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TURKISH JOURNAL of ORTHODONTICS

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

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

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

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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.

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

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Contents

Original Articles

Review

Case Report

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ORIGINAL ARTICLE

Upper Lip Asymmetry During Smiling: An Analysis Using Three-Dimensional Images

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ABSTRACT

Objective: The aim of this study was to use three-dimensional images to determine the presence of upper lip asymmetry at rest and during smiling in a group of individuals with no history of orthodontics or facial cosmetic surgery.

Methods: Standardized three-dimensional frontal resting and smiling images of 54 volunteers were analyzed using the 3dMDvultus software (3dMD, Atlanta, GA). Measurements were made from the soft tissue nasion, ipsilateral ala, subnasale, and menton to the right and left commissures of the lip. A 2.5 mm or greater difference between the right and left sides was defined as an asymmetry. The agreement on the presence or absence of asymmetry between the subjects' states of rest and smiling was determined by the McNemar's chi-squared test. Statistical significance was defined as $p<0.05$.

Results: Menton was the most stable facial landmark to evaluate the upper lip symmetry at rest and during smiling ($p=0.002$). Using menton as a landmark, only one of the 54 subjects showed asymmetry while resting, but 12 (22%) showed asymmetry when smiling.

Conclusion: As part of treatment planning for orthodontics or orthognathic surgery, patients should be evaluated for the upper lip symmetry during resting and smiling. The presence of asymmetry during smiling is a significant clinical problem that needs to be recognized so that patients can be informed about the effect it can have on the final esthetic result.

Keywords: Esthetics, three-dimensional images, smiling, orthodontics, orthognathic surgery

INTRODUCTION

Facial attractiveness and dental esthetics have been shown to have a significant impact on the social status and quality of life (1, 2). Several studies have reported that attractive individuals are perceived to be more intelligent, talented, and successful (3-5). One important component of facial attractiveness is smile esthetics (6-8). Although, teeth color has been reported to be the most important factor in smile attractiveness, the vertical thickness and the symmetry of the lips have been also ranked as important variables (6, 9-11).

Facial and smile asymmetries can arise not only from the hard tissue, but also from the soft tissue imbalances. Furthermore, lip asymmetry can affect the amount of tooth and gingival display, which could also contribute to an unesthetic smile. The effect of hard tissue cants on facial esthetics has also received much attention in the literature; however, soft tissue asymmetry should also be analyzed as a patient's smile can have a dramatic impact on the esthetic results of both orthodontic and surgical cases. This is especially important considering that individuals pursuing orthodontics or orthognathic surgery may have heightened awareness of their preoperative and postoperative facial esthetics. Achieving an esthetic smile has been shown to be one of

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the most important reasons why patients request orthodontic treatment (12).

The lip position at rest and during smiling can have an important effect on facial appearance following orthognathic surgery. In the case of mandibular advancement and setback, patients often place greater emphasis on changes in the lip position than on the chin position when considering their profile changes (13). However, favorable results in correcting smile asymmetry are relatively unpredictable (14, 15). Smiling is not a static phenomenon; it is influenced by many muscle groups that are not always involved in the different types of orthognathic surgery (16). In fact, smile asymmetry may be the result of asymmetry of the perioral musculature itself (15).

Because of the importance of lip symmetry in facial appearance, it is essential to adequately determine deviations from the ideal symmetry prior to orthognathic surgery to avoid unfulfilled patient expectations postoperatively (17). Previously, soft tissue asymmetry has generally been studied using photographs at rest and during smiling; however, to the best of our knowledge, there have been only two studies that have evaluated lip asymmetry using a three-dimensional technique (18, 19). One of these used soft tissue landmarks unlike those used in this study, and the other focused on the laterality of the corners of the mouth during a portrait smile. The aim of this study was to determine the presence of resting and smiling upper lip asymmetry in a group of individuals with no facial skeletal asymmetry and no history of orthodontics or facial cosmetic surgery, using three-dimensional imaging software.

METHODS

The ethical approval for this investigation was obtained from the Virginia Commonwealth University Institutional Review Board. The study included 54 volunteers (24 males, 30 females) between 20 and 35 years of age with a balanced and symmetric face, who were not currently receiving orthodontic treatment, who had no history of orthodontic treatment, or who were not pursuing orthognathic surgery. Standardized resting and smiling frontal view images were obtained with a 3dMDface stereophotogrammetry camera (3dMD, Atlanta, GA). The subjects were seated ensuring that their head was in the focal field of the camera and were instructed to look at a fixed point directly in front of their eyes to obtain a natural head position. Instructions prior to capturing the resting image included, "Say 'Emma', relax your lips, and try not to blink." To obtain a relatively normal smiling picture, instructions included, "Smile as big as you would for a picture and try not to blink." Using the 3dMDvultus software (3dMD, Atlanta, GA, US), the two images were superimposed by the best fit method described by the software manufacturer following selection of surfaces that were predicted to remain unchanged between the two images: the forehead and the upper one-third of the nasal bridge. A root mean squared value (RMS) was recorded from each image that assessed the accuracy of the surface superimposition. The RMS values of 0.5 mm or less were deemed acceptable, as recommended by the manufacturer. Following successful registration, landmarks were plotted on each image. Measurements (mm) were then made from nasion, ipsilateral ala, subnasale, and menton to the left and right commissure of the lip, respectively, using the caliper setting (Figure 1). A ≥2.5 mm difference between the right and left commissure of the lip defined an asymmetry.

Statistical Analysis

To evaluate consistency of the measurements, 40 measurements were independently reevaluated by the data collector (AM). Based on this independent sample of rechecked measures, the intraclass correlation coefficient was >0.7 for all landmarks, indicating a good measurement reliability. Normality of the study measures was assessed using the Shapiro-Wilk test and visual test. All measures demonstrated sufficient normality. The agreement on the presence or absence of asymmetry between the subjects' states of rest and during smiling was determined by McNemar's chi-squared test. Statistical significance was defined as $p<0.05$. SAS EG v.6.1 (SAS Institute, Cay, NC, USA) was used for all analyses.

RESULTS

Although the use of all four landmarks revealed that some patients had an asymmetrical smile, menton appeared to be the

Table 1. The number of subjects with an asymmetry of ≥2.5 mm at rest and while smiling using various landmarks as a reference point; only menton was determined to be statistically significant as the point of reference to evaluate the differences in the distance to the left and right commissure, respectively

	Resting Asymmetry	Smiling Asymmetry	Both	p*
Ala	7	5	1	0.5271
Menton	1	12	0	0.0023
Nasion	2	4	1	0.3173
Subnasale	4	11	1	0.0522
Overall	11	23	3	0.0233

*p from the McNemar's chi-squared test of agreement between the resting and smiling asymmetry

Table 2. Differences in the distance from menton to the left and right commissure in individuals with an asymmetry >2.5 mm when smiling. The asterisk sign indicates the right-side asymmetry.

Subject	Smiling Asymmetry (in mm)
Subject 1	4.11
Subject 2	3.46
Subject 3	2.74
Subject 4	3.01
Subject 5	2.63
Subject 6	4.06*
Subject 7	4.15*
Subject 8	7.76
Subject 9	2.69
Subject 10	4.32*
Subject 11	2.58
Subject 12	3.62

most stable facial landmark to evaluate lip symmetry at rest and during smiling because it was able to show the greatest change in asymmetry from resting to smiling (p=0.0023) (Table 1). Using menton as a landmark, only one of the 54 subjects showed asymmetry at rest, but 12 (22%) showed asymmetry while smiling (Table 2). Of these 12 subjects, nine had asymmetry on the left side. This is demonstrated in the Bland-Altman Plots in Figures 2A and 2B. Table 3 provides the average absolute difference (absolute value of difference from left to right to eliminate negatives) for each of the landmarks along with the minimum and maximum for both resting and smiling.

DISCUSSION

The findings of this study indicate that a relatively significant number of people who have lip symmetry at rest showed asymmetry during smiling. Since the study participants were 20 to 35-year-old healthy individuals who could be candidates for orthodontics or orthognatic surgery, it indicates that the presence of asymmetry during smiling should be considered when developing a diagnosis and treatment plan. A soft tissue asymmetry absent at rest but noticeable while smiling is generally not correctable by orthognathic surgery. Therefore, patients need to be made aware of the situation prior to treatment so that they do not consider it a result of the treatment and are displeased with the results. This is particularly true in light of the fact that many patients with an asymmetrical smile may be unaware of the situation (14).

A difference in the position of the commissures of ≥2.5 mm was chosen as an indicator of the upper lip asymmetry based on studies involving the recognition of a maxillary cant and the study of Batwa et al. (11) who showed that such a lip asymmetry had a relative impact on smile esthetics (20). Although clinically soft tissue menton is generally not considered to be a reliable reference point to determine facial skeletal asymmetry, in this 3dMD study, it proved to be most reliable for measuring the upper lip symmetry because the subjects had no bony facial asymmetry, and soft tissue menton is not subject to simultaneous movement when the facial muscles activate during smiling. The asymmetry was most frequently on the left side. This type of laterality has also been shown by Okamoto et al. (18) using three-dimensional facial images (1).

