and evaluate the production time needed to design and produce bonding trays using indirect laboratory-produced and virtually designed orthodontic custom trays. Both the active and the passive time used in both the techniques will be considered using *in vitro* analysis methods. This study aimed to compare the active working time required for bracket placement and the passive non-working time that serves as pause time or time spent in between tray production.

METHODS

A total of 40 adult study casts were included in this study. All of them were permanent dentition casts without morphological abnormalities.

All the study casts were duplicated using an additional silicone material (Adisil®, Goslar, Germany). The 40 study casts were divided into 2 equal groups: digital IBTs (DIBTs) and laboratory IBTs (LIBTs). In the DIBT group, the study casts were 3D scanned using the model scanner D800 (3Shape, Copenhagen, Denmark). In both groups, the Discovery® smart brackets (Dentaurum, Ispringen, Germany) and Ortho-Cast M-Series buccal tubes (Dentaurum, Ispringen, Germany) were used. However, 3M Superior Fit Buccal Tubes MBT (3M Oral Care, Saint Paul, Minnesota, USA) were used for virtual bonding, whereas Ortho-CastM-Series mini buccal tubes (Dentaurum, Ispringen, Germany) were bonded to the gypsum model in the LIBT group.

Laboratory Indirect Bonding Tray Technique

The clinical crown facial axis (FACC) and FA point were marked on each crown using a pencil (TL1: time spent for signing the FACC and FA point) (Figure 1). Then, the study cast was isolated with an isolating material (ISO-K, Wangen, Swiss) (TL2: time spent for isolating) and after 1 min of curing (TL3); every bracket was positioned on the FA point using a flowable light-cured resin (FlowTain™ L.V., Reliance Orthodontic Products Inc., Itasca, Illinois, USA) (TL4) (Figure 2). After checking the correct axis and mesiodistal relation, every bracket was polymerized for 12 seconds (TL5). The vestibular area of the study cast was blocked with wax strips (approximately 2–3 mm away from the bonded brackets) (TL6). Every bracket and the occlusal surfaces were embraced with transparent A-silicone (Memosil® 2, Heraeus Kulzer GmbH, Hanau, Germany) (TL7). After 5 minutes of curing (TL8), the tray was removed from the study cast and finalized with a scalpel (TL9) (Figures 3 and 4). Every procedural step (TL1–TL9) was measured in minutes. The overall production time was determined by TTL (Table 1).

Digital Indirect Bonding Tray Technique

Orthoanalyzer software (3Shape, Copenhagen, Denmark) was used for virtual bracket positioning. The teeth were segmented, and facial axis (FA) points were automatically calculated and manually modified for precise placement (Figure 5). The long axis of the teeth and mesiodistal relation were checked and adjusted (TD1), followed by automatic digital bracket bonding (TD2) (Figure 6). Thereafter, the virtually bonded study cast was converted

Table 1. Abbreviations used for different time measurements in both groups

TT	Total time of the entire production process (active and passive time) for laboratory (TTL) and digitally (TTD) produced trays
TtA	Total time spent for active process steps (active working time) for laboratory (TtLA) and digitally (TtDA) produced trays
TtP	Total time spent for passive process steps for laboratory (TtLP) and digitally (TtDP) produced trays
TBrA	Total time spent for active process steps during bracket bonding for laboratory (LTB) and digitally (DTB) produced trays
TTrA	Total time spent for active process steps during tray production for laboratory (LTT) and digitally (DTT) produced trays
TBrP	Total time spent for passive process steps during bracket bonding for laboratory (LTBP) and digitally (DTBP) produced trays
TTrP	Total time spent for passive process steps during tray production for laboratory (LTTP) and digitally (DTTP) produced trays

into a "bracket transfer master model" in which the undercuts on the brackets were blocked out, and an indirect transfer tray was designed (TD3). Before preparing the tray for printing via the nesting process using CAMbridge™ software (Bego, Bremen, Germany), another bonding tray was designed and then nested onto the same platform (TD4) (Figure 7). The last step (TD5) was 3D printing, which was manipulated using VarseoWax® Splint material with a Varseo S printer (BEGO, Bremen, Germany). Each print consisted of 2 IBTs that were post-processed for 10 minutes in an ethanol solution in a non-heated ultrasonic bath (TD6) (Figure 8). Later, the trays were polymerized for another 5 minutes in a light-polymerization unit (TD7) and separated from the printing supports (TD8). Every procedural step (TD1–TD8) was measured in minutes. The overall production time was determined as TTD (Table 1).

The total time spent for production was divided into active and passive steps. In the LIBT group, the active steps included manual bracket positioning on the study cast and production of the silicone transfer tray (TtLA=TL1 to TL7 and TL9). Passive production steps in the DIBT group consisted of printing 2 transfer trays on 1 platform and cleaning them in an ultrasonic bath, followed by light polymerization.

Statistical Analysis

Statistical analysis was performed with IBM SPSS Statistics 23 (IBM Corp.; Armonk, NY, USA). The nonparametric Mann–Whitney U test was used to compare the time spent for each step between both groups. The significance level of analysis was set at $p<0.05$.

RESULTS

The active steps, including manual bracket positioning on the study cast and silicone transfer tray production (TtLA=TL1 to TL7 and TL9), took significantly longer than the time required to position the brackets on the 3D study cast and design the transfer tray (TtDA=TD1+TD2+TD3+TD4+TD8) (Table 2) ($p<0.01$). Passive production steps in the DIBT group consisted of printing 2 transfer trays on 1 platform and cleaning them in an ultrasonic bath, followed by light polymerization. These steps (TtDP=TD5+TD6+TD7) took 2 hours and 33.08 min on average (Table 2).

Table 2. Comparison of time spent for each step between DIBT and LIBT with Mann Whitney U test

Procedural step	DIBT Mean ± SD (n:20)	LIBT Mean ± SD (n:20)	p
TT(a)	167.4±32.4	24.7±1.9	0.001
TtA(b)	13.6±0.8	17.7±1.9	0.001
TtP(c)	153.8±32.8	7±0	0.001
TBrA(d)	1.8±0.25	12.4±1.4	0.001
TTrA(e)	11.8±0.78	5.2±0.75	0.001
TBrP(f)	0±0	1±0	0.001
TTrP(g)	153.8±32.8	6±0	0.001

(a) Total time of the entire digital production process (active working and passive non-working time)
(b) Total digital/laboratory active working time
(c) Total digital/laboratory passive working time
(d) Total time spent for active process steps during digital/laboratory bracket bonding
(e) Total time spent for active process steps during digital/laboratory tray production
(f) Total time spent for passive process steps during digital/laboratory bracket bonding
(g) Total time spent for passive process steps during digital/laboratory tray production

In the DIBT group, the mean total time for 3D orthodontic tray production was 167.4±32.4 minutes, whereas the LIBT group

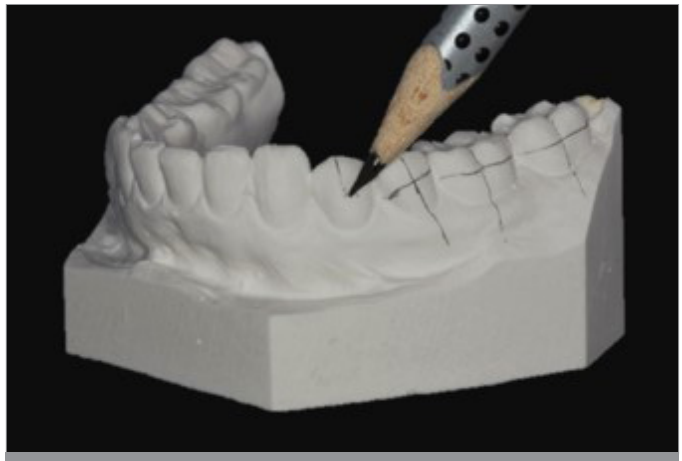

Figure 1. Marking the clinical crown facial axis and facial axis point

Figure 2. Placing the brackets

Figure 3. Fabrication of the silicone transfer tray

Figure 4. Finalizing the indirect bracket bonding tray

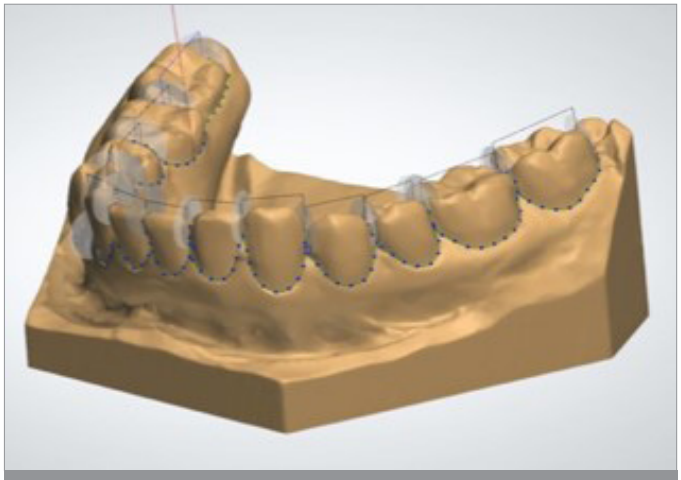

Figure 5. Segmenting tooth crowns

showed a significantly shorter total time for custom silicone tray production, with an average of 24.7±1.9 minutes (p=0.001).

This study compared the passive production steps in both groups, which were significantly different (p<0.01). The LIBT group had less passive time than the DIBT group (Figure 9). LIBT processing took an average of 7 min (TtLP=TL3+TL8). TtLP did not vary as specified by the manufacturer; thus, the standard deviation was 0 seconds. On the other hand, time spent on active process steps in the digital indirect bonding tray (DIBT) and laboratory indirect bonding tray groups showed a significantly shorter time for DIBT (Figure 10).

The total active time (TtDA, TtLA) was subdivided into a bonding process (DTB, LTB) and a production process (DTT, LTT) (Tables 2). Model segmentation and bracket positioning on the virtual study cast (DTB=TD1+TD2) took 1.8±0.25 min on average, whereas marking the FA point, isolating the study cast, and manually positioning the brackets (LTB=TL1+TL2+TL4+TL5) took 12.4±1.4 min on average. The time needed for LTB was significantly higher than that needed for DTB (p<0.01). In the DIBT group, DTT (TD3+TD4+TD8) was the nesting process during which 2 bonding trays were finalized by separating them from the printing supports. The steps of this process were significantly more time-consuming than those for conventional transfer tray production (LTT=TL6+TL7+TL9) (p<0.01).

Furthermore, the total passive production time (TtDP, TtLP) was subdivided into bonding (DTBP, LTBP) and transfer tray production (DTTP, LTTP) segments. The passive time and the time needed for DTBP in the virtual positioning of the brackets was 0 seconds. Moreover, passive time during the manual bracket bonding was less than 1 min but still significantly longer than the time needed for DTBP (p<0.01).