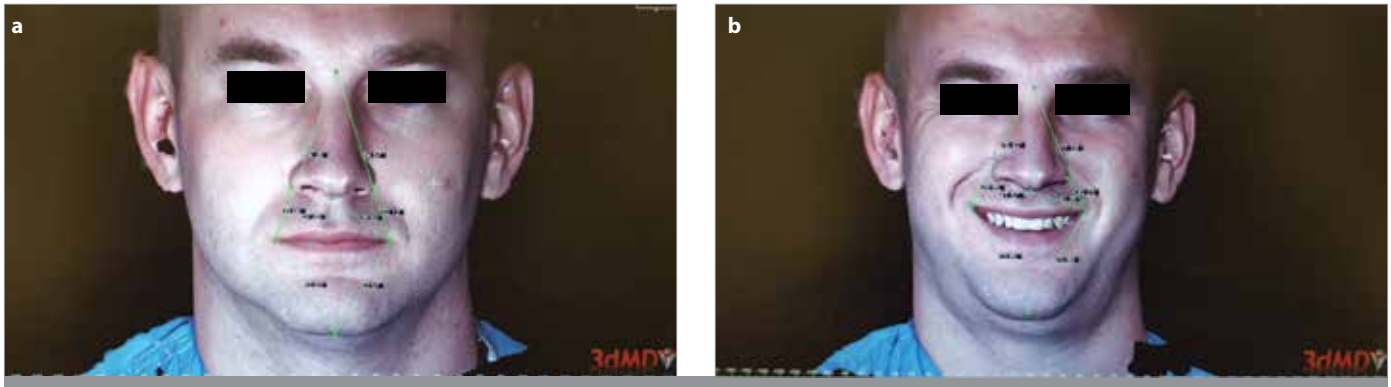

Figure 1. a, b. Measurements (mm) made from nasion, ipsilateral ala, subnasale, and menton to the left and right commissure of the lip with the patient at rest (a); measurements (mm) made from nasion, ipsilateral ala, subnasale, and menton to the left and right commissure of the patient's lip while smiling; note the lip asymmetry (b)

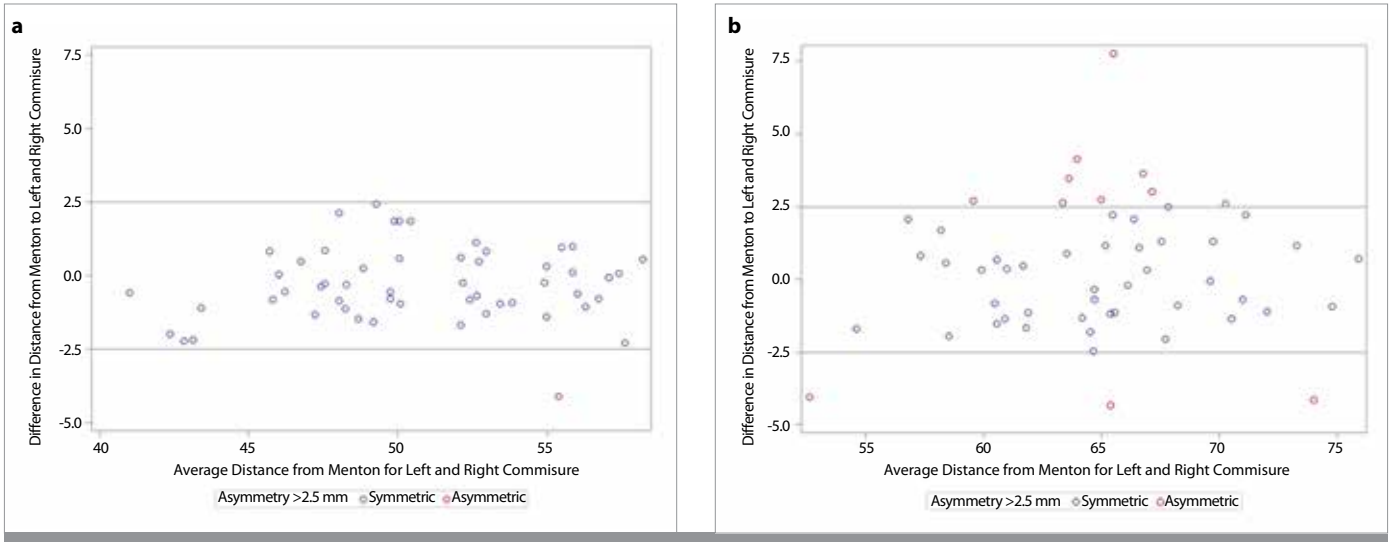

Figure 2. a, b. Bland-Altman plot of comparison of the distance to the left and right commissure from menton at rest (a); Bland-Altman plot of comparison of the distance to the left and right commissure from menton when smiling (b)

Table 3. Summary of the absolute difference between the left and right commissure from each landmark

	Resting			Smiling		
Landmark	**Mean**	**Minimum**	**Maximum**	**Mean**	**Minimum**	**Maximum**
Menton	1.02	0.03	4.11	1.77	0.06	7.76
Nasion	0.98	0.05	2.67	1.08	0.00	5.07
Subnasale	1.30	0.04	6.21	1.46	0.07	4.45
Ipsilateral ala	1.30	0.04	3.68	1.10	0.03	4.34

Although it was assumed that the measurement from menton to the labial commissure was a vertical measurement, it also has a horizontal component. However, because a natural smile cannot anatomically be purely horizontal, any vertical difference between the two sides is still reflective of an upper lip asymmetry. A malpositioned nose potentially introduced the largest source of error in this study because it can result in the ala, philtrum, and nasion being shifted off the midline.

It has been claimed that there is a difference between a spontaneous and posed smile and that the posed smile may be more asymmetrical; however, later studies have shown no difference (3, 7, 8). Moreover, even if there is a difference, one needs to consider that patients generally evaluate their smile in a posed position and are, therefore, more likely to detect asymmetry.

This study did not have the power to accurately determine the true prevalence of the upper lip asymmetry because of the small number of subjects. There was also a considerable variation in the findings depending on the landmark used. However, it still shows that the presence of the upper lip asymmetry when smiling is a significant clinical problem and that the two-dimensional studies used in the past have underestimated the magnitude of this condition.

CONCLUSION

A significant number of individuals have an upper lip asymmetry when smiling. This problem needs to be recognized in patients considering orthodontics or orthognathic surgery so that they can be informed that the condition is not correctable and that it can affect the final esthetic result.

Ethics Committee Approval: Ethics committee approval was received for this study from the Institutional Review Board of Virginia Commonwealth University.

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

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - D.M.L., E.T.; Design - D.M.L., A.M.; Supervision - D.M.L., E.T.; Resources - S.J.L.; Materials - S.J.L.; Data Collection and/or Processing - A.M., E.T.; Analysis and/or Interpretation - C.C., A.M.; Literature Search - A.M.; Writing Manuscript - A.M., D.M.L.; Critical Review - D.M.L., S.J.L.

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

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ORIGINAL ARTICLE

Evaluation of the Compliance of Orthodontists to Infection Control Procedures in Turkey

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ABSTRACT

Objective: Orthodontists do not perform surgical procedures, nevertheless they are obliged to practice appropriate sterilization techniques to prevent cross-infection. This is also important from an ethical and legal point of view. The aim of the present study is to evaluate the compliance of orthodontists to infection control procedures in Turkey.

Methods: A questionnaire with 36 items was delivered by e-mail to a total of 1152 orthodontists/residents between October 2014 and March 2015 by the Turkish Orthodontic Society. Various data from surveys were analyzed using the IBM SPSS statistics 22 software.

Results: The questionnaire was completed by 130 (11.28%) respondents. 95.4% of the orthodontists were immunized against hepatitis B. The usage rates of type B autoclave, non-type B autoclave, and dry-heat sterilizer were 40%, 17.7%, and 16.9%, respectively. A total of 24.6% of the orthodontists used disinfectant solutions for the sterilization of hand instruments and pliers; the rate of using disinfectants for the sterilization of dental handpieces was found to be higher (56.9%).

Conclusion: The infection control procedures in the field of orthodontics must be improved in Turkey. Training on compliance with the infection control principles should be included in education programs, and these programs should be repeated on a regular basis.

Keywords: Orthodontics, sterilization, disinfection, infection control procedure

INTRODUCTION

Infection control is crucial for orthodontists and for patient health. The concept of sterilization and disinfection was introduced into the dental practice with the recognition of hepatitis B as an occupational disease in 1975, and considerable steps have been taken in infection control procedures with increasing prevalence of human immunodeficiency virus (HIV)/acquired immune deficiency syndrome (AIDS) in the mid-1980s. Dental practitioners are exposed to various types of microorganisms. This exposure poses dental practitioners to the risk of developing infections from mild flu to more severe conditions such as HIV (AIDS), hepatitis B, and hepatitis C. Finally, all precautions must be taken, and sterilization and disinfection methods must be rigorously practiced assuming all patients in dental practice are potential carriers of an infectious disease (1-3).

Infection control procedures in dental practice have been published for the first time in 1978 by the American Dental Association. The Center for Disease Control and Prevention (CDC) later established and implemented the principles for the first time in 1986 and published the guidelines for infection control in 1988, 1989, 1993, and 2003, particularly dedicated to the dental practice (4-8).

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All dental procedures carry the risk of direct or indirect cross-infection between the patients and dental care professionals. Current dental services have adopted "standard infection control" measures originally described in the Guidelines for Infection Control in Dental Health-Care Settings published in 2003 by the CDC, the steering organization setting the standards in healthcare services worldwide; the guidelines recognize saliva, in addition to blood, as a potential source of infection. According to the guidelines of the CDC published in 2003, all private practice and clinics must have a written infection control program and have designated an infection control coordinator; the employees must be informed and monitored, and the program must be updated on a regular basis (8-10).

In Turkey, the Turkish Dental Association (TDB) published a special edition for Infection Control in Dental Practice in 2000 (11). In 2007, the Istanbul Chamber of Dental Practitioners distributed an educational CD of Infection Control Directory in Dental Practice in March/April edition (9). Dental practice is a team work involving dental assistants, and the assistants are important components of this team and they play an important part in sterilization (12). Regarding the infection control, the Ministry of Labor and Social Security enacted the Occupational Health and Safety law, and further legal regulations on the patient and employee safety are underway (13, 14). However, training strategy for infection control in dental practice in Turkey does not put dental practitioners at the center of education starting from their education period in the faculty, but, indeed, dental practitioners are primarily responsible for the provision of dental health services (9).