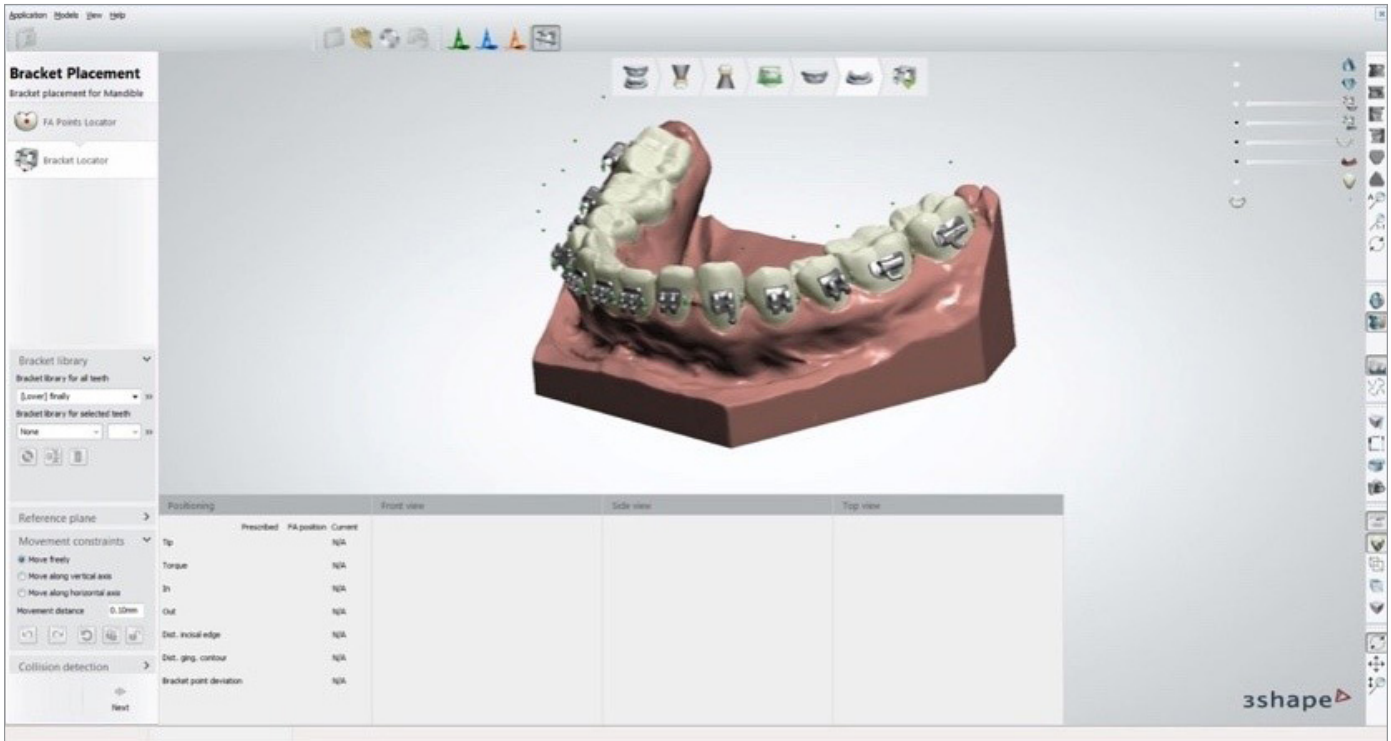

Figure 6. Automatically positioned brackets on the facial axis points

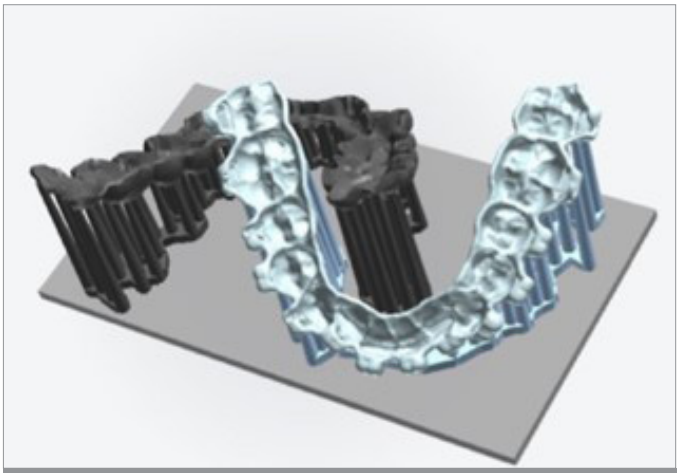

Figure 7. Nesting the transfer trays in CAMbridge™

Figure 8. Finalizing the 3D-printed indirect bracket bonding tray on the study cast

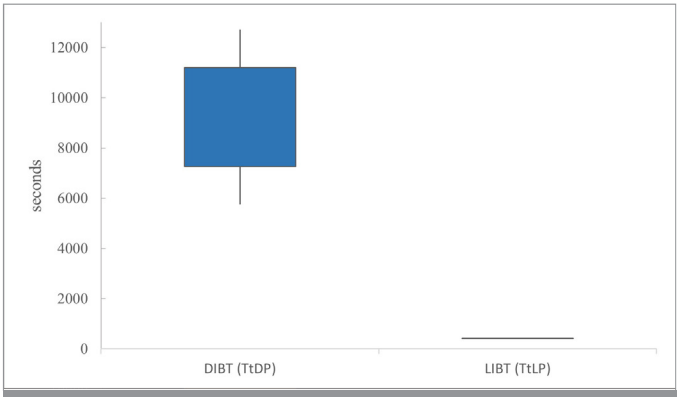

Figure 9. Comparison of the time spent on passive process steps in the digital indirect bonding tray and laboratory indirect bonding tray groups showing a significantly higher time needed in the DIBT group

DTTP corresponded to TtDP and showed a significantly longer total passive production time during digital transfer tray production than during silicone indirect custom tray (LTTP) production ($p<0.01$) (Table 2).

DISCUSSION

This study aimed to compare the consumed time in indirect bonding systems using virtual planning (DIBT) and conventional (LIBT) methods.

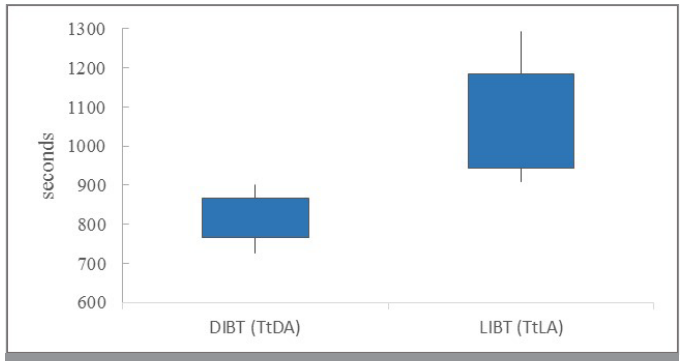

Figure 10. Comparison of the time spent on active process steps in the digital indirect bonding tray and laboratory indirect bonding tray groups showing a significantly shorter time needed in the DIBT group

For this purpose, a total of 20 study cast models were used per group. Intended bracket placement via CAD/CAM and conventional methods were compared, including the active working time and passive non-working time. Orthoanalyzer software was used for virtual bracket bonding, and a blinded experienced dental technician was asked to bond the study casts and fabricate the transfer trays. In both methods, time was calculated as working and non-working time zones. The total production time for LIBTs was significantly shorter than that for DIBTs. However, discrimination between active working and passive non-working steps should be differentiated. In LIBT processing, 9 steps (7 active, 2 passive) were needed, whereas DIBT processing needed only 8 steps (5 active and 3 passive). The virtual bracket bonding needed only 13.5% of the time needed for the plaster model. The digital production process takes only half as long as the laboratory processing.

The working time of the DIBT study group was found significantly shorter than that of the LIBT group. The non-working time for the DIBT group was found to be 91.8%, whereas that for the LIBT group was comparatively lower (28.2%). The duration mentioned in this study for the LIBT group was 24.74 min, which is considered lower than the results of the studies by Bozelli et al. (15) (26.24 min) and Aguirre et al. (16) (29.83 min).

In the LIBT group, production process took 6 hours and 12 min, whereas in the DIBT group, it took 23 hours and 6 min, of which only 3 hours and 30 min was the working time. The printing volume area of the 3D printer directly affects the amount of bonding trays per printed project. The Varseo S 3D printer with an overall volume of 96 mm×54 mm×85 mm (BEGO, Bremen, Germany) was used in this study for DIBT production. Align Technology (San Jose, California, USA) uses 3D Systems (Rockwell, South Carolina, USA) for Invisalign® 3D-printed models from the ProJet® 3510 MP printer, which has a construction volume of 298 mm×185 mm×203 mm, resulting in printing 24 models per print; however, the ClearCorrect (Round Rock, Texas, USA) uses the Objet30 OrthoDesk (Stratasys, Eden Prairie, Minnesota, USA), which has a build volume of 300 mm×200 mm×100 mm with a capacity of 20 models per print (17). The recommended computer requirements of 16 GB of RAM, 2 GB of GeForce, and 1 TB of free HDD storage for the appliance Designer™, Orthoanalyzer™, and CAMbridge™ programs were not met; instead, the computer

used in this study only met the minimum requirements. Accordingly, the duration of steps TD1, TD2, TD3, and TD4 could have been accelerated, thereby reducing the processing time.

The bracket positioning duration is also influenced by the operator; however, it was not taken into consideration in either manufacturing method because of high variance.

Careless handling while transporting the models can lead to undesired changes in the position of the brackets. With digital gluing, the program allows the orthodontist to monitor the position of the bracket on his/her own computer, regardless of the place of production. Israel et al. (18) examined the accuracy of digital bracket placement and compared with conventional bracket placement. They concluded that, there were no significant differences between the digitally positioned brackets and the manually glued brackets. This result allows us to assume that the DIBT and LIBT study groups might have an approximately equally accurate bracket placement. The assumption that an experienced orthodontist can place the brackets more precisely than a student has been researched by Armstrong et al. (19). and their results showed that there was no correlation between the accuracy of the bracket placement and the experience of the practitioner. The only difference was found for the time needed to bond the brackets, which was higher for the students.

In this study, a material (Memosil) was selected for the LIBT group, and silicone-produced trays were not separated into segments. Dörfer (20) demonstrated that, the selection of materials for aligner production with regard to the transmission accuracy showed significant results, and Memosil or Futar-D/Memosil should be preferred to 0.5 or 2-mm thermo-forming aligners and that the transfer trays should not be separated. The risk of bracket position movement was found to be the highest using thermoplastic aligners, unlike silicone, which can be carefully adapted to the brackets because thermoplastic material has no control over the pressure exerted on the brackets (21).

The VarseoWax® Splint material was used in the DIBT group, and there are still no studies regarding the transmission accuracy as an IBT. For an improved statement, further studies need to evaluate bracket bonding process on patients followed by an intraoral scan overlaid with a transfer plaster model. The brackets of laboratory-made transfer aligners have an individual adhesive base owing to the adhesive previously placed on the plaster model.

The adhesive base depends on the amount of adhesive used and the contact pressure of the brackets on the plaster teeth. Impairment of the adhesive bond of already polymerized adhesive bases has been frequently discussed in the literature; however, Aksakalli et al. (22) and Brandon et al. (23) reported an adhesive force that does not deviate from the directly glued brackets. This issue does not arise with the 3D-printed trays as a pre-settable adhesive strength (spacer) guarantees the uniformity of the adhesive, which is applied to the bracket base just prior to the gluing of the brackets.

CONCLUSION

The gross time of DIBT is indeed higher, but the net time compared to LIBT is significantly shorter. When considering the dental technician working hours and thus the personnel costs for producing laboratory produced bracket transfer trays, the digital planning and production of 3D printed indirect bracket transfer trays can be represented as a time efficient production method.

Ethics Committee Approval: Ethic Committee approva is not necessary due to the nature of this study.

Informed Consent: Verbal informed consent was obtained from the patients who agreed to take part in the study.

Peer-review: Externally peer-reviewed.

Author Contributions: Supervision – J.P., A.O., C.V.S.; Design – J.P., C.V.S.; Supervision – J.P., A.O., C.V.S.; Resources – J.P., C.V.S.; Materials – J.P., C.V.S.; Data Collection and/or Processing – J.P.; Analysis and/or Interpretation – J.P.; Literature Search – J.P., A.O., A.J; Writing Manuscript – J.P., A.O., A.J., C.V.S.; Critical Review – J.P., A.O., C.V.S.

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Original Article

Approaches of Turkish Dentists in Cases of Orthodontic Lingual Retainer Failures

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Main points:

- Fixed lingual retainers are used to prevent relapse after orthodontic treatments. However, failure of lingual retainers may occur during retention period.
- Turkish dentists generally refer patients to orthodontists in cases of lingual retainer failure.
- In terms of the factors affecting the choice to remove a failed bonded retainer among dentists, the orthodontist's opinion appears to be the most important whereas the patient's demand is the least important factor.

ABSTRACT

Objective: This study aimed to investigate the approaches of Turkish dentists in cases of orthodontic lingual retainer failures.

Methods: A self-administered questionnaire was used to quantify dentists' approaches to lingual retainer failures. The first part of the study investigated the demographic characteristics. In the second part, dentists' approaches to cases of failed retainers were assessed. The third part had questions related to the type of retainers bonded solely to the canines or to all the 6 anterior teeth. Descriptive statistics were done with Pearson's $\chi 2$ test, and Mann-Whitney U test was used.

Results: A total of 320 Turkish dentists participated in the survey. Experienced and public dentists preferred to advise the patients whose retainers had failed to contact their orthodontist more frequently ($p<0.05$). Regarding their approach to patients who requested removal of the bonded retainer, inexperienced dentists more frequently preferred to refer the patients to an orthodontist ($p<0.05$). With regard to factors affecting the choice to remove a bonded retainer, the most and the least importance were attributed to the orthodontist's opinion and the patient's demand, respectively.

Conclusion: Turkish dentists prefer referring their patients to orthodontists rather than performing procedures in cases of failure associated with bonded retainers. Different demographic characteristics seem to have an impact on these approaches.

Keywords: Orthodontic retainer, retention, survey

INTRODUCTION

After orthodontic treatment, despite successful treatment process, the teeth tend to return to their initial position, and this is known as relapse. Relapse, which is observed in most patients, is usually caused by stretching of the periodontal fibers (1). Retention after orthodontic treatment is a process that is performed almost regularly to prevent relapse (2). Retention is an indispensable requirement to succeed in orthodontic treatment and prevent occlusions from returning to the pre-treatment positions (3).

In almost every patient, orthodontic retention is used to stabilize the treatment results and prevent dental changes after treatment (4). Retention procedures vary from country to country. For instance, in the Netherlands, Norway, the United States, and Australia, bonded retainers are preferred more frequently in the mandibular region, whereas in the United Kingdom, removable retention is more frequently preferred in both the maxillary and mandibular regions (5-9). In a study conducted in 2016, Turkish orthodontists reported that they commonly used bonded retainers as the retention protocol in both maxillary and mandibular regions (10). Rigid canine-to-canine bonded retainers are attached solely to the canines (3-3 retainers), although they may also be

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bonded to all the 6 anterior teeth (3-2-1-1-2-3 retainers), and 3-2-1-1-2-3 lingual retainers are generally considered to be more effective in maintaining the position of the anterior teeth (11, 12).

However, lingual retainers may cause some problems over time as they stay in the mouth for a long period. Using long-term lingual retainers may increase plaque accumulation and gingival recession (13). In addition, because the lingual region is more exposed to the forces of mastication, the failure rate is higher in this region (5). Some studies reported that retainers often failed within a few months after bonding (14, 15). In the early stages of retainer administration, follow-up is performed mainly by the orthodontist, and in the following periods, patients are usually referred to general practitioners (16).

Dentists may have different approaches regarding lingual retainer failure cases due to the differences in the demographic characteristics. To date, to the best of our knowledge, only one study was conducted in relation to this topic in Switzerland (16), and the perspectives of Turkish dentists have not yet been investigated. The purpose of this study was to investigate the approaches of Turkish dentists in lingual retainer failure cases.

METHODS

Ethical approval was obtained from the ethics committee at Sutcu Imam University in Turkey (approval no. 2019-66). Written informed consent was obtained from the dentists who participated in the survey. The sample size was calculated using the Raosoft web survey software (http://www.raosoft.com/samplesize.html). With a 90% confidence level, 5% alpha error, 50% response distribution rate, and 26,674 population size (the number of dentists in Turkey according to TUIK statistical data), a total of 268 participants were required (17). In February 2019, a link that directed people to a web-based questionnaire page (Google forms) was sent to the Turkish dentists via a web platform.

Table 1. Questionnaire used for the study

1.	What is your sex?
a)	Male
b)	Female
2.	How much experience do you have in the profession?
a)	≤10 years
b)	>10 years
3.	Do you work at a private institution or a public institution?
a)	Private
b)	Public
4.	Which option is your approach to patients whose retainer failed (debonded or broken)?
a)	I advise patients to contact their orthodontists (A1)
b)	I remove the retainer completely and I do not bond the retainer again (A2)
c)	I bond the retainer again (A3)
d)	I change the failed retainer with a new one (A4)
5.	Which option is your approach to patients who request removal of a bonded retainer?
a)	I explain to the patients all the possible consequences, and then I remove the retainer (A1)
b)	I explain to the patients all the possible consequences, and I do not remove the retainer (A2)
c)	I refer the patients to the orthodontists who bonded the retainer (A3)
6.	How much is the factor of time of retention effective in your decision to remove the retainer (score between 0 and 5)?
7.	How much is the factor of patient's demand effective in your decision to remove the retainer (score between 0 and 5)?
8.	How much is the factor of orthodontist's opinion effective in your decision to remove the retainer (score between 0 and 5)?
9.	How much is the factor of periodontal status effective in your decision to remove the retainer (score between 0 and 5)?
10.	How much is the factor of need for a new restoration effective in your decision to remove the retainer (score between 0 and 5)?
11.	What do you recommend to the patients with retainers for oral hygiene ? (Multiple options can be checked)
a)	Same as a normal patient
b)	Interdental brush
c)	Dental floss
d)	Toothpick
e)	Others
12.	Which type of retainer (3-3 or 3-2-1-1-2-3) retains teeth efficiently?
13.	Which type of retainer (3-3 or 3-2-1-1-2-3) complicates oral hygiene more?
14.	Which type of retainer (3-3 or 3-2-1-1-2-3) prevents restoring teeth more?
15.	Which type of retainer (3-3 or 3-2-1-1-2-3) increases periodontal problems more?

The questionnaire was prepared on the basis of a previous survey study (16). The first part of the questionnaire included questions about demographic characteristics such as sex, experience, and workplace of the participants. The second part investigated the approaches of the participants to patients whose lingual retainers had failed (debonded or broken) and who referred to the dentists to remove the retainer. In addition, the effects of factors such as time of retention, the patient's demand, the orthodontist's opinion, periodontal status, and the need for a new restoration on the decision to remove the retainer were investigated (scores between 0 and 5). Furthermore, the questionnaire included questions about oral hygiene recommendations for patients with fixed retainers. The third part included questions about the efficiency of each type of retainer (3-3 or 3-2-1-1-2-3). The survey questions are presented in Table 1.

Table 2. Distribution of Turkish dentists (n=320) by sex, experience, and workplace

Demographic characteristics	Factors	n	%
Sex	Male	126	39.4
	Female	194	60.6
Experience	≤10 years	260	81.2
	>10 years	60	18.8
Workplace	Private	172	53.8
	Public	148	46.2

Statistical Analysis

Data analysis was performed using the Statistical Package for Social Sciences version 23.0 software (IBM Corp.; Armonk, NY, USA). As the data were not normally distributed, the mean values of the factors that affected the participants' choice to remove a bonded retainer were compared on the basis of demographic characteristics using (nonparametric) Mann-Whitney U test. Answers related to types of retainers and approaches of Turkish dentistry practitioners were analyzed using a χ^2 test with descriptive statistics. The Cronbach's alpha internal consistency coefficient was determined to verify the reliability of the survey. The probability level for statistical significance was set at α=0.05.

RESULTS

A total of 320 Turkish dentists participated in the survey. The distribution of the participants (n=320) according to their sex (male or female), experience (≤10 years or>10 years), and workplace (public or private) is shown in Table 2. A total of 60.6% of the participants were women, 81.2% had ≤10 years of experience, and 53.8% worked at private clinics (Table 2). The survey had an adequate reliability with a Cronbach's alpha coefficient of 0.723.

Most of the participants preferred to advise the patients whose retainers failed to contact an orthodontist. However, very few participants preferred to remove the retainer and did not bond the retainer again (Figure 1). The participants with an experience