Orthodontists usually do not perform comprehensive surgical procedures, but they are obliged to use appropriate sterilization techniques to prevent cross-infection in daily practice. This is also important from an ethical and legal point of view (15-18). However, the studies have found that orthodontists have lower compliance to the infection control procedures than dentists. The main reason for this is that they work on pediatric cases, they do not perform procedures in deep tissues, sterilization procedures result in the loss of time and money, and sterilization procedures cause corrosion in orthodontic pliers (19-21). There are many studies in the literature that studied the effects of sterilization on orthodontic archwires, pliers, brackets, bands, and elastic ligatures and evaluated infection control procedures to be followed in the practice of orthodontics and the compliance of orthodontists to these procedures (22-28). However, no comprehensive research evaluating the compliance of the Turkish orthodontists to the infection control procedures is available.

In the present study, we aimed to evaluate sterilization and disinfection methods employed in the practice of orthodontics in Turkey and the compliance of orthodontists to these methods.

METHODS

In the present study, a 36 items questionnaire (Appendix 1) was delivered to a total of 1152 orthodontists/residents affiliated to the Turkish Orthodontic Society (TOD) between October 3, 2014 and March 23, 2015 (29). Two deliveries were made using the resources of TOD and two deliveries personally by the authors. A total of 130 (11.28%) respondents completed the questionnaire.

The questionnaire inquired the following variables:

- Experience in practice,
- Place of work,
- Daily patient capacity,
- Number of dental assistant,
- Sterilization devices used,
- Whether or not regular control and maintenance of the sterilization devices are performed,
- The methods used in sterilization control,
- Sterilization status of the instruments and method of sterilization,
- Disposal of bands, brackets, and archwires removed from the patients,
- Whether they use recycled brackets/orthodontic materials,
- Disinfection status of the impressions and appliances delivered to the dental laboratory,
- Presence of written communication line with the dental laboratory,
- Place of sharp objects disposal container,
- Methods used for the cleaning of environmental surfaces at the clinic and type of gloves used,
- Use of protective masks and goggles during environmental cleaning,
- Hand washing practices before wearing and after removing gloves,
- Use of a separate protective mask in each patient,
- Use of protective goggles/face shield during treatment,
- Presence of written infection control program,
- Hepatitis B, influenza, and tetanus vaccination status.

Statistical Analysis

Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) version 22.0 software (IBM Corp.; Armonk, NY, USA). Descriptive data were expressed in frequency. The chi-square, Fisher's exact, and Yates continuity correction tests were used to compare the qualitative data. A p value of <0.05 was considered statistically significant.

RESULTS

The responses of a total of 130 orthodontists and residents included in the present study were compared according to the experience in orthodontics, place of work, and daily number of examined patients (Table 1-5).

Table 1. Descriptive characteristics of the orthodontists/residents included in the study

		n	%
Experience in orthodontics	≤20 years	105	80.8
	>20 years	25	19.2
Place of work	Private office	32	24.6
	Private oral and dental health clinic	28	21.5
	University clinic	70	53.8
Daily patient volume	0-10	53	40.8
	10-20	50	38.5
	>20	27	20.8

Table 2. Percentage of orthodontists/residents who responded to questions regarding infection control procedure

		n	%
Written infection control program at your clinic	Yes	65	50
	No	65	50
A separated sterilization room	Yes	113	86.9
	No	17	13.1
Cleaning of the instruments to be sterilized	Manually with water	61	46.9
	Ultrasonic cleaner	31	23.8
	Washer disinfector	38	29.2
A separated instrument washing sink separate from the hand washing sink	Yes	107	82.3
	No	23	17.7
Sterilization devices used	Type B autoclave	52	40.0
	Non-type B autoclave	23	17.7
	Cassette autoclave	19	14.6
	Dry-heat sterilizer	22	16.9
	No response	14	10.8
Annual maintenance of sterilization devices	Yes	109	83.8
	No	21	16.2
Cleaning of water tank of the autoclave	Yes	102	78.5
	No	28	21.5
Packing of instruments to be sterilized in the autoclave	I do pack	115	88.5
	I do not pack	15	11.5
Autoclave sterilization control	I perform	77	59.2
	I do not perform	53	40.8
Supply of biological indicator spore test for the control of autoclave sterilization	I perform	58	44.6
	I do not perform	72	55.4
Regularly keeping and storing of sterilization records	Yes	67	51.5
	No	63	48.5
Methods used for the sterilization of dental handpieces	Wiping the outer surface with disinfectant solution	74	56.9
	In the autoclave	37	28.5
	Handpiece autoclave	19	14.6
Methods used for the sterilization of hand instruments/orthodontic pliers	Wiping with a disinfectant solution	32	24.6
	Autoclave	74	56.9
	Cassette autoclave	16	12.3
	Dry-heat sterilizer	8	6.2
Sterilization of molar bands after purchase	Yes	36	27.7
	No	94	72.3
Sterilization of molar bands after trial in the patient	Sitting in disinfectant	45	34.6
	Autoclave	69	53.1
	Cassette autoclave	9	6.9
	Dry-heat sterilizer	7	5.4
Disposal of the bands, brackets, and archwires removed from the patients during or after treatment	Waste basket	53	40.8
	Sharps bin	66	50.8
	Metal waste bin	11	8.5
Use of recycled brackets/orthodontic materials	Yes	25	19.2
	No	105	80.8
Disinfection status of impressions or appliances to be delivered to an outer laboratory	Yes	79	60.8
	No	51	39.2

Table 2. Percentage of orthodontists/residents who responded to questions regarding infection control procedure (Continued)

Written communication line with outer laboratory	Yes	93	71.5
	No	37	28.5
Knowledge of biofilm development in the dental unit water lines requiring cleaning	Yes	97	74.6
	No	33	25.4
Place of sharps bin	At the clinic	73	56.2
	At the sterilization room	57	43.8
Environmental surface cleaning	I disinfect	100	76.9
	I cover with dedicated cloths	30	23.1
Type of gloves used in instrument and environmental cleaning	I do not wear	6	4.6
	Kitchen-type gloves	24	18.5
	Examination gloves	100	76.9
Wearing protective mask and goggles during environmental cleaning/manual cleaning of instruments	Yes	64	49.2
	No	66	50.8
Hand washing before wearing gloves	Yes	74	56.9
	No	56	43.1
Hand washing after removing gloves	Yes	124	95.4
	No	3	4.6
Using a separate protective mask for each patient	Yes	41	31.5
	No	89	68.5
Wearing protective goggles/shields during treatment	Yes	63	48.5
	No	67	51.5
Hepatitis B vaccination status	Yes	124	95.4
	No	6	4.6
Influenza vaccination status	Yes	21	16.2
	No	109	83.8
Last tetanus vaccination	6-10 years	78	60.0
	10-20 years	20	15.4
	>20 years	32	24.6

Of the total respondents, 80.8% have an experience less than 20 years, and 19.2% have an experience more than 20 years in the field of orthodontics; 24.6% work in private offices, 21.5% work in private oral and dental health clinics, and 53.8% work in university clinics. In terms of daily patient capacity, 40.8% of the respondents have 0-10, 38.5% of them have 10-20, and 20.8% have over 20 patients (Table 1).

Percentage of orthodontists/residents who responded to questions regarding infection control procedure are shown in Table 2. The rates of using type B autoclave, non-type B autoclave, cassette autoclave, and dry-heat sterilizer were 40%, 17.7%, 14.6%, and 16.9%, respectively. The rate of packing instruments to be sterilized in the autoclave was 88.5%, autoclave sterilization control was 59.2%, and supplying biological indicator spore test for controlling of autoclave sterilization was 44.6%. The rate of wiping the outer surface of dental handpieces with disinfectant solution was 56.9%, and using autoclave for the sterilization of hand instruments/orthodontic pliers was 56.9%. Whereas the rate of sitting molar bands in disinfectant solution after trial in the patient was 34.6%, the rate of autoclave sterilization was 53.1%. The rates of using waste basket and sharps bin for the disposal of the bands, brackets, and archwires removed from the patients during or after treatment were 40.8% and 50.8%, respectively. Hepatitis B immunization rate was 95.4% (Table 2).

Percentage of orthodontists/residents who responded to questions regarding infection control procedure according to experience are shown in Table 3. The rate of biological indicator spore test supply for controlling autoclave sterilization of junior orthodontists with an experience of less than 20 years (50.5%) was significantly higher than senior orthodontists with an experience of more than 20 years (20%). The rate of using waste basket for the disposal of bands, brackets, and archwires removed from the patients during or at the end of the treatment of junior orthodontists (45.7%) was significantly higher than senior orthodontists (20%). The rate of using sharps bin of junior orthodontists (47.6%) was lower than senior orthodontists (64%); however, this difference was not statistically significant. The rate of washing hands before wearing gloves of junior orthodontists (51.4%) was significantly lower than senior orthodontists (80%). The rate of autoclave usage for the sterilization of dental handpieces was lower among junior orthodontists (26.7%) and senior orthodontists (36%). On the other hand, the rate of wiping the outer surface of dental handpieces with disinfectant solution was higher

Table 3. Percentage of orthodontists/residents who responded to questions regarding infection control procedures according to experience

		Experience		
		≤20 years	>20 years	
		n (%)	n (%)	p
Presence of dental assistant		93 (88.6%)	25 (100%)	0.121
Presence of a written infection control program at the clinic		52 (49.5%)	13 (52%)	1.000
Presence of a separated sterilization room		94 (89.5%)	19 (76%)	0.096
Cleaning of the instruments to be sterilized	Manually with water	48 (45.7%)	13 (52.0%)	0.856
	Ultrasonic cleaner	25 (23.8%)	6 (24.0%)	
	Washer disinfector	32 (30.5%)	6 (24%)	
Presence of a separated instrument washing sink separate from the hand washing sink		87 (82.9%)	20 (80%)	0.772
Sterilization devices used	Type B autoclave	45 (47.4%)	7 (33.3%)	0.305
	Non-type B autoclave	19 (20.0%)	4 (19.0%)	
	Cassette autoclave	16 (16.8%)	3 (14.3%)	
	Dry-heat sterilizer	15 (15.8%)	7 (33.3%)	
Annual maintenance of sterilization devices		87 (82.9%)	22 (88%)	0.763
Cleaning of water tank of the autoclave		82 (78.1%)	20 (80%)	1.000
Packing of instruments to be sterilized in the autoclave		93 (88.6%)	22 (88%)	1.000
Autoclave sterilization control		62 (59%)	15 (60%)	1.000
Supply of biological indicator spore test for the control of autoclave sterilization		53 (50.5%)	5 (20%)	0.011*
Regularly keeping and storing of sterilization records		58 (55.2%)	9 (36%)	0.132
Methods used for the sterilization of dental handpieces	Wiping the outer surface with disinfectant solution	60 (57.1%)	14 (56.0%)	0.461
	In the autoclave	28 (26.7%)	9 (36.0%)	
	Dedicated device (handpiece autoclave)	17 (16.2%)	2 (8.0%)	
Methods used for the sterilization of hand instruments/orthodontic pliers	Wiping with a disinfectant solution	23 (21.9%)	9 (36.0%)	0.138
	Autoclave	62 (59.0%)	12 (48.0%)	
	Cassette autoclave	15 (14.2%)	1 (4.0%)	
	Dry-heat sterilizer	5 (4.8%)	3 (12.0%)	
Sterilization of molar bands after purchase		26 (24.8%)	10 (40%)	0.200
Sterilization of molar bands after trial in the patient	Sitting in disinfectant solution	37 (35.2%)	8 (32.0%)	0.624
	Autoclave	57 (54.3%)	12 (48.0%)	
	Cassette autoclave	6 (5.7%)	3 (12.0%)	
	Dry-heat sterilizer	5 (4.8%)	2 (8.0%)	
Disposal of the bands, brackets, and archwires removed from the patients during or after treatment	Waste basket	48 (45.7%)	5 (20.0%)	0.040*
	Sharps bin	50 (47.6%)	16 (64.0%)	
	Metal waste bin	7 (6.7%)	4 (16.0%)	
Use of recycled brackets/orthodontic materials		19 (18.1%)	6 (24%)	0.573
Disinfection status of impressions or appliances to be delivered to an outer laboratory		67 (63.8%)	12 (48%)	0.220
Written communication line with outer laboratory		75 (71.4%)	18 (72%)	1.000
Knowledge of biofilm development in the dental unit water lines requiring cleaning		80 (76.2%)	17 (68%)	0.555
Place of sharps bin	At the clinic	59 (56.2%)	14 (56%)	1.000
	At the sterilization room	46 (43.8%)	11 (44%)	
Environmental surface cleaning	I disinfect	83 (79%)	17 (68%)	0.361
	I cover with dedicated cloths	22 (21%)	8 (32%)	

Table 3. Percentage of orthodontists/residents who responded to questions regarding infection control procedures according to experience (Continued)

Type of gloves used in instrument and environmental cleaning	Do not wear	5 (4.8%)	1 (4.0%)	0.966
	Kitchen-type gloves	19 (18.1%)	5 (20%)	
	Examination gloves	81 (77.1%)	19 (76%)	
Wearing protective mask and goggles during environmental cleaning/manual cleaning of instruments		49 (46.7%)	15 (60%)	0.329
Hand washing before wearing gloves		54 (51.4%)	20 (80%)	0.018*
Hand washing after removing gloves		100 (95.2%)	24 (96%)	1.000
Use of a separate protective mask for each patient		36 (34.3%)	5 (20%)	0.253
Wearing protective goggles/shields during treatment		50 (47.6%)	13 (52%)	0.864
Hepatitis B vaccination status		100 (95.2%)	24 (96%)	1.000
Influenza vaccination status		14 (13.3%)	7 (28%)	0.125
Last tetanus vaccination	6-10 years	67 (63.8%)	11 (44.0%)	0.116
	10-20 years	16 (15.2%)	4 (16.0%)	
	>20 years	22 (21.0%)	10 (40.0%)	

Chi-square, continuity (Yates) correction, and Fisher's exact tests were used, *p<0.05

Table 4. Percentage of orthodontists/residents who responded to questions regarding infection control procedures according to the place of work

		Place of work			
		Private office n (%)	**Private oral and dental health clinic n (%)**	**University clinic n (%)**	**p**
Presence of dental assistant		32 (100%)	27 (96.4%)	59 (84.3%)	0.020*
Presence of a written infection control program at the clinic		16 (50%)	13 (46.4%)	36 (51.4%)	0.905
Presence of a separated sterilization room		21 (65.6%)	24 (85.7%)	68 (97.1%)	0.001**
Cleaning of the instruments to be sterilized	Manually with water	19 (59.4%)	13 (46.4%)	29 (41.4%)	0.419
	Ultrasonic cleaner	6 (18.8%)	7 (25.0%)	18 (25.7%)	
	Washer disinfector	7 (21.8%)	8 (28.6%)	23 (32.9%)	
Presence of a separated instrument washing sink separate from the hand washing sink?		26 (81.3%)	24 (85.7%)	57 (81.4%)	0.867
Sterilization devices used	Type B autoclave	16 (53.3%)	16 (61.5%)	20 (33.3%)	0.007**
	Non-type B autoclave	4 (13.3%)	0 (0%)	19 (31.7%)	
	Cassette autoclave	2 (6.7%)	6 (23.1%)	11 (18.3%)	
	Dry-heat sterilizer	8 (26.7%)	4 (15.4%)	10 (16.7%)	
Annual maintenance of sterilization devices		20 (62.5%)	25 (89.3%)	64 (91.4%)	0.001**
Cleaning of water tank of the autoclave		25 (78.1%)	24 (85.7%)	53 (75.7%)	0.553
Packing of instruments to be sterilized in the autoclave		26 (81.3%)	28 (100%)	61 (87.1%)	0.067
Autoclave sterilization control		13 (40.6%)	16 (57.1%)	48 (68.6%)	0.028*
Supply of biological indicator spore test for the control of autoclave sterilization		4 (12.5%)	15 (53.6%)	39 (55.7%)	0.001**
Regularly keeping and storing of sterilization records		9 (28.1%)	13 (46.4%)	45 (64.3%)	0.003**
Methods used for the sterilization of dental handpieces	Wiping the outer surface with disinfectant solution	21 (65.6%)	12 (42.9%)	41 (58.6%)	0.050
	In the autoclave	11 (34.4%)	10 (35.7%)	16 (22.9%)	
	Dedicated device (handpiece autoclave)	0 (0%)	6 (21.4%)	13 (18.6%)	
Methods used for the sterilization of hand instruments/orthodontic pliers	Wiping with a disinfectant solution	11 (34.4%)	11 (39.3%)	10 (14.3%)	0.050
	Autoclave	17 (53.1%)	12 (42.9%)	45 (64.3%)	
	Cassette autoclave	2 (6.3%)	5 (17.9%)	9 (12.9%)	
	Dry-heat sterilizer	2 (6.3%)	0 (0%)	6 (8.6%)	

Table 4. Percentage of orthodontists/residents who responded to questions regarding infection control procedures according to the place of work (Continued)

Sterilization of molar bands after purchase		13 (40.6%)	5 (17.9%)	18 (25.7%)	0.125
Sterilization of molar bands after trial in the patient	Sitting in disinfectant solution	13 (40.6%)	8 (28.6%)	24 (34.3%)	0.254
	Autoclave	17 (53.1%)	14 (50.0%)	38 (54.3%)	
	Cassette autoclave	1 (3.1%)	5 (17.9%)	3 (4.3%)	
	Dry-heat sterilizer	1 (3.1%)	1 (3.6%)	5 (7.1%)	
Disposal of the bands, brackets, and archwires removed from the patients during or after treatment	Waste basket	9 (28.1%)	11 (39.3%)	33 (47.1%)	0.456
	Sharps bin	19 (59.4%)	15 (53.6%)	32 (45.7%)	
	Metal waste bin	4 (12.5%)	2 (7.1%)	5 (7.1%)	
Use of recycled brackets/orthodontic materials		6 (18.8%)	3 (10.7%)	16 (22.9%)	0.386
Disinfection status of casts or equipment to be delivered to an outer laboratory		16 (50%)	16 (57.1%)	47 (67.1%)	0.234
Written communication line with outer laboratory		25 (78.1%)	21 (75%)	47 (67.1%)	0.470
Knowledge of biofilm development in the dental unit water lines requiring cleaning		22 (68.8%)	20 (71.4%)	55 (78.6%)	0.520
Place of sharps bin	At the clinic	18 (56.3%)	17 (60.7%)	38 (54.3%)	0.845
	At the sterilization room	14 (43.8%)	11 (39.3%)	32 (45.7%)	
Environmental surface cleaning	I disinfect	26 (81.3%)	21 (75%)	53 (75.7%)	0.797
	I cover with dedicated cloths	6 (18.8%)	7 (25%)	17 (24.3%)	
Type of gloves used in instrument and environmental cleaning	Do not wear	1 (3.1%)	1 (3.6%)	4 (5.7%)	0.836
	Kitchen-type gloves	5 (15.6%)	7 (25%)	12 (17.1%)	
	Examination gloves	26 (81.3%)	20 (71.4%)	54 (77.1%)	
Wearing protective mask and goggles during environmental cleaning/manual cleaning of instruments		17 (53.1%)	16 (57.1%)	31 (44.3%)	0.454
Hand washing before wearing gloves		22 (68.8%)	14 (50%)	38 (54.3%)	0.276
Hand washing after removing gloves		32 (100%)	24 (85.7%)	68 (97.1%)	0.018*
Use of a separate protective mask for each patient		6 (18.8%)	9 (32.1%)	26 (37.1%)	0.178
Wearing protective goggles/shields during treatment		14 (43.8%)	15 (53.6%)	34 (48.6%)	0.749
Hepatitis B vaccination status		31 (96.9%)	28 (100%)	65 (92.9%)	0.282
Influenza vaccination status		6 (18.8%)	3 (10.7%)	12 (17.1%)	0.663
Last tetanus vaccination	6-10 years	15 (46.9%)	15 (53.6%)	48 (68.6%)	0.091
	10-20 years	4 (12.3%)	5 (17.9%)	11 (15.7%)	
	>20 years	13 (40.6%)	8 (28.6%)	11 (15.7%)	

Chi-square test was used, *p<0.05, **p<0.01

than autoclave usage in both junior orthodontists (57.1%) and senior orthodontists (56%). However, these differences were not statistically significant (Table 3).