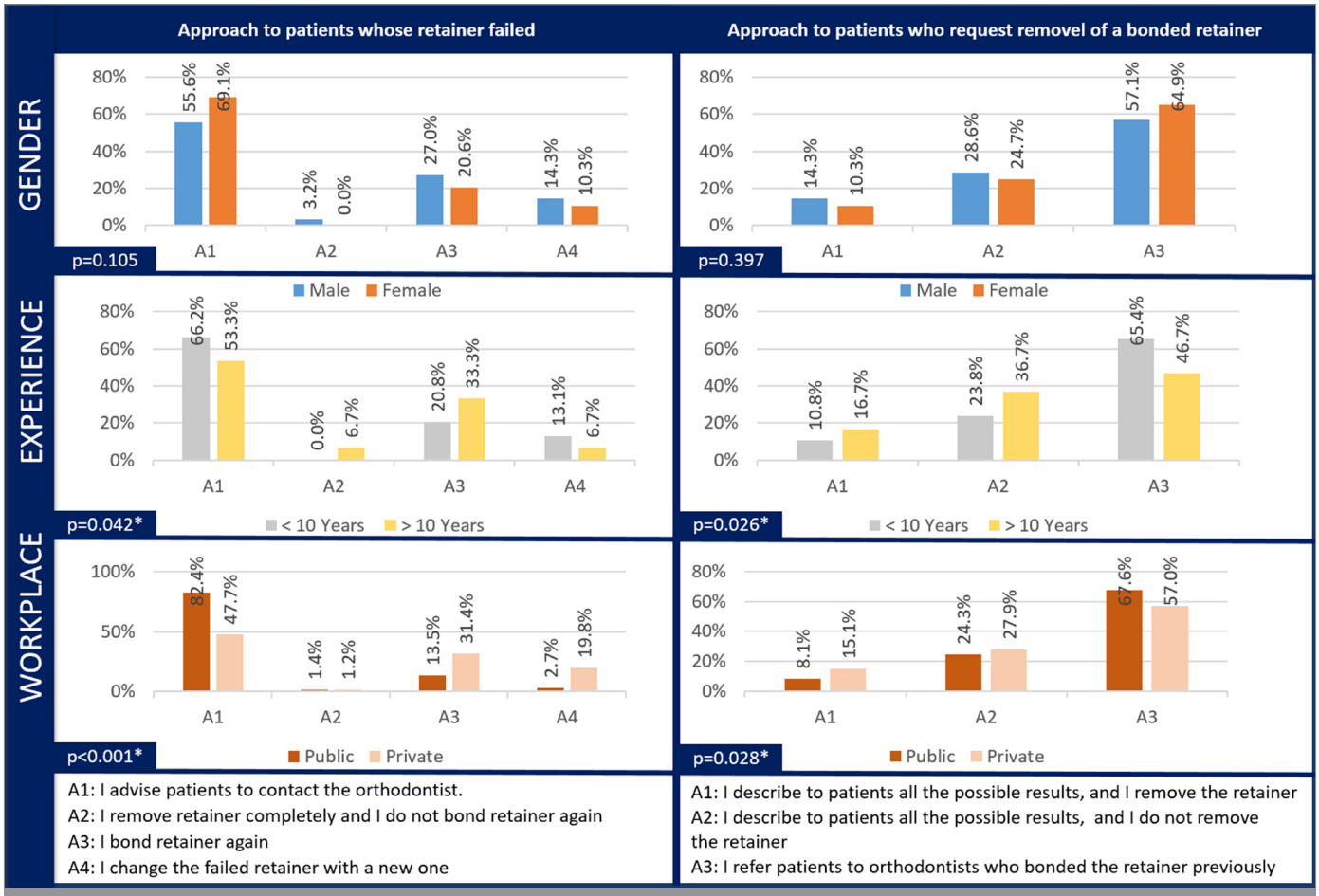

Figure 1. Descriptive statistics and Pearson's χ2 tests displaying the approach of dentists to patients with lingual retainers

Table 3. Statistical data comparing the participants' demographic characteristics and factors affecting their choice of removing a bonded retainer using Mann-Whitney U test.

Demographic characteristics	Factors affecting the choice of removing a bonded retainer	Dentists' scores			
		Mean±SD (F1)	Mean±SD (F2)	Mean±SD (Total)	p
Male (F1) vs Female (F2)	Time of retention (Q6)	3.93±1.52	4.23±1.35	4.11±1.42	0.101
	Patient's demand (Q7)	1.53±1.46	1.57±1.16	1.56±1.28	0.410
	Orthodontist's opinion (Q8)	4.63±0.80	4.87±0.38	4.78±0.60	0.011*
	Periodontal status (Q9)	4.03±0.87	4.21±1.10	4.14±1.02	0.054
	Need for a new restoration (Q10)	3.85±1.17	4.22±0.99	4.08±1.08	0.018*
≤10 years (F1) vs >10 years (F2)	Time of retention (Q6)	4.08±1.44	4.26±1.36	4.11±1.42	0.519
	Patient's demand (Q7)	1.65±1.32	1.17±1.09	1.56±1.28	0.065
	Orthodontist's opinion (Q8)	4.79±0.61	4.77±0.57	4.78±0.60	0.891
	Periodontal status (Q9)	4.21±0.95	3.87±1.25	4.14±1.02	0.190
	Need for a new restoration (Q10)	4.05±1.07	4.20±1.16	4.08±1.08	0.276
Public (F1) vs Private clinics (F2)	Time of retention (Q6)	3.99±1.58	4.23±1.28	4.11±1.42	0.414
	Patient's demand (Q7)	1.12±1.07	1.94±1.80	1.56±1.28	<0.001*
	Orthodontist's opinion (Q8)	4.87±0.37	4.69±0.74	4.78±0.60	0.075
	Periodontal status (Q9)	4.08±1.08	4.20±0.97	4.14±1.02	0.517
	Need for a new restoration (Q10)	3.96±1.12	4.17±1.05	4.08±1.08	0.130

Scored 0–5
*Significant at p<0.05; SD: Standard deviation; F1: Factor 1; F2: Factor 2

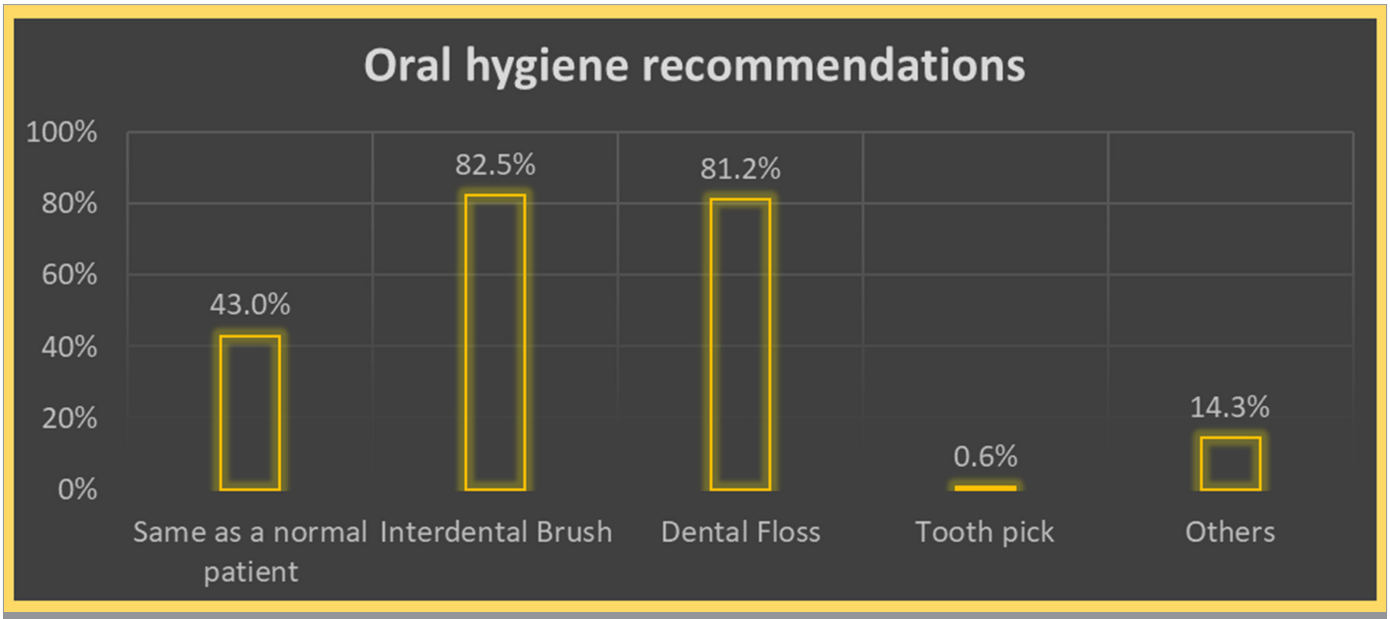

Figure 2. Descriptive statistics revealing the rate of participants' oral hygiene recommendations

of ≤10 years and those who worked at public clinics more frequently preferred to refer the patients to the orthodontist than the others (p<0.05), but no associations were found in terms of the sex of the participants (p>0.05) (Figure 1). Participants with ≤10 years of experience and those who worked at public clinics more frequently preferred to refer the patients who requested removal of the bonded retainer to the orthodontist who bonded the retainer previously (p<0.05), but no association was found in terms of the sex of the participants (p>0.05) (Figure 1).

In terms of the factors affecting the choice to remove a bonded retainer, the most and the least importance were attributed to the orthodontist's opinion (Mean±Standard deviation=4.78±0.60) and the patient's demand (Mean±Standard deviation=1.56±1.28), respectively. In terms of the time of retention and periodontal status, no significant differences were found among sexes, experience, or workplaces (p>0.05). The participants who worked at private clinics attributed significantly more importance to the patient's demand than those who worked at public clinics (p<0.001). No significant differences were observed among experience and sex factors in terms of the patient's demand (p>0.05). The female participants attributed significantly more importance to the orthodontist's opinion than the male participants (p=0.011). No significant differences

Table 4. Statistical data on answers related to 3-3 or 3-2-1-1-2-3 retainers (Pearson's χ2 tests)

Questions	Retainer type	Gender		p-value	Experience		p-value	Workplace		p-value
		Male	Female		<10 Years	>10 Years		Public	Private	
Which one retains teeth efficiently? (Q12)	3-3	3.2%	4.1%	0.758	3.1%	6.7%	0.313	6.8%	1.2%	0.096
	3-2-1-1-2-3	96.8%	95.9%		96.9%	93.3%		93.2%	98.8%	
Which one prevents cleaning much more? (Q13)	3-3	14.3%	19.6%	0.388	18.5%	13.3%	0.505	13.5%	2.7%	0.661
	3-2-1-1-2-3	85.7%	80.4%		81.5%	86.7%		86.5%	97.3%	
Which one prevents making make restoration much more? (Q14)	3-3	12.7%	6.2%	0.154	9.2%	6.7%	0.654	18.9%	16.3%	0.392
	3-2-1-1-2-3	87.3%	93.8%		90.8%	93.3%		81.1%	83.7%	
Which one increases periodontal problems much more? (Q15)	3-3	12.7%	15.5%	0.626	16.2%	6.7%	0.253	10.8%	7.0%	0.870
	3-2-1-1-2-3	87.3%	84.5%		83.8%	93.3%		89.2%	93.0%	

* Significant at p<0.05

were obtained among the experience and workplace factors in terms of orthodontist's opinion (p>0.05). In terms of need of a new restoration, the female participants attributed significantly more importance than the male participants (p=0.018). No significant differences were observed among the experience and workplace factors in terms of need of a new restoration (p>0.05) (Table 3).

Most participants responded that 3-2-1-1-2-3 retainers retained teeth more efficiently compared to 3-3 retainers; however, these retainers prevent cleaning and making restoration, and increase the periodontal problems . No significant differences were obtained among the factors (p>0.05) (Table 4).

Most participants recommended using interdental brush (82.5%) and dental flosses (81.2%) for oral hygiene of their patients, and toothpicks were the least recommended (0.6%) (Figure 2).

DISCUSSION

In Turkey, the most commonly performed retainer procedures to prevent relapse after orthodontic treatments involve lingual retainers (10). Lingual retainers have been used by orthodontists for many years because they provide optimal retention in terms of function and esthetics. However, failures may occur in lingual retainers shortly after application (14). In retainer applications, the follow-up is performed by the orthodontists in the short term, whereas in the long term, such patients are usually referred to general dentists. However, the Turkish dentists, particularly those who worked at public institutions, stated that they preferred to refer the patient to an orthodontist when the retainer failed or when the patient demanded the retainer to be removed. There may be several possible reasons for this situation. Although dentists are allowed to charge for certain state-specified treatments in public services, they cannot charge for some treatments such as retainer bonding. Besides, in Turkey, the workload in the public sector is much higher than that in private clinics (18). Dentists working at private clinics tended to remove the retainer more often when patients demanded the removal of a bonded retainer. This trend may be related to seeking provision of patient satisfaction and confidence.

Ideally, the follow-up examination of the orthodontic patients should be performed by the orthodontist. However, lengthy recommended retention periods (often, the retention period may be for lifetime) may necessitate the orthodontists to share the responsibility of these patients with dentists. In some countries, it is considered that this responsibility belongs to general dentists 6 months after the application of the retainer (16). However, in Turkey, this responsibility is generally given to orthodontists. In our study, in general, inexperienced practitioners did not dare to repair debonded or broken lingual retainers. The reason may be that, over the years, experienced practitioners improve their skills in dentistry practice by treating more patients and participating in courses. However, in a study conducted in Switzerland, unlike the case in our study, most dentists preferred rebonding in the case of retainer failures. In addition, when the patient demanded the retainer removal, they preferred to inform them about the possible consequences and leave the retainer *in situ* (16).

While deciding to remove a bonded retainer, the dentists attributed more importance to the orthodontist's opinion than to the patient's demand. Interestingly, time of retention and patient's demand in Switzerland were more important than the orthodontist's opinion (16). Dentists who worked at private clinics more frequently considered patient demand more important than orthodontist's opinion in preferring to remove the retainer. Physicians who work at private clinics might not be able to refuse patients' demands in order not to lose income. Furthermore, the female participants attributed more importance to the orthodontist's opinion, but participants of both sexes seemed to attach great importance to the opinion of the orthodontist. Retainers may need to be removed when a new restoration is needed based on the position of the dental caries. In these cases, surprisingly, it seemed that female practitioners tended to remove the bonded retainer more often. However, it was difficult to predict which factors played a role in these differences between sexes.

Although bonded retainers are as effective as removable ones, in the long term, it was shown that they can escalate periodontal problems, plaque formation, gingival recession, and calculus accumulation (19, 20). In general, lingual retainers may be bonded as 3-3 or 3-2-1-1-2-3. Although the Turkish dentists considered the 3-2-1-1-2-3 retainers to be better, they thought that these retainers had some disadvantages in terms of periodontal problems and restoration on the related teeth. In fact, which retainer is ideal is a controversial issue, and the periodontal status of the patient, the amount of mobility of the teeth, and the type of malocclusion are the factors that may affect this choice (21). Renkema et al. (22) found that the failure rate of lower retainers bonded to all the anterior teeth was higher than those that were bonded to only the canines. However, in patients who have teeth with spacing and extreme rotations in the anterior region, the 3-2-1-1-2-3 retainers may be the right choice for maintaining stability. The 3-3 retainers should be considered in cases of periodontal problems (5). Many researchers claimed that the 3-3 retainers were easier to be cleaned by the patients and dentists (16, 21). It seems that the approaches of the Turkish participants to these retainers were in agreement with the results of these studies. Additionally, in our study, there was no significant difference between the participants in terms of the answers given to the questions about retainer types.

Insufficient oral hygiene in orthodontic patients with lingual retainers is an important factor in the development of white spot lesions, dental caries, and gingival inflammation due to the dental plaque accumulation (23). Tooth brushing is considered the primary means of plaque reduction to prevent dental caries or gingival inflammation (24). However, excess plaque deposition in areas around the lingual retainer require patients to use hygiene tools, such as an interdental brush and dental floss in addition to tooth brushing (23). In this respect, as in Switzerland, Turkish dentists highly recommend interdental brush and dental floss to the patients with lingual retainers (16, 25). However, in Netherlands, the use of a toothpick was recommended rather than interdental brush and dental floss (5).

CONCLUSION

When all these data were reviewed comprehensively, it was observed that Turkish dentists preferred a conservative approach in the cases of lingual retainer failure and generally referred the patients to the orthodontists. Besides, it was observed that different demographic characteristics had an impact on the approaches of dental practitioners.

Ethics Committee Approval: This study was approved by Ethics committee of Sutcu Imam University, (Approval No: 2019-66).

Informed Consent: Written informed consent was obtained from the participants who agreed to take part in the study.

Peer-review: Externally peer-reviewed.

Author Contributions: Supervision – A.K.; Design – Ö.H, A.K.; Supervision – A.K.; Resources – A.K.; Materials – A.K.; Data Collection and/or Processing – Ö.H.; Analysis and/or Interpretation – Ö.H.; Literature Search – Ö.H.; Writing Manuscript – Ö.H, A.K.; Critical Review – A.K.

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Review

Temporomandibular Disorders: Fundamental Questions and Answers

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Main points:

- Orthodontic treatment does not appear to either prevent or relieve temporomandibular disorder (TMD) to a great degree.
- Occlusal splints accompanied by occlusal reconstruction have shown satisfactory results in treating TMD.
- The occlusion should be treated using a holistic approach, that acknowledges the dynamic, morphological and functional interrelationship between occlusion, joint and muscles.
- Panoramic radiograph is not a reliable method to evaluate the bony structures of the temporomandibular joint.
- Depressed mood is fairly common in patients with chronic TMD.

ABSTRACT

This review aimed to present the current evidence-based answers to a questionnaire which was developed to evaluate the beliefs and knowledge of dental professionals concerning temporomandibular disorder (TMD). A literature review was conducted using the PubMed/Medical Literature Analysis and Retrieval System Online (MEDLINE), Cochrane, Google Scholar, and Scopus search engines from January 1980 to June 2020 corresponding to TMD diagnosis, causes, management, and consequences. A total of 50 articles were considered relevant and selected for full review. The etiology of TMD is multifactorial and complicated and involves several direct and indirect factors. Orthodontic treatment does not appear to either prevent or relieve TMD to a great degree. Nevertheless, condylar and occlusal stability reduces the risk of TMD development. As a result, an assessment of the function of masticatory system prior to beginning orthodontic therapy is fundamental. If signs and symptoms of TMD are significantly present, they should be managed before any orthodontic intervention. Moreover, psychological disorders are strongly associated with joint and facial pain. Thus, professionals who work with chronic TMD patients need to be aware of the psychological aspects of chronic pain and refer the patient for psychological evaluation when warranted. Future research elucidating a cause-effect relationship and neurobehavioral processes underlining chronic pain should be performed.

Keywords: Diagnosis, etiology, questionnaire, temporomandibular disorder, treatment

INTRODUCTION

Temporomandibular disorder (TMD) is a broad term referring to all neuromuscular and musculoskeletal conditions of the masticatory muscles, temporomandibular joint (TMJ), and the adjacent structures (1). TMD is described as the most common orofacial pathology of non-dental origin, and it affects mostly women and those aged 20-45 years (2). The most frequent clinical features are chronic myofascial pain, masticatory muscle pain, and limited range of mouth opening (3). However, other symptoms, such as earache, headache, neuralgia, and toothache, may also be present (4). Although the etiology of TMD is complicated, it is likely multifactorial with biomechanical, neuromuscular, psychosocial, and biological influences. Plausible causes involve trauma, functional shift, parafunctional habits, occlusal overloading, increased joint friction, depression, stress, anxiety, and alexithymia (5). The role of each of these potential components is still controversial, and they can contribute either independently or collectively (6). TMD treatment is classified as non-invasive, mini-invasive, and invasive. Although each of these treatment modalities provides favorable results in reducing TMJ pain, no specific therapy

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has been shown to be predominantly effective over the other (7). Moreover, one determinant of successful TMD treatment, which is frequently overlooked, is the practitioner's knowledge and beliefs concerning the disorder itself. Thus, patients are often misdiagnosed and undergo various therapies for unrelated disorders; a fact that often leads to frustration, dissatisfaction, and compromised quality of life (8).

In 1993, Le Resche, Truelove, and Dworkin (9) developed a survey to evaluate the knowledge and beliefs of general dentists. The questionnaire included 4 fields of study: pathophysiology, chronic pain, psychophysiology, and psychiatric disorders. Items were answered on an 11-point scale, ranging from 0 "strongly disagree" to 10 "strongly agree." Since then, multiple scientific articles have used the questionnaire for surveying either general dentists and/or orthodontists (10, 11). In 2016, the questionnaire was modified by Porto et al. (12) to meet the current diagnostic and treatment standards. The aim was to evaluate the changes in experts' knowledge and beliefs about TMD after the administration of the first such survey by Le Resche, Truelove, and Dworkin in 1993. The results showed that the knowledge and beliefs related to TMD have not significantly changed in the past 20 years. Thereafter, the specific updated survey has been used again to assess the awareness of both general dentists and orthodontists about TMD (13).

This study aimed to answer the 38 questions of the questionnaire of Porto et al. (12) as an attempt to update the knowledge of dental professionals, as well as, to present the current evidence-based knowledge concerning the etiology, diagnosis, consequences, and management of TMD. A literature review was conducted using the PubMed, Medical Literature Analysis and Retrieval System Online (MEDLINE), Cochrane, Google Scholar, and Scopus search engines from January 1980 to June 2020 corresponding to TMD diagnosis, causes, management, and consequences. A total of 50 articles were considered relevant and selected for full review.

CLINICAL AND RESEARCH CONSEQUENCES

In this study, the questionnaire of Porto et al. (12) was used as a reference point to answer controversial issues of TMD in the following 4 domains: pathophysiology (Table 1), chronic pain (Table 2), psychophysiology (Table 3), and psychiatric disorders (Table 4).

Pathophysiology Domain of Temporomandibular Disorder

Occlusal equilibration

Occlusal equilibration involves selective iatrogenic grinding of dental surfaces to increase intercuspation in the centric relationship or to enhance guidance during excursions. Treatment objectives include the establishment of an acceptable centric relation with a harmonious intercuspal position and an acceptable lateral and protrusive guidance. However, clinicians are recommended to avoid this method as an initial TMD therapy in the absence of restorative prematurities, because it is not confirmed by any solid biological background or analogy with other musculoskeletal

Table 1. Pathophysiology domain and the most highly rated answers among orthodontists in the questionnaire of Porto et al. (12)

Statement	Score (%)
Occlusal equilibration is a useful early treatment for TMD.	50.4 disagree
Orthodontic treatment can prevent the onset of TMD.	59.8 disagree
Arthroscopic surgery is almost completely effective in repositioning the disc in patients with internal derangements.	58.1 disagree
Orthodontic therapy is the best treatment to resolve TMD in a patient with a skeletal malocclusion.	67.5 disagree
TMD caused by trauma is much more difficult to treat and has a far worse prognosis than other types of TMD.	33.1 agree
Panoramic film is a reasonable method to evaluate the bony structures of the TMJ.	66.7 disagree
When bony changes are seen on a panoramic film, a tomogram is mandatory to define the treatment plan.	45.7 agree
The presence of arthritic changes on tomograms, along with crepitus in the joint, indicates the need for treatment.	48.5 disagree
The position of the condyle in the fossa as seen on the tomogram is a very accurate indicator of internal derangement.	53.8 disagree
Mandibular repositioning splints are more effective than maxillary repositioning splints.	47.5 disagree
Splint therapy is only effective when the splint is used for more than 16 hours/day.	40.8 disagree
Nocturnal bruxism is caused by occlusal interference.	71.2 disagree
Ice packs and/or heat packs and passive muscle stretching are good early treatments for TMD.	74.7 agree
All individuals with clicking TMJs require treatment.	96.2 disagree
Balancing interference is commonly related to TMD.	34.5 agree

TMD: Temporomandibular disorder; TMJ: Temporomandibular joint

Table 2. Chronic pain domain and the most highly rated answers among orthodontists in the survey of Porto et al. (12)