Percentage of orthodontists/residents who responded to questions regarding infection control procedure according to place of work are shown in Table 4. The presence of dental assistant in private clinics (100%) was significantly higher than in university clinics (84.3%). The presence of a separated sterilization room at university clinics (97.1%) was significantly higher than other private centers. The rate of type B autoclave usage in private oral and dental health clinics (61.5%) was significantly higher than in university clinics (33.3%), and non-type B autoclave usage in university clinics (31.7%) was significantly higher than in private oral and dental health clinics (0%). The rate of annual maintenance of sterilization devices in private offices (62.5%) was significantly lower than in private oral and dental health clinics (89.3%) and university clinics (91.4%), and autoclave sterilization control in private offices (40.6%) was significantly lower than in university clinics (68.6%). The rate of supplying biological indicator spore test for controlling of autoclave sterilization in private offices (12.5%) was significantly lower than in private oral and dental health clinics (53.6%) and university clinics (55.7%). The rate of regularly keeping and storing sterilization records (28.1%) in private offices was significantly lower than in university clinics (64.3%). The rate of washing hands after removing gloves was significantly lower in private oral and dental health clinics (85.7%) than in private offices (100%) and university clinics (97.1%) (Table 4).

Percentage of orthodontists/residents who responded to questions regarding infection control procedure according to daily patient capacity are shown in Table 5. The rate of wearing protective mask and goggles during environmental cleaning/manual

Table 5. Percentage of orthodontists/residents who responded to questions regarding infection control procedures according to the daily volume of patient

		Daily patient volume			
		0-10	10-20	>20	
		n (%)	n (%)	n (%)	p
Presence of dental assistant		45 (84.9%)	47 (94%)	26 (96.3%)	0.151
Presence of a written infection control program at the clinic		31 (58.5%)	23 (46%)	11 (40.7%)	0.250
Presence of a separated sterilization room		44 (83%)	44 (88%)	25 (92.6%)	0.466
Cleaning of the instruments to be sterilized	Manually with water	28 (52.8%)	23 (46.0%)	10 (37.0%)	0.299
	Ultrasonic cleaner	15 (28.3%)	11 (22.0%)	5 (18.5%)	
	Washer disinfector	10 (18.9%)	16 (32.0%)	12 (44.5%)	
Presence of a separated instrument washing sink separate from the hand washing sink?		44 (83%)	40 (80%)	23 (85.2%)	0.837
Sterilization devices used	Type B autoclave	18 (39.1%)	20 (44.4%)	14 (56.0%)	0.636
	Non-type B autoclave	12 (26.1%)	7 (15.6%)	4 (16.0%)	
	Cassette autoclave	9 (19.6%)	7 (15.6%)	3 (12.0%)	
	Dry-heat sterilizer	7 (15.2%)	11 (24.4%)	4 (16.0%)	
Annual maintenance of sterilization devices		45 (84.9%)	39 (78%)	25 (92.6%)	0.243
Cleaning of water tank of the autoclave		38 (71.7%)	42 (84%)	22 (81.5%)	0.288
Packing of instruments to be sterilized in the autoclave		45 (84.9%)	43 (86%)	27 (100%)	0.107
Autoclave sterilization control		30 (56.6%)	31 (62%)	16 (59.3%)	0.856
Supply of biological indicator spore test for the control of autoclave sterilization		22 (41.5%)	26 (52%)	10 (37%)	0.379
Regularly keeping and storing of sterilization records		25 (47.2%)	27 (54%)	15 (55.6)	0.704
Methods used for the sterilization of dental handpieces	Wiping the outer surface with disinfectant solution	33 (62.3%)	26 (52.0%)	15 (55.6)	0.166
	In the autoclave	13 (24.5%)	19 (38.0%)	5 (18.5%)	
	Dedicated device (handpiece autoclave)	7 (13.2%)	5 (10%)	7 (25.9%)	
Methods used for the sterilization of hand instruments/ orthodontic pliers	Wiping with a disinfectant solution	13 (14.5%)	16 (32.0%)	3 (11.1%)	0.556
	Autoclave	29 (54.7%)	26 (52.0%)	19 (70.4%)	
	Cassette autoclave	7 (13.2%)	6 (12.0%)	3 (11.1%)	
	Dry-heat sterilizer	4 (7.5%)	2 (4.0%)	2 (7.4%)	
Sterilization of molar bands after purchase		10 (18.9%)	18 (36%)	8 (29.6%)	0.147
Sterilization of molar bands after trial in the patient	Sitting in disinfectant solution	21 (39.6%)	18 (36.0%)	6 (22.2%)	0.540
	Autoclave	26 (49.1%)	25 (50%)	18 (66.7%)	
	Cassette autoclave	2 (3.8%)	5 (10%)	2 (7.4%)	
	Dry-heat sterilizer	4 (7.5%)	2 (4.0%)	1 (3.7%)	
Disposal of the bands, brackets, and archwires removed from the patients during or after treatment	Waste basket	22 (41.5%)	22 (44.0%)	9 (33.3%)	0.782
	Sharps bin	28 (52.8%)	23 (46.0%)	15 (55.6)	
	Metal waste bin	3 (5.7%)	5 (10%)	3 (11.1%)	
Use of recycled brackets/orthodontic materials		11 (20.8%)	11 (22%)	3 (11.1%)	0.479
Disinfection status of impressions or appliances to be delivered to an outer laboratory		28 (52.8%)	32 (64%)	19 (70.4%)	0.264
Written communication line with outer laboratory		39 (73.6%)	35 (70%)	19 (70.4%)	0.912
Knowledge of biofilm development in the dental unit water lines requiring cleaning		38 (71.7%)	37 (74%)	22 (81.5%)	0.631
Place of sharps bin	At the clinic	32 (60.4%)	25 (50%)	16 (59.3%)	0.533
	At the sterilization room	21 (39.6%)	25 (50%)	11 (40.7%)	

Table 5. Percentage of orthodontists/residents who responded to questions regarding infection control procedures according to the daily volume of patien (Continued)

Environmental surface cleaning	I disinfect	43 (81.1%)	36 (72%)	21 (77.8%)	0.543
	I cover with dedicated cloths	10 (18.9%)	14 (28%)	6 (22.2%)	
Type of gloves used in instrument and environmental cleaning	Do not wear	2 (3.8%)	4 (8.0%)	0 (0%)	0.411
	Kitchen-type gloves	10 (18.9%)	7 (14%)	7 (25.9%)	
	Examination gloves	41 (77.4%)	39 (78%)	20 (74.1%)	
Wearing protective mask and goggles during environmental cleaning/manual cleaning of instruments		18 (34%)	28 (56%)	18 (66.7%)	0.011*
Hand washing before wearing gloves		29 (54.7%)	27 (54%)	18 (66.7%)	0.516
Hand washing after removing gloves		51 (96.2%)	49 (98%)	24 (88.9%)	0.178
Use of a separate protective mask for each patient		16 (30.2%)	18 (36%)	7 (25.9%)	0.638
Wearing protective goggles/shields during treatment		18 (34%)	26 (52%)	19 (70.4%)	0.007**
Hepatitis B vaccination status		50 (94.3%)	48 (96%)	26 (96.3%)	0.893
Influenza vaccination status		4 (7.5%)	9 (18%)	8 (29.6%)	0.036*
Last tetanus vaccination	6-10 years	30 (56.6%)	31 (62.0%)	17 (63.0%)	0.607
	10-20 years	11 (20.8%)	7 (14.0%)	2 (7.4%)	
	>20 years	12 (22.6%)	12 (24.0%)	8 (29.6%)	

Chi-square test was used, *p<0.05, **p<0.01

cleaning of instruments in facilities with a daily patient volume of 0-10 patients (34%) was significantly lower than in facilities with a daily patient volume of 10-20 patients (56%) and 20 patients and above (66.7%). The rate of wearing protective goggles/shields during treatment in facilities with a daily patient volume of 0-10 patients (34%) was significantly lower than in facilities with a daily patient volume of 20 patients and above (70.4%). The rate of influenza vaccination in facilities with a daily patient volume of 0-10 patients (7.5%) was significantly lower than in facilities with a daily patient volume of 20 patients and above (29.6%) (Table 5).

DISCUSSION

In the literature, many studies outside of Turkey relevant to the infection control procedures in dental practice were found. There are survey studies reported from Canada and the US that evaluated the compliance of orthodontists to the infection control procedures (22, 23, 30). There are, however, a few studies evaluating the compliance of orthodontists to the infection control procedures in Turkey. Various articles have been published regarding sterilization and disinfection practices in orthodontics, such as the study published in the special edition of TDB in 2000 and the reports published by Akçam and Özdiler (21) in 1999, Ozer et al. (1) in 2005, and Aksoy et al. (31) in 2011 (11). The only study that evaluated the attitudes of orthodontists towards infection control and the procedures practiced by these orthodontists was performed by Saraç and Yalçın (32) in 1995.

The results of the present study were evaluated taking into account the experience, place of work, and daily patient capacity of the orthodontists/residents. The rate of dental assistant was higher in private offices (100%) and private oral and dental health clinics (96.4%), whereas this rate was lower in university clinics (84.3%), and the difference between these facilities that was caused by understaffing in university clinics was found to be statistically significant (Table 4). When the rate of dental assistant was evaluated according to the patient volume, the rate of dental assistant was 84.9% in facilities with a daily patient volume of 0-10, 94% in facilities with a daily patient volume of 10-20, and 96.3% in facilities with a daily patient volume more than 20 (Table 5). Although the difference was not statistically significant, work load increases with daily patient volume, and accordingly, number of dental assistant increases. In the practice of experienced orthodontists, number of dental assistant was found to be higher with increasing daily patient volume.

In a study published by Topcuoglu and Kulekci (33) in 2009, progress of the dental practitioners on infection control practices within a 2-year period was evaluated in Turkey. The autoclave usage rate increased from 39% to 62%, and dry-heat sterilizer usage rate decreased from 71% to 55% in a 2-year period. In the present study, some type of autoclave usage rate between 2014 and 2015 was 72.3%, and the dry-heat sterilizer usage rate was 16.9% (Table 2). There seems to be an improvement in autoclave usage over the years among dental practitioners and orthodontists. However, autoclave usage rate could not be compared between the two groups of orthodontists as there were no studies conducted in the same period on dental practitioners and orthodontists.

In a survey study on 110 orthodontists published by Saraç and Yalçın (32) in 1995, 32.3% of orthodontists were immunized against hepatitis B, autoclave usage rate was 9%, and dry-heat sterilizer usage rate was 14.5%. In the present study, 95.4% of orthodontists were immunized against hepatitis B, type B autoclave usage rate was 40%, non-type B autoclave usage rate was 17.7%, cassette autoclave usage rate was 14.6%, and dry-heat sterilizer usage rate was 16.9% (Table 2). In recent years, type B autoclave has been established as the most appropriate device

in dental practice as it possesses the highest vacuum system that is able to sterilize all types of loads; the instruments used in dental practice are mostly in type B hollow load class (30, 33, 34). In the present study, the rate of type B autoclave usage was 53.3% in private offices, 61.5% in private oral and dental health clinics, and 33.3% in university clinics. The usage rates for autoclaves other than type B and cassette autoclave were found to be lower (Table 4). The usage rate for type B autoclave was higher in private offices and private oral and dental health clinics, whereas previously purchased autoclaves other than type B were found to be used in university clinics. The usage rate for cassette autoclaves was lower than type B and non-type B autoclaves. The manufacturers recommend cassette autoclaves owing to rapid sterilization feature; however, cassette autoclaves are not suitable for orthodontic purposes (9, 34, 35). Dry-heat sterilizer performs sterilization at high temperature in prolonged duration. In addition, instruments removed from dry-heat sterilizer must be stored in ultraviolet cabinets. Otherwise, the instruments become contaminated (35). The usage rate for dry-heat sterilizer was found to be low (16.9%) in the present study (Table 2). Compared with the results of Saraç and Yalçın (32), positive but insufficient progress in the compliance to the infection control procedures observed in recent years can be attributed to the courses and training programs on the infection control. Training on infection control procedures in dental practice must be included in education program to be conducted on a regular basis, and these programs must be audited.

According to the study by McCarthy et al. (22) that evaluated 265 orthodontists and 5176 dental practitioners in 1997, 94% of the orthodontists and 92.3% of the dental practitioners were immunized against hepatitis B virus. In their study, 62.4% of the orthodontists and 81.5% of the dental practitioners reported that they changed their protective mask for each patient; the rate of using protective goggles was 88.7% in orthodontists and 96.4% in dental practitioners. The rate of hepatitis B vaccination was 95.4% among orthodontists/residents (Table 2), and this rate was consistent with the rates reported in the study by McCarthy et al. (22). In the present study, the rate of changing protective mask in each patient was 31.5%, and the rate of using protective goggles was 48.5% among orthodontists/residents (Table 2). These figures are considerably lower than those reported by McCarthy et al. (22).

According to the study by Davis et al. (23) that evaluated 140 orthodontists in 1998, the rate of using protective goggles was 95%, and the rate of washing hands after removing gloves was 99.2%. The rate of subjects washing hands after removing gloves was 95.4% (Table 2), and this rate was comparable with that reported in the study by Davis et al. (23). However, in our study, the rate of using protective goggles was considerably lower (48.5%) (Table 2).

The rates of subjects disinfecting pliers and hand instruments were 12%, 50%, and 21% in the studies by Davis et al. (23), Cash (36), and Woo et al. (37), respectively. In the studies by Davis et al. (23) and Cash (36), the rates of using autoclave for the sterilization of hand instruments were 26% and 18%, respectively; the rates of using dry-heat sterilizer were 72% and 24%, whereas the rates of using autoclave for the sterilization of pliers were 14% and 11%, and the rates of using dry-heat sterilizer were 80% and 20%, respectively. In the present study, the rate of using disinfection for the sterilization of orthodontic pliers and hand instruments was 24.6%, the rate of using autoclave was 56.9%, and the rate of using dry-heat sterilizer was 6.2% (Table 2). According to the findings of the present study, autoclave was the most commonly preferred method, and dry-heat sterilizer was the least commonly preferred method for the sterilization of pliers and hand instruments. Lower autoclave usage rates in the studies by Davis et al. (23) and Cash (36) are caused by temporal differences between the studies. In the US and other countries, infection control procedures in dental practice were established by the guidelines of the CDC published in 1993, which declared universal precautions against bloodborne pathogenic agents. This subject has attracted attention in Turkey for the first time in 2000s.

The rate of washing hands before wearing gloves was 56.9%, and the rate of washing hands after removing gloves was 95.4% in the present study (Table 2). The rate of washing hands before wearing gloves was significantly higher in senior orthodontists who had an experience of more than 20 years than in junior orthodontists who had an experience of lower than 20 years (Table 3). This difference highlights that the importance of hand washing practice in infection control was not sufficiently understood, and particularly, junior orthodontists do not pay strict attention to hand washing practice before wearing gloves.

When comparing protective goggles/shield usage rates, it was significantly lower in facilities with a daily patient volume of 0-10 patient than in facilities with a daily patient volume of more than 20 patients. Similarly, the rate of influenza vaccination was also significantly lower in facilities with a daily patient volume of 0-10 patients than in facilities with a daily patient volume of more than 20 patients. The rate of using protective mask and goggles during environmental cleaning was significantly lower in facilities with a daily patient volume of 0-10 patients than in facilities with a daily patient volume of 10-20 patients and 20 patients and above (Table 5). These findings suggest that the orthodontists attach more importance to infection control procedures with increasing daily patient volume, and in connection with this, they enhance protective measures.

In university clinics, while the rate of wiping hand instruments and orthodontic pliers with disinfectant solutions was lower, the rate of using autoclave sterilization was relatively higher than in private offices and private oral and dental health clinics. The rate of using dry-heat sterilizer was quite lower in private offices and university clinics (Table 4). Although wiping off orthodontic pliers and hand instruments without performing sterilization is not an appropriate method, this is used in all centers with lower rates observed in university clinics. As an ideal sterilization method, the rate of using autoclave does not exceed 64%. This finding suggests an inadequacy in sterilization of orthodontic pliers and hand instruments in Turkey.

The rate of wiping off the outer surface of dental handpieces was 56.9%, and the rate of using autoclave sterilization was 28.5%, whereas the rate of using dental handpiece autoclave was 14.6% (Table 2). Although wiping dental handpieces with disinfectant solutions without performing sterilization is an inappropriate and an inefficient means of sterilization, the rate of this method was considerably high. According to the study by Vendrell et al. (38) published in 2002, disinfection with ethanol, propanol (Incidur®) spray, and isopropanol (Iso-Septol) spray was not satisfactory in reducing the number of microorganisms. Dental handpieces must be therefore sterilized using the autoclave, and wiping the outer surface with a disinfectant solution must be abandoned (38).

According to the guidelines of the CDC published in 2003, dental handpieces with confirmed sterilization must be used in each patient (8). This requires keeping available dental handpieces in the number equals to the number of patients to be examined in that particular day or using rapid sequence sterilization methods.

The rate of sterilization for the purchased molar bands before trial in the patient was 27.7%, the rate of sitting in a disinfectant solution after trial was 34.6%, and the rate of autoclave sterilization was 53.1% (Table 2). Although the rate of sterilization for the purchased molar bands was low, the rate of sterilization after trial in the patient was found to be higher.

The study, published by Wichelhaus et al. (39) in 2006, reported that instruments that come into contact with blood in the mouth should be sterilized, and disinfection of instruments used outside of the mouth would be sufficient. Thermal disinfection and 5% Sekusept® Plus combined with ultrasonic bath were suggested for use in disinfection of heat-sensitive mouth retractor, photo mirror, and elastic chains (39). The rate of manual washing of hand instruments with water in the present study was 46.9%, whereas the rates of using ultrasonic cleaner and washer disinfector were 23.8% and 29.2%, respectively (Table 2).

The rate of using recycled brackets/orthodontic materials was found to be 19.2% (Table 2). In a study published by Oshagh et al. (40) in 2012, softening of archwires was reported after sterilization in the autoclave; however, this change was reported to be at low levels and does not pose a problem in clinical practice (40).

The rate for the presence of a separated sterilization room was 65.6% in private offices, 85.7% in private oral and dental health clinics, and 97.1% in university clinics (Table 4). The presence of a separated sterilization room is particularly important for the applicability of infection control procedures. The presence of a separated sterilization room carries a particular importance owing to risk of dispersion of infected particles while washing the instruments, evacuation of the vapor during autoclave cycle, inhalation of disinfectant agents, and protecting the sterility of the sterilized instruments. However, the rate of a separated sterilization room was particularly lower in private offices owing to inadequate physical conditions.

The rate of biological indicator spore test supply for controlling autoclave sterilization was significantly higher among junior orthodontists with an experience of less than 20 years than among senior orthodontists with an experience of more than 20 years. Whereas the rate of using waste basket for the disposal of bands, brackets, and archwires removed from the patients during or at the end of the treatment was higher in junior orthodontists, the rate of using sharps bin and metal waste bin was higher in senior orthodontists (Table 3). These results indicate an improvement in student education and increasing consciousness regarding infection control and sterilization in educational curriculums. However, the present study found that junior orthodontists do not show particular attention to the disposal of bands, brackets, and archwires removed from the patients into the infected waste bin.

The rate of annual maintenance for sterilization devices and using biological indicator spore test in autoclave sterilization control were significantly lower in private offices than in private oral and dental health clinics and university clinics. The rate of using autoclave sterilization control and regularly keeping and storing of sterilization records were significantly lower in private offices than in university clinics (Table 4). These results clearly indicate that maintenance and control procedures are more meticulously performed with institutionalization and increasing audit rates.