Statement	Score (%)
PRN narcotics ("as needed" for pain) are a treatment of choice when TMD pain is severe.	55.3 disagree
Antidepressants are never indicated in the management of TMD.	60.1 disagree
An extensive history of previous treatment failures in a patient with TMD is usually an indication for surgery.	55.7 disagree
Chronic pain is a behavioral as well as a physical problem.	63.4 agree
Although some patients with TMD have psychological problems, these problems are usually unrelated to their pain.	70.8 disagree
Poor quality of sleep is a major factor in the development of TMD.	21.1 agree
Difficulty with sleep is a common finding in chronic pain.	72.2 agree
Some patients use pain as an excuse to avoid unpleasant chores.	41 agree
Behavior modification treatments are appropriate for patients with chronic TMD pain.	69.4 agree
Patients with chronic TMD should be advised to rest and limit their work and social activities when they are experiencing pain.	34.1 disagree

TMD: Temporomandibular disorder; PRN: Pro re nata

Table 3. Psychophysiology domain and the most highly rated answers among orthodontists

Statement	Score (%)
The mechanisms of acute and chronic pain are the same.	82.6 disagree
Biofeedback can be useful for treating TMD.	64.9 agree
Oral parafunction habits are often significant in the development of TMD.	71 agree
Patients with TMD who clench/brux do so either during the day or at night, but not both.	78.6 disagree
Stress management is indicated in many patients with TMD.	89.8 agree
Stress is a major factor in the development of TMD.	78.3 agree
Tension and stress increase jaw muscle EMG levels in susceptible patients.	79.6 agree
Progressive muscle relaxation is not an effective treatment for TMD.	61 disagree
Information on the daily pattern of the TMD symptoms can be helpful for identifying contributing factors.	91.7 agree

TMD: Temporomandibular disorder; EMG: Electromyography

Table 4. Psychiatric domain and the most highly rated answers among orthodontists

Statement	Score (%)
Clinical depression is rare in patients with chronic TMD.	65.2 disagree
Depressed mood is fairly common in patients with chronic TMD.	70.1 agree
Anxiety disorders are more common in patients with TMD than in the population at large.	49.7 agree
Depression can be an important etiologic factor in chronic pain.	73.5 agree

TMD: Temporomandibular disorder

areas. The two major drawbacks are the irreversibility of the technique and the possible development of tooth sensitivity (14).

Cryotherapy

Cryotherapy includes the application of the local use of low temperatures in a traumatic and/or inflammatory region. Local effects involve vasoconstriction and reduction of inflammation, pain, and muscle spasms. Nonetheless, scientific data proving its efficacy are insufficient, probably owing to the introduction of more updated techniques, such as ultrasound and transcutaneous electrical stimulation (15).

Orthodontics and Temporomandibular Disorder

Whether abnormal skeletal characteristics cause TMD or vice versa has not been clearly clarified yet in the literature. Although, TMD has been associated with posterior crossbite, anterior open bite, Angle Class II and III malocclusions, and increased overjet (16). Some acute malocclusions (sudden occlusal changes) might also arise as a consequence of a joint or muscle disorder. Even though, recent studies have concluded that orthodontic treatment cannot prevent TMD to a great degree. Since, the difference of TMD incidents between orthodontically treated and untreated subjects was not statistically significant (2, 17, 18). Orthodontists should recognize how occlusion can become a risk factor for TMD and incorporate an orthopedic approach in cases of TMD symptomatology to establish both condylar and occlusal stability. In more detail, occlusal splints accompanied by occlusal reconstruction have shown satisfactory results in treating TMD (19-21). Imai et al. (21) concluded that 60% of patients achieved pain relief following the aforementioned approach. Moreover, TMD symptoms are not likely to reoccur following the establishment of balanced occlusion and proper alignment after orthodontic treatment.

The Role of Panoramic Radiography in the Temporomandibular Disorder Diagnosis

Although panoramic radiography is the most common initial diagnostic tool in dentistry; it fails to exclude significant morphological abnormalities in TMJ. More specifically, due to the superimposition of the skull base and the zygomatic arch, only excessive alterations in the articular tubercle can be observed. Therefore, bony changes, such as erosions and osteophytes, are difficult to be detected in conventional radiographs. Cone-beam computed tomography (CBCT) is considered superior to 2D radiography in illustrating the condylar head morphology and evaluating the presence of condylar deformities, such as osteoarthrosis. On the other hand, magnetic resonance imaging (MRI) is the recommended imaging modality for the evaluation of the disc-condyle relationship, the soft tissues, and for the diagnosis of the disc displacement (22). As a result, the use of fused MRI and CBCT images to visualize the TMJ in a single display can significantly improve the examiners' reliability and accuracy of assessment of disc positions.

Temporomandibular Osteoarthritis

When osteoarthritic changes are observed in 2D radiographs, an extended and detailed inspection of the patient's medical history and a scrutinous physical examination should be performed as well. Clinical features indicating TMD include joint tenderness, crepitus, and pain during mouth opening and lateral movements. The information gathered should be integrated with CBCT imaging to exclude any differential diagnosis. Radiographically, the disease includes cortical bone erosion and degenerative bone changes, such as sclerosis, flattening, subchondral cysts and osteophytes. The abovementioned signs of temporomandibular osteoarthritis (OA) correspond to different disease stages. Erosive lesions and reduction in joint space indicate acute or early stages; whereas sclerosis, flattening, subchondral cyst, and osteophytes illustrate the later stages of OA (23). However, even when the aforementioned radiographic changes are observed, TMD treatment is indicated only if both symptomatology and considerably limited function are present.

Occlusal Splint Therapy

Dental occlusal splints have been the mainstay of TMD treatment over the past decades in cases of discopathies and inflammatory/degenerative changes. The advantages of occlusal splints include occlusal stability, balance in centric relation, as well as reduction of tension and pain in the joint and the adjacent tissues. The opinion that splints must be used for at

least 16 hours/day to be effective has not been proved yet in the literature (24). Thus, a prospective study could clarify the relationship between the hours of application of occlusal splints and their effectiveness in establishing condylar stability. Moreover, clinical comparisons between the maxillary and mandibular occlusal splints have shown no significant differences in their treatment outcomes. More specifically, maxillary and mandibular splints seem to be equally beneficial in reducing TMD signs and symptoms. The maxillary appliance provides a better stabilization than the mandibular appliance because all of the mandibular teeth can contact against a flat surface. The choice of maxillary or mandibular splint depends mostly on clinical observations. As a case in point, fabricating the appliance on the arch with missing teeth increases the intercuspal contacts and thus equilibrates the occlusion. Furthermore, in patients who are expected to benefit from daytime application, a mandibular splint, which is rather less noticeable and produces fewer speech problems, is more befitting. While, in cases of severe overjet, the construction of anterior and lateral canine guidance is easier established with maxillary stabilization splint. If the appliance is to be worn only during sleep, the majority of dentists choose maxillary occlusal splints, although this choice is considered more like a pattern of tradition (25).

Clicking of the Temporomandibular Joint

Clicking occurs when the condylar head extends over the edge of the displaced articular disc during mouth opening and/or closing. Thus, clicking alone is not an indication for TMD treatment. However, when clicking sounds are noted, a detailed clinical evaluation should be performed. This includes evaluation of the occlusion, detection of occlusal interferences, joint palpation, and assessment of the masticatory muscles (26).

Arthroscopy

TMJ arthroscopy serves as either a diagnostic procedure or a minimally invasive TMD treatment for internal derangement with arthroscopic lysis or lavage. Joint visualization ensures accurate stage diagnosis and identification of OA. Moreover, arthroscopy includes fluid infusion under pressure to expand the TMJ and to break any adherences that are liable for reduced condyle movements. The success rate in internal derangement cases is high in terms of pain relief and maximum mouth opening. In a recent systematic review, arthroscopy lysis and lavage were found to have superior efficacy in functional outcome and degree of pain control than arthrocentesis (27).

Balancing Interference

The relation between occlusal interference and TMD shows no consensus in the literature yet. Though, it has been proven that occlusal interferences might cause minor transient changes in the myoelectric contraction patterns of the jaw muscles and short-term clinical symptoms and signs, such as pain and fatigue of the jaw muscles, headache and clicking (28). Other studies support the individual differences in vulnerability to occlusal interference, such as a previous history of TMD or even psychological factors. Therefore, further research and more updated methods are required (29).

Trauma Cases and Temporomandibular Disorder

Trauma can be divided into macrotrauma (for example, whiplash-type injury) and microtrauma (for example, parafunctional habits). Traumatic microlesions of the masticatory muscle fibers release local inflammatory mediators, such as bradykinin, prostaglandins, substance P, and histamine. These substances can transmit nociceptive impulses to the central nervous center, triggering both peripheral and central sensitization. Trauma is defined as a predisposing or initiating cause of TMD. A study including 400 patients with TMD revealed that TMJ pain was directly related to a positive history of whiplash trauma in 24.5% of the patients (30). However, there are no scientific data to confirm that treating patients with TMD with a trauma history is a more arduous task than treating patients with TMD with differential diagnosis (14).

Chronic Pain Domain of Temporomandibular Disorder

Medical Treatment of Temporomandibular Disorder

Pharmaceutical treatment of TMD includes non-opioid analgesics (acetaminophen), mild opiates (tramadol hydrochloride), anti-inflammatory drugs (ibuprofen and diclofenac), and/or muscle relaxants (tetrazepam).

Pro re nata (PRN) narcotics can be prescribed to alleviate acute pain symptoms when non-steroidal anti-inflammatory drugs are contraindicated. In any case, both careful selection of patients and prescription at regular intervals for a specific period (for example, 3 times a day for 10 days) are mandatory. Owing to the significant reduction in intracapsular pain, opioids may also be injected intra-articularly. List et al. (31) concluded that intra-articular morphine increases the pain threshold of the affected joint. Narcotics prescribed to alleviate chronic pain associated with TMD should be eschewed due to the increased risk of abuse, tolerance, and addiction.

Antidepressants can alleviate TMD pain because of their analgesic impact on chronic pain, independently of their antidepressant effect. Tricyclic antidepressants (TCAs) appear to be the most efficient in controlling chronic pain; 25 mg/day of amitriptyline is adequate in reducing pain and discomfort in patients with TMD (32). However, it has been suggested that the effects of amitriptyline are equal to those illustrated in the placebo groups. Thus, the reported benefits of amitriptyline are plausibly based on the difficulty most patients have in measuring subjective sensations of pain and discomfort. Moreover, typical side effects include xerostomia, sedation, memory impairment, constipation, and orthostatic hypotension (33).

Other antidepressants, which are frequently prescribed to patients with TMD, are selective serotonin reuptake inhibitor antidepressants (SSRIs). These medications provide greater compliance rates owing to the reduced incidence of side effects than TCAs. Moreover, SSRIs result in fewer antihistaminergic, anticholinergic, and antiadrenergic incidences. However, gastrointestinal disturbances, headache, sexual dysfunction, dry mouth, and excessive sweating are some of the adverse drug reactions (34).

Indications of Invasive Temporomandibular Disorder Treatment
Absolute indications of surgical interventions include ankylosis (fibrous or osseous joint fusion), neoplasia (osteochondroma), developmental disorders (condylar hyperplasia), and dislocation (chronic or recurrent), whereas relative indications are internal derangement, arthritic conditions, and trauma (35).

Psychological Disorders and Temporomandibular Disorder
TMD is a somatic and psychological condition involving fatigue, sleep disturbances, anxiety, and depression. Psychological problems (e.g. depression and anxiety) may cause stress to the TMJ and masticatory muscles via the stimulation of the sympathetic nervous system (36). In addition, current research has confirmed the relationship between psychological disorders/dysfunctions and chronic pain (37). At this point, it should be noted that patients with a high level of psychological distress benefit from multimodal treatment approaches (38).

Sleep Quality in Patients with Temporomandibular Disorder
The relationship between pain and sleep quality in patients with TMD is well documented. Patients with TMD show a high prevalence of sleep disorders. Nevertheless, whether TMD is the cause rather than the result of sleep disorders has not been clarified yet in the literature (39). According to a recent systematic review, patients with TMD have two or more sleep disorders in a percentage of 43%, with insomnia (36%) and sleep apnea (28.4%) as the most frequent (40).

Behavioral modification
Although, the effectiveness of behavioral modifications in chronic pain management is unable to be demonstrated scientifically, owing to the lack of a standard treatment methodology; in general, the combination of cognitive-behavioral treatment concentrating on somatization, readiness, and self-efficacy provides beneficial outcomes in managing chronic TMD pain (41).

Moreover, despite the consequences of TMD pain on physical and psychological health, practitioners should encourage their patients to maintain an adequate activity level and correct posture, abstain from excessive rest, and perform various chores when physically feasible.

Psychophysiology Domain of Temporomandibular Disorder

Pain mechanisms
The mechanisms of acute and chronic pain differ greatly from one another. The alteration from acute to chronic pain occurs in a pathophysiological and histopathological manner. The stimuli initiating a nociceptive response vary; however, the mechanism of interaction between the receptors and the peripheral internal defense system is similar (42).

Biofeedback
As mentioned earlier, psychological factors, such as stress, mental tension, anxiety, or depression, may be involved in TMD. To improve the effectiveness of TMD treatment, patients should overcome their stress and other TMD-associated psychological factors via bio-behavioral treatment and other treatment approaches, such as therapeutic education, cognitive-behavioral therapy, and methods of physiological self-regulation.

Biofeedback regulates muscle tension and decreases muscle pain. This method provides extrinsic feedback that otherwise would be unknown to the recipient. Thus, patients acquire supplementary information in addition to the intrinsic feedback, which is naturally acquired.

Electromyography (EMG) biofeedback is the technique of getting feedback from the body to measure the frequency, intensity and duration of muscle spasms. It can be used to either enhance the activity of weak muscles or to attenuate the tone of muscle spasms (43). Shedden Mora et al. (44) have found that patients undergoing biofeedback-based cognitive-behavioral therapy showed greater improvement in pain coping skills and increased satisfaction than those following an occlusion-centered approach.

Parafunctional habits
Parafunctional functions are one of the main evidence-based causes of TMD. Oral parafunctions include bruxism, clenching, excessive gum chewing, lip/nail biting, and non-nutritive sucking. A recent study has shown that excessive gum chewing (more than 4 hours/day) is positively correlated with auricular pain and either clicking or clenching. It should also be noted that 87.5% of individuals with disc displacement and TMD pain are bruxers (14).

Electromyography Levels of Patients with Temporomandibular Disorder
It has been proven that stress and tension are associated with increased EMG levels in the jaw muscle. Tsai et al. (45) concluded that the EMG activity of the masticatory muscles was increased significantly under conditions of induced stress. Therefore, progressive muscle relaxation is considered an effective therapeutic method for TMD to increase the range of motion and decrease pain.

Identifying the factors contributing to TMD and educating the patients to relieve stress is one of the most challenging aspects. Preferably, a daily symptom pattern should be used as a guide. However, when the identification of the daytime contributing factors cannot be accomplished, patients should record the incidents of pain, clenching, and masticatory muscle tension together with the associated events on an hourly basis. This often helps the patients to identify which events are mostly related to their pain. Patients may require additional psychological support in ways to relax and/or break habits (46).

Psychiatric Domain of Temporomandibular Disorder

Depression
TMD is strongly associated with elevated levels of depression and anxiety, and women are more susceptible to severe depression. Women show an increased level of monoamineoxidase, an enzyme that metabolizes norepinephrine, serotonin, and dopamine, owing to premenstrual and postmenstrual hormonal changes (47). However, depression is also associated with articular pain (48).

Anxiety

The link between chronic pain and mental balance seems to have a bidirectional etiology, with pain-causing fluctuations in mental balance and vice versa. The level of anxiety is directly associated with muscle hyperactivity and facial pain. Nevertheless, anxiety shows no significant differentiation between the sexes (49). Moreover, conditions such as generalized anxiety disorders and social anxiety disorder increase the risk of developing TMD (50).

CONCLUSION

TMD is the most frequent type of non-odontogenic orofacial pain, which often results in compromised welfare of individuals with TMD. As a result, it has been the stimulus for a plethora of research investigations. However, despite the plethora of studies, there is a lack of comprehensive, unified, and systematic characterization of the etiology, diagnosis, and treatment of TMD. On the positive side, a consensus has been reached on four points: First, orthodontic treatment does not appear to either prevent or relieve TMD to a great extent. Nevertheless, condylar and occlusal stability reduces the risk of TMD development. Second, panoramic X-rays do not show valid morphological changes in the TMJ. Third, PRN narcotics and antidepressants can both be prescribed for pain relief to TMD patients. Psychological disorders, such as depression and anxiety, are strongly associated with joint and facial pain. Finally, yet importantly, current evidence supports the positive effect of biofeedback-based cognitive-behavioral therapy on the pain coping skills of individuals with TMD. Future research elucidating the cause-effect relationship and neurobehavioral processes underlining chronic pain is warranted.

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Interview

Interview with Dr. Domingo Martin on "Temporomandibular Joint, Functional Occlusion and Excellence in Orthodontics"

TJO: In orthodontics, our objective is to establish an ideal occlusion with good facial esthetics and stability. Is there something missing?

Dr. Martin: There is something missing but it is because people don't have a clear understanding of what a good occlusion is. It is easy to say an ideal occlusion. I can still remember a well-known orthodontist used to always say "We gave the patient a good functional occlusion." And everyone uses the word "functional occlusion". But not everyone understands what a good functional occlusion is. We wrote an article about stability and in the article, I made the statement "we need to change the definition of occlusion". It is not me who says this. It is the president of the American Academy of Restorative Dentistry. He says, "If we only look at teeth, and if we only think that occlusion is teeth, we are never going to understand occlusion fully." What is an ideal occlusion? Well, the ideal occlusion is an occlusion that is in harmony with the stable condylar position. If we only look at teeth, we can say that they fit nicely but we cannot say that is an ideal occlusion. Let me see how you bite, how you chew, if you have the correct arc of closure and all of your teeth hit simultaneously bilaterally with the condyles seated. This is something that Jeff Okeson says. My definition of an ideal occlusion would be orthopedic stability. I think we spend too much time talking about occlusion, but occlusion is not really explaining the whole situation. When we use the word "occlusion" we only talk about teeth. When you talk about "orthopedic stability", you talk about teeth, joints, arc of closure, and chewing pattern. I agree that the objective should be facial esthetics but also orthopedic stability.

TJO: Why is orthopedic stability so important in orthodontics?

Dr. Martin: I guess it is because I have grey hair. The older I get, the more I understand how important orthopedic stability is. I am now being able to see my patients 20-30 years posttreatment. What do I see? I see that the cases are very stable. When I say stable, I mean no tooth wear, no TMJ symptoms, and very little crowding. I don't care about minor crowding, I think we should not be obsessed with 1.5-2 mm of lower incisor crowding. There is nothing stable in the universe, everthing moves. Why should teeth not move? However, we don't want 6-8 mm of crowding. So, when you achieve orthopedic stability you also achieve the correct arc of closure. And this is so important. When the patient opens and closes, there should be nothing getting in the way of the mandible during mastication, chewing or autorotation. The teeth should hit perfectly and evenly. This is the only way that you can have a good functional occlusion where the canines and the incisors disocclude the posterior teeth. For this to happen you have to have a stable condylar position. The minute that you don't have orthopedic stability, you don't have functional occlusion. And then, we see tooth wear, muscle symptoms, sometimes TMJ symptoms, and much more lower incisor crowding. I think that the lower incisors are not receiving the forces along their long axis. They are receiving lateral and oblique forces because of the mandible not moving correctly when we don't have the correct arc of closure. So, this is why for me orthopedic stability is so important. Because it is all about longevity. It makes me upset seeing a mother who says "Doctor, I had orthodontics when I was young.". When I look at her teeth, I am ashamed. If this is what orthodontics is going to give you 25 years from now, well, something is wrong. I don't mind a little bit of tooth wear, or maybe a little bit of lower incisor crowding. But it is not what I see. Usually, when I retreat many patients who had orthodontic treatment, the first thing I notice is the orthopedic instability. We are paying a price for orthopedic instability and yet we still do not give it importance. I heard recently a speaker saying that tooth wear was totally normal, and we should wear our teeth just as our ancestors. I don't accept this.

TJO: Do you use fixed retainers?

Dr. Martin: I do use fixed retainers. But I usually make them out 1-2 years later. And I tell the patients and the parents that there is going to be a little bit of tooth movement. I don't want to be responsible for fixed retention. I see lots of unwanted side effects with fixed retainers. We have to be careful and take full responsibility for fixed retainers. After all it's us who placed them.

TJO: In the literature, there is no consensus regarding the relationship between occlusion and the temporomandibular disorders. How do you comment on the potential role of the malocclusion in the onset of the temporomandibular disorders?

Dr. Martin: Let's start from two very well respected doctors, Dr. Jeff Okeson and Dr. James McKee. Dr.Jeff Okeson says that it is difficult to find a relationship between the occlusion and the temporomandibular joint if we continue to look at static occlusion. We have to realize even though there is lots of literature, they are still looking at static occlusions. I can look in a patient's mouth looking like a beautiful Class I, but he has symptoms. We place a splint, and it is no longer Class I. All the studies are being done with Class I occlusions as ideal can be a false position. This is why Dr.McKee talks about changing the definition of occlusion. He says "if we change the definition of the occlusion, it will probably come a time where we will find a relationship between the occlusion and TMD." But if we only look at the teeth, it will be difficult to find a relationship. I have spoken with many specialists, some agree, and some don't. You can not trust what you see in the mouth, because it is not what really exists. I saw a patient last year. He had the worst tooth abrasions, and he was only twelve years old. Both joints were on the eminence. How many people are looking at joints in 12 years old children? When I see that amount of tooth wear, the first thing that I think is something is wrong in the system. It is not about stress, he plays football all day, he is on the bike, he is happy and doesn't worry about anything. Why does he have tooth wear? This is a beautiful example of orthopedic instability. It is probably related to tooth wear. I say probably, because the day that I finish his treatment and restore his teeth, I will have to see the patient five years later at least to see if he stops wearing his teeth. But I have done it enough times so I know he will stop wearing his teeth. I respect the literature but when it comes to occlusion, the problem is the definition of the word occlusion. As long as we only talk about teeth, we are never going to find the relationship. In fact, what Dr.McKee says "much of the confusion that we see in the literature relating occlusion to TMD is because of the definition of occlusion". We need to bring the researchers and the clinicians together. We have been saying this for years, but we never do it. Many of the researchers are surrounded by the clinicians who already think that the teeth have nothing to do with TMJ. So, it is not evidence based but bias based. These are not my words but the words of Dr.Vanarsdall. They already know what they believe and that is what they are going to research. I think we need to do more research and that is what I am doing right now.