The most appropriate method for evaluating the compliance of orthodontists to infection control procedures is a survey study. However, in the present study, adequate feedback from orthodontists has not been achieved despite all our efforts. It would be better if the percentage of participation was higher so that the results could be more satisfying.

CONCLUSION

1. Although hepatitis B immunization rate was high among orthodontists/residents (95.4%), the rate of using protective goggles during treatment (48.5%) and the rate of using a separate protective mask for each patient (31.5%) were low.
2. During sterilization procedure, the usage rate for type B autoclave was higher than other devices. The usage rates for type B autoclave, non-type B autoclave, cassette autoclave, and dry-heat sterilizer were 40%, 17.7%, 14.6%, and 16.9%, respectively, and not at sufficient levels.
3. Although the usage rate for autoclave in sterilization of hand instruments and orthodontic pliers was higher in university clinics (64.3%) than in private offices (53.1%) and private oral and dental health clinics (42.9%), 24.6% of orthodontists used disinfectants in this procedure.
4. The rate of cleaning dental handpieces with wipes without performing sterilization was considerably high (56.9%).
5. In university clinics, the rate of using a specially produced device (handpiece autoclave) in sterilization of dental handpieces was considerably low (18.6%).
6. The rate of using biological indicator in autoclave sterilization control was lower in senior orthodontists (20%) who had an experience of more than 20 years than in junior orthodontists (50.5%).
7. The rate of using protective goggles during treatment was higher in facilities that had a higher daily volume of patient (70.4%); however, the rate of using a separate protective mask in each patient was lower (25.9%).

8. The rate of using examination gloves instead of thick kitchen-type gloves during cleaning of instruments and environmental cleaning was 76.9%.
9. The rate of disposing bands, brackets, and archwires into the waste basket instead of sharps bin was 40.8%.
10. Although the rate of sterilization of molar bands after purchase was low (27.7%), the rate of sitting molar bands in disinfection solution after trial was 34.6%, and the rate of sterilization of molar bands after trial was found to be 65.4%.
11. Orthodontists attach more importance to infection control procedures with increasing daily patient volume, and in connection with this, they enhance protective measures.

In conclusion, based on these study findings, it is obvious that there is a need for improving the compliance to the infection control procedures in the practice of orthodontics in Turkey. We, therefore, consider that training on the compliance to the infection control procedures must be taken into the scope of doctoral and residency training, knowledge of previous graduates must be updated, the training programs should be repeated on a regular basis through endeavors of dental association, and the practice of professionals should be audited.

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Appendix 1. Survey Form
Infection Control in Orthodontics

1. How long have you been working as a dental practitioner/ orthodontist?
a) 0-5 years
b) 6-10 years
c) 11-15 years
d) 16-20 years
e) more than 20 years

2. Place of work?
a) Private office
b) Private oral and dental health clinic
c) Public oral and dental health clinic/state hospital
d) University clinics

3. Daily patient volume?
a) 0-5
b) 6-10
c) 11-15
d) 16-20
e) >20

4. Number of dental assistant?
a) 0
b) 1
c) 2
d) 3
e) 4
f) 5
g) >5

5. Is there a written infection control program at your clinic?
a) Yes
b) No

6. Is there a separated sterilization room?
a) Yes
b) No

7. How do you perform sterilization of the instruments?
a) Manually with water
b) Ultrasonic cleaner
c) Washer disinfector

8. Is there a separated instrument washing sink separate from the hand washing sink?
a) Yes
b) No

9. Sterilization devices used?
a) N type autoclave
b) B type autoclave
c) S type autoclave
d) Cassette autoclave
e) Dry-heat sterilizer

10. Is annual maintenance performed for sterilization devices?
a) Yes
b) No

11. Do you perform cleaning of water tank of the autoclave?
a) Yes
b) No

12. Packing of instruments to be sterilized in the autoclave?
a) Metal tray
b) Special tray
c) Autoclave bag
d) Wrap
e) I do not pack

13. Which methods do you use in the control of autoclave sterilization?
a) Chemical
b) Biological
c) Chemical+Biological
d) Bowie - Dick test
e) I do not use

14. How do you supply biological indicator spore test in the control of autoclave sterilization?
a) Spore test by mail
b) Branded tests
c) I do not perform biological control

15. Do you regularly keep and store sterilization records?
a) Yes
b) No

16. How do you sterilize dental handpieces?
a) In the autoclave
b) In a dedicated device (dental handpiece autoclave)
c) Wiping the outer surface with disinfectant solution

17. How do you sterilize hand instruments/orthodontic pliers?
a) Dry-heat sterilizer
b) Autoclave
c) Cassette autoclave
d) Wiping with a disinfectant solution

18. Do you sterilize molar bands after purchase?
a) Yes
b) No

19. How do you sterilize molar bands after trial in the patient?
a) Dry-heat sterilizer
b) Autoclave
c) Cassette autoclave
d) Sitting in disinfectant solution

20. Where do you dispose the bands, brackets, and archwires you remove from the patients during or after treatment?
a) Waste basket
b) Sharps bin
c) Metal waste bin
d) Infected waste bin

21. Do you use recycled brackets/orthodontic materials?
a) Yes
b) No

22. Do you disinfect impressions or appliances to be delivered to an outer laboratory?
a) Yes
b) No

23. Do you have a written communication line with the outer laboratory?
a) Yes
b) No

24. Do you know that biofilms develop in the dental unit water lines requiring cleaning?
a) Yes
b) No

25. Where do you place sharps bin?
a) At the clinic
b) In the sterilization room

26. How do you perform environmental surface cleaning?
a) I cover with dedicated cloths.
b) I disinfect.

27. Which type of gloves do you use during cleaning of instruments and environmental cleaning?
a) Examination gloves
b) Kitchen-type gloves
c) I do not wear

28. Do you wear protective mask and goggles during environmental cleaning/manual cleaning of instruments?
a) Yes
b) No

29. Do you wash your hands before wearing gloves?
a) Yes
b) No

30. Do you wash your hands after removing gloves?
a) Yes
b) No

31. Do you use a separate protective mask for each patient?
a) Yes
b) No

32. Do you wear protective goggles/shields during treatment?
a) Yes
b) No

33. Have you had hepatitis B vaccine?
a) Yes
b) No

34. Have you had influenza vaccine?
a) Yes
b) No

35. When did you have your last tetanus vaccine?
a) 0–5 years
b) 6–10 year
c) 11–15 years
d) 16–20 years
e) >20 years

36. What are your comments regarding infection control in dental practice/orthodontics?

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ORIGINAL ARTICLE

Evaluation of Internet Information about Lingual Orthodontics Using DISCERN and JAMA Tools

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ABSTRACT

Objective: To investigate the quality and reliability of websites providing information about lingual orthodontics in Turkish.

Methods: An internet search was conducted on March 6th, 2017, using popular search engines in Turkey: Google™, bing™, YAHOO!®, and Yandex® for the keywords "lingual ortodonti, görünmeyen braketler, and görünmeyen teller". The top 10 websites for each keyword and search engine were examined, and duplicates, irrelevant websites, websites showing scientific articles, and orthodontic supplies market sites were excluded. The remaining 58 sites were assessed using the DISCERN instrument and JAMA benchmarks

Results: The authors of the remaining sites were orthodontists (48%) and dentists (5%), while 46% of the websites did not state author names. Ninety-one percent lacked references, and 87% lacked a date. Only 30% were balanced and unbiased. The mean overall DISCERN score was very poor (43%) or poor (40%). Of the 58 websites, 48% (28 sites) met authorship, 7% (4 sites) attribution, 71% (41 sites) disclosed website ownership, and 3% (2) currency benchmarks of JAMA.

Conclusion: Information on the internet related to lingual orthodontics is poor. Clinicians should warn patients that information on the internet about lingual orthodontics might be inadequate, and they should direct patients to higher-quality websites.

Keywords: Access to information, orthodontics, health care quality, access, evaluation

INTRODUCTION

The internet is a source of information that is increasingly used by both health professionals and patients (1). According to statistics released by the Turkish Statistical Institute, in 2016, 54.9% of individuals in the 16-74 age group have been using computers, and 61.2% the internet. In the first 3 months of 2016, internet users used it predominantly (82.4%) for creating profiles on social media, sending messages, and sharing photos. These tasks were closely followed by watching videos (74.5%); reading online news, newspapers, or magazines (69.5%); searching for health-related information (65.9%); searching for information about goods and services (65.5%); and listening to music (63.7%). The percentage of internet users surfing almost every day or at least once a week was 94.9% (2). The search for health-related information was reported to be 94.9% among regular users by Demirel et al. (3). According to the results of their research, the internet is preferred because it is an easy, cheap, and fast way of accessing information; 30.4% of internet users make their health-related decisions based on the internet; and they also use this information to communicate with their physicians.

Traditionally, a person in need of orthodontic treatment is informed directly about his or her own malocclusion following the examination by the orthodontist. However, today, most of the patients inform themselves through the internet, even before going to the doctor. For these reasons, the quality, reliability, and accuracy of information on the web is critical. To help both clinicians and patients to choose quality websites on health-re-

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lated information, validation tools were developed that can assess various properties of internet sites (4-6). Quality Criteria for Consumer Health Information (DISCERN), Journal of American Medical Association (JAMA) benchmarks, LIDA (Minervalidation Inc.), Health on the Net Code of Conduct (HONCode) are some of those. Up to now, the number of studies on internet-based information on orthodontics has been limited (7-11). Measurement tools, search engines, and keywords used in these studies vary.

The increase in the number of adults opting for orthodontic treatment can be traced back to various factors, such as the increase in aesthetic awareness, improved appearance of fixed orthodontic devices, and increased social acceptance of fixed orthodontic devices (12, 13). Lingual orthodontic treatment usually is preferred by adult patients with high aesthetic expectations. As treatment mechanics continue to develop, the interest in this field continues to increase, although only slowly, due to its technical difficulties and high cost (14, 15). Because of patients increasing demand of lingual orthodontics, and because, to our knowledge, there are no studies about internet information on lingual orthodontics, the purpose of this study is to evaluate the quality of information on lingual orthodontics on the internet using DISCERN and JAMA scales.