TJO: Dr. Martin, this is a very good suggestion for the researchers to come together with the clinicians.

Dr. Martin: Yes, I have many university students doing research in my office. A group from Budapest is looking at the relationship between vertical control and facial esthetics. Another researcher is evaluating the relationship between vertical control and the airway. As you can see, I am trying to bring evidence to what we do. However, in the world of TMJ, it is not so simple. There are so many variables.

TJO: Dr.Roth says "Don't believe what you see in mouth!". What are your essential diagnostic tools for treatment planning?

Dr. Martin: Let's not forget that we were not born to have beautiful teeth. That is our invention. We were born to have teeth to be able to chew and to be able to survive. However, in the 1920s and 1930s, Hollywood decided that the actors should have beautiful teeth. That is when the orthodontic movement began, and their goals were mainly esthetics. But the main goal of teeth is to survive, even today. That means that the teeth will always reach the maximum intercuspation in spite of tooth wear and condyle position to be able to chew. It is not easy to chew on 2 or 3 molars. The patients who have open bite will tell you. They don't chew, they swallow. There is no doubt that if these patients who have open bites could bring their mandible forward and bring the teeth together, they would do it. But they cannot. However, many patients move the mandible forward unconsciously, out of the condyle position, to bring the teeth into maximum intercuspation. So, why does Dr.Roth say, "Don't believe what you see in the mouth." ? Very simple, because of the definition of occlusion. If you think that occlusion should be a condyle position and a dental position, you have to look at the teeth, but you also have to check the joint position. "Does the patient bite correctly?". You should always ask yourself that question. When I see ideal teeth, I want to see how the patient really bites. When the patient bites really well, I say this is good occlusion and this is orthopedic stability. However, when I see a good dentition, and take the mandible and all of a sudden, I realize that there is a contact at the back, I know that the patient is now autorotating to avoid the contact, I cannot trust what I see in the mouth. Unfortunately, this happens in a large percentage of patients who have problems. These problems are almost always associated to an unstable occlusion and orthopedic instability. Don't trust what you see in the mouth, because it has nothing to do with the mounted model. Sometimes it is not easy to find the first contact because of the muscle splinting taking the mandible to maximum intercuspation. It is difficult to change this muscle ingram. This is why we use splints which relax the muscles and move the condyles to a stable position. I don't know where that position is. No one knows and it doesn't matter. All that matters, is if the patient is easy to manipulate and we have our arc of closure. Some symptomatic patient become asymptomatic. However now we have a new dental position. We use splints because we want to diagnose. There is no doubt that the splints help us to resolve many symptoms such as muscle pain, headaches, shoulder and neck pain, but it is actually a diagnostic tool. There is more to a splint that just to resolve symptoms, the advantages of using a splint is because now you know exactly what you need to do to maintain the patient asymptomatic. The splint is telling you "don't believe what you see in the mouth, this is now the real occlusion and

you have your job to do". There is no doubt that the skeletal anchorage has changed our life tremendously. In the past, it wasn't easy to solve these problems. We had to extract more teeth and do more surgery. Now, it is so much easier. I am not afraid to put a splint in a patient's mouth. Dr. Kazumi Ikeda used to call it "the hidden open bite". When you splint the patient, you are probably going to get an open bite, which was already there but it was hiding from you.

TJO: Apart from the splints, what other diagnostic tools do you use?

Dr. Martin: I cannot imagine my office today without CBCTs. In fact, if it wasn't because of the ethical and the radiation, I would probably take CBCTs on 100% of my patients. I am very cautious. I don't want to take CBCT of children because I don't need to on a routine basis, but when I need to, there is no doubt I will take a CBCT. CBCT is an important tool in my diagnostic process when there is orthopedic instability. When there is orthopedic instability, the joints and the teeth don't speak the same language. The CBCT will tell us: do we have a normal joint? Do we have a joint suffering from degenerative joint disease? Has the patient suffered from degenerative joint disease in the past? Is it symmetrical or asymmetrical? Are the joints well positioned in the fossa? It is not easy to make this decision because there are variations. But the variations should be within the norms. You can not say it is out of the fossa because it is slightly down and back. But you can say that there is tendency for that condyle to be down and back. However, in many instances, it is so far out of the fossa that you know that the condyle is not in the fossa. Now you know that there is an orthopedic instability situation because the joints are not in the correct position. Don't forget, the teeth take the joints out of the fossa. The joint is where it is due to the teeth, they are responsible for this position. What is happening at the tooth level that makes these joints go back. This is the diagnostic process that you have to look at. Do I take MRIs? I barely take MRIs. Because I don't need them. By looking at CBCT and by doing my joint analysis, I can more or less tell if the disc is displaced with or without reduction or if the patient has no disc. Everytime there is degenerative joint disease, the discs are gone. When the disc is totally displaced, as orthodontists we have a very important job to do. We have to stabilize the joint on the posterior ligament. The posterior ligament is going to be the pseudo disc. We have to take care of the posterior ligament very well, because this is what is going to be able to keep the mandible in the correct stable position and the patient asymptomatic. We also look at MRIs and mountings of course. The mountings will tell us if there is MIC-OC discrepancy. Then we look at the CBCTs and do our joint analysis. We also look at the skeletal pattern. Dolichofacial patients have more problems than normal patients.

TJO: Are you advocating the mounting of the study models?

Dr. Martin: I always say that you can do very good orthodontics without mounting models. However, you are going to miss some patients. You think that some patients have a good occlusion, and you take the mounted models, and you say "wow". It is not easy to see by just looking in the mouth and white handheld models do not always give you the entire information you need. How do you reach that level of perfection where you know exactly who you should mount and who you should not mount? It is very difficult. However, Dr.Roth mounted all his patients, there was a time where he was choosing which patients to mount and which not to mount until he realized that he had made many mistakes. Therefore, he one day decided just to mount all patients to make sure he did not make mistakes. Even in today's digital world and CBCTs, it is still important to mount models. Without any doubt the future will be digital mounted models.

TJO: Do you prefer digital mounting instead of analog systems?

Dr. Martin: I don't prefer it because I was born with models and articulator in my hands. I will always miss it, but I am sure the new generations are not going to miss it and although I will miss it does not mean that I will not start using this technology. On the contrary, I am an avid user of digital technology. In the digital world, you can now incorporate 4D movements with the scanned models or teeth, use CBCT and with the new ModJaw tracking system, we can incorporate the correct center of rotation which will revolutionize today's world of dentistry. Just because you have an articulator on the screen and you move the articulator, does not mean that you have the correct arc of closure. That's why I don't care for these programs that use arbitrary center of rotation, they are nice but they are not precise. We are more precise because we are incorporating the center of rotation, the correct arc of closure with the scanned dentition all at the same time. In fact, to tell you the truth, we don't take impressions, face bow transfers and mounted models anymore.

TJO: How do you incorporate the movements with the digital models?

Dr. Martin: We use different software programs.

TJO: According to your treatment philosophy, the correct 3D positioning of the posterior teeth is a very important step. Could you explain why we need to pay attention to the vertical control of the molars?

Dr. Martin: It is all about the arc of closure. The problems always arise at the posterior teeth. And it is almost always a transverse problem. Dr.Vanarsdall used to talk about this so often. He wasn't thinking about the second molars. But Dr.Vanarsdall gave us reasons why the transverse dimension was so important and why we needed to expand. Even though there wasn't a crossbite, we still needed to expand. What I realized over the years is that the second molars which are so important in the arc of closure are usually the reason why there is false position of the condyle and you cannot trust what you see in the mouth. It is mainly transverse in a large percentage of the patients. Both dental and skeletal transverse problems should be corrected. Sometimes you need to correct the torque. However, when you incorporate the skeletal pattern, now you have to change the torque and intrude the molars because of the posterior rotation of the mandible. The second molar is very important. We still see the JCO's surveys that a large percentage of orthodontists are still not banding the sec-

ond molars. That is very sad because we are giving the patients esthetics but we are not resolving the functional problem. And some patients are going to suffer because of that. I resolve most of these problems by treating the second molars and it works. Patients are asymptomatic, they have no tooth wear, we do full mouth reconstructions with composite and they are stable.

TJO: There is a changing trend about extraction treatment toward nonextraction by the use of TADs and expansion. What is your opinion?

Dr. Martin: There is no doubt that the number of extraction cases have come down a large amount. I have never cared about distalizing molars, because it wasn't an ideal treatment or solution for avoiding extractions since it was very difficult to move the molars en masse. But today, with TADs and especially palatal skeletal anchorage, we can move these molars almost en masse. This is of course avoiding lots of extractions. In the past I would never expand to avoid extractions but today we are avoiding extractions by expansion because we can expand more than before due to palatal anchorage. So, there is no doubt we do less extractions. But I just wrote an article about stability and I wrote about the importance of taking a mounted model before you take off the appliances. It is very nice to avoid extractions, but you have to ask yourself "Did I achieve all the goals?". Because our goal should not be nonextraction. Are we treating too many patients nonextraction because of TADs and because of expansion and not achieving our goals? Then, this is a problem.

TJO: What are the key factors for stability?

Dr. Martin: The number one factor for stability in my opinion is occlusion. Teeth need to receive occlusal forces along their long axis. However, this should happen with the condyles seated, with the correct arc of closure, bilateral simultaneous contacts on all teeth. This is of course orthopedic stability. Nothing is isolated, they are all interrelated. So, occlusal forces are the most important factors for stability. When teeth receive occlusal forces along their long axis, they are going to be more stable. Another factor for stability is tooth eruption. This is why I extract many deciduous teeth. Because I want the teeth to erupt in the mouth with no rotations. This is another very important factor because a minute a tooth erupts rotated, it has memory. When I see that I have lack of space for the lateral incisors, I will extract deciduous canines immediately because I want the lateral incisors to erupt perfectly aligned in the mouth. This is another very important factor for stability, to have the teeth erupt in the correct position in the dental arch.

TJO: How would you define the excellence in orthodontics?

Dr. Martin: If you achieve all the goals in all your patients, you are the best orthodontist in the world. And we all know it is not easy to achieve all the goals in all patients. Facial esthetics is so important and everything you do to improve facial esthetics is going to be an excellent treatment. Sometimes you have to go for the surgery. But today with skeletal anchorage, we are seeing lots of incredible skeletal changes. Dental esthetics is another factor for excellence but is not always in our hands. We have small, abraided or colored teeth. In order to have excellence, you need a good prosthodontist in your team to be able to finish your cases. Then, you need orthopedic stability, longevity of the teeth and no abrasion. If you have good facial and dental esthetics, functional occlusion, periodontal health and stability, that is excellence in orthodontics. I think that excellence is an attitude. You have to want the excellence, you have to convince your patients that excellence is important for them and for you. And then, you have to go for it. But you also need to know your limitations.

TJO: Thank you very much for this informative interview.