METHODS

An internet search was conducted on March 6th, 2017, using popular search engines in Turkey: Google™ (www.google.com), bing™ (www.bing.com), YAHOO!® (www.yahoo.com), and Yandex® (www.yandex.com) (16). The terms *"lingual ortodonti"* (lingual orthodontics), *"görünmeyen braketler"* (invisible braces), and *"görünmeyen teller"* (invisible wires) were used as keywords, because these were phrases most often used by patients in our experience. The top 10 websites for each keyword and search engine were evaluated. Scientific articles and orthodontic product websites were not included. After excluding duplicates and irrelevant websites (Figure 1), the remaining 58 websites were scored by a single examiner (HKO-orthodontist). The websites included in the study were evaluated using the DISCERN tool and JAMA benchmarks. The website type, presentation type, the profession of the author, and target group were also recorded.

DISCERN Tool

The DISCERN tool was developed by Charnock et al. (17) for the health field in 1998 and has been translated into Turkish by Gökdoğan et al. (18). DISCERN consists of 16 questions (graded 1-5) and three parts: reliability (Questions 1-8), quality information on treatment choices (Questions 9-15), and overall score (Question 16).

The DISCERN manual contains detailed information for each question, as well as instructions and examples to make the evaluation easy. According to this tool, considering the total average scores, websites were divided into 5 groups as follows: score between 16 and 26 is very poor, score between 27 and 38 is poor, score between 39 and 50 is fair, score between 51 and 62 is good, and score higher than 63 is excellent.

JAMA Benchmarks

The JAMA benchmarks were published as a suggestion for basic quality standards for internet information on health care by Silberg et al. (19) in 1997. It evaluates four key features that must be clearly visible on a website:

Authorship (Author): Writers and contributors should be informed about their linkages and subject qualifications.

Attribution: References and references for all content should be clearly listed, and copyright information should be included.

Disclosure: The potential conflict of interest arising out of the website's ownership, sponsorship, advertising, insurance liability, commercial financing, or support must be clearly and fully disclosed.

Currency: The dates on which the content was uploaded and updated should be specified.

Care should be taken to ensure that each criterion is clearly stated when the assessment is made.

Statistical Analysis

Statistical data processing was performed using Microsoft Excel Version 2016 (MS Excel 2016). Descriptive analysis such as mean and frequency was calculated.

RESULTS

From the 120 websites found, 62 were excluded (41 duplicated, 21 irrelevant) (Figure 1). The authors of the remaining 58 sites were orthodontists (48%), dentists (5%), and non-disclosed authors (47%). The total DISCERN score of the 58 websites was poor (average score 28.9). No website has reached excellent, or good score. More than half of the websites were scored as poor, or very poor (64%) (Table 1).

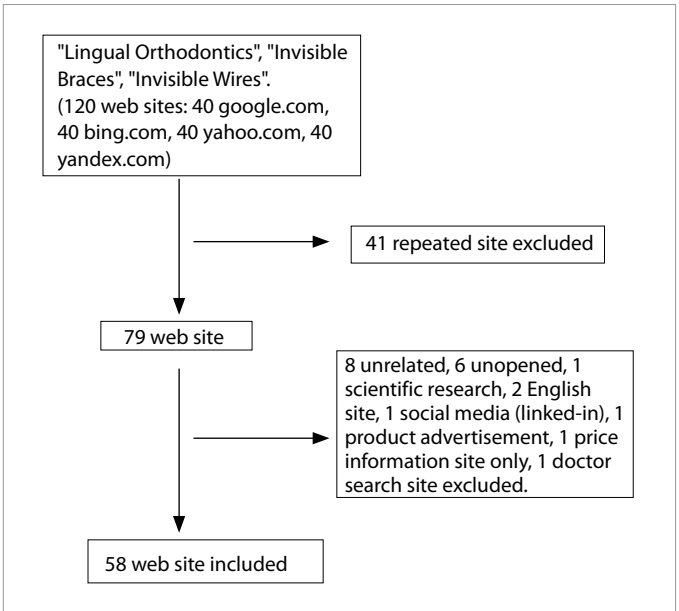

Figure 1. Flow diagram of the selection process

Table 1. DISCERN and JAMA scores according to profession of the authors

	Total (n=58)	Orthodontist (n=28)	Dentist (n=3)	No Author Disclosed (n=27)
Total DISCERN score (16-80)				
16-26 (very poor)	26	11	1	14
27-38 (poor)	23	10	2	11
39-50 (fair)	9	7	0	2
51-62 (good)	0	0	0	0
63-80 (excellent)	0	0	0	0
Average DISCERN score	28.9	30.5	30	27.1
Average number of JAMA benchmarks satisfied (0-4)	1.36	1.8	2.3	0.8

Table 2. DISCERN and JAMA scores according to information type and website type

	Presentation Type		Website Type	
	Video (n=5)	Text (n=53)	Information (n=15)	Advertisement (n=43)
Total DISCERN score (16–80)				
16-26 (very poor)	4	22	8	18
27-38 (poor)	0	23	5	18
39-50 (fair)	1	8	2	7
51-62 (good)	0	0	0	0
63-80 (excellent)	0	0	0	0
Average score	24.8	29.3	28.5	29.0
Average number of JAMA benchmarks satisfied (0-4)	1.2	1.36	1	1.49

According to presentation type, 91% of the websites were in text form, and 9% of the websites were in video form. According to website type, 74% of the websites were in the form of advertisement, and 26% of the websites were prepared for information purposes only (Table 2).

When using the keyword "görünmeyen teller" (invisible wires), two websites were explaining only aligner treatment, four websites were explaining lingual orthodontics, but the photos were about aligner treatment, and one website was explaining lingual orthodontics, but the video in the website was about buccal braces. When using "görünmeyen braketler" (invisible braces), one video-type website was about ceramic braces, and one website was explaining lingual orthodontics, but the photos were about aligner treatment.

Table 3 shows how the websites performed for each question; it shows the average scores out of five. The question about "achieving the aims" (Question 2) scored highest; followed by the question about "clarity regarding the aims" (Question 1). The lowest scoring questions were "if no treatment was used" (Question 12) and "clarity regarding the sources of information used to compile the publication" (Question 4).

Assessment according to JAMA benchmarks revealed no website that met all JAMA benchmarks. The principle of disclosure was adhered to most frequently, while the principle of attribution was the most poorly adhered (Table 4).

Table 3. Average score per DISCERN question amongst all websites assessed

	DISCERN Questions	Mean Score (1-5)
1	Are the aims clear?	2.5
2	Does it achieve its aims?	2.93
3	Is it relevant?	2.25
4	Is it clear what sources of information were used to compile the publication (other than the author or producer)?	1.12
5	Is it clear when the information used or reported in the publication was produced?	1.36
6	Is it balanced and unbiased?	1.81
7	Does it provide details of additional sources of support and information?	1.45
8	Does it refer to areas of uncertainty?	1.78
9	Does it describe how each treatment works?	2.09
10	Does it describe the benefits of each treatment?	2.36
11	Does it describe the risks of each treatment?	1.97
12	Does it describe what would happen if no treatment is used?	1
13	Does it describe how the treatment choices affect overall quality of life?	2
14	Is it clear that there may be more than one possible treatment choice?	1.78
15	Does it provide support for shared decision making?	1.21
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.	1.95

Table 4. JAMA benchmarks and percentages

JAMA Benchmarks	n	Percentage of Websites Adhering to Principle
Authorship	28	48%
Attribution	4	6.8%
Disclosure	43	74%
Currency	4	6.8%

DISCUSSION

This is the first study to evaluate the quality of information related to lingual orthodontics in Turkish on the internet. This study

has been designed in view of the fact that information about lingual orthodontics on the internet is likely to be inadequate or incorrect.

The top 10 websites were evaluated, considering that the keywords entered in each search engine came from a large number of internet sites, but the patients often look the first page (20). The scope of the internet is very broad, and a search yields millions of results, but naturally, the user only displays some of them.

One-third of the websites were duplicated websites showing that different search engines and the three different keywords do not produce vastly different results. The keywords were chosen presuming what lay people might employ when searching the internet for lingual orthodontics. But results showed also other treatment options under the name of lingual orthodontics. This confusion might be because these keywords could also be preferred for ceramic braces or aligner treatment. Using the Google Trends application to determine keywords might help to get popular keywords used for search in Turkey and in the world. It might be argued that different keywords might have produced different results for the first 10 websites. The fact that one-sixth of the initial websites were irrelevant shows either that the keywords chosen did not pinpoint lingual orthodontic treatment alone, or that website providers did not bother with quality of the content.

Internet studies on orthodontics have reported that the quality of internet information is variable. Patel and Cobourne (7) used LIDA and FRES tools with the keyword "orthodontic extraction", and Google™ and YAHOO!® search engines, and found that their reliability of the websites was inadequate. Parekh and Gill (8) used LIDA tool and GDC criteria for the keyword "orthodontic practice" and three different search engines (UK-based sites), and reported that websites generally do not comply with ethical rules and are not sufficiently reliable.

Verhoef et al. (9) used LIDA and FRES tools with the keywords "cleaning braces, brushing braces, oral hygiene and braces" and Google™, YAHOO!®, and bing™ search engines, and found that the quality was low. Patel and Cobourne (10) used DISCERN, LIDA, and GDC criteria with the keyword "orthodontic braces" using the Google™ search engine and stated that many websites do not comply with ethical rules, and the quality of information varies. McMorrow and Millett (11) used DISCERN, JAMA, FRES, LIDA, and HONCODE tools with the keyword "adult orthodontics" using Google™, YAHOO!®, and bing™ search engines, and reported that informative websites were limited and of fair quality. Our study showed that the information on the internet related to lingual orthodontics is poor, parallel to the above-mentioned studies.

In lingual orthodontics, customized lingual braces and wire systems like Incognito™ and Harmony®, as well as fabricated lingual braces and wires, are used. Websites do not adequately describe and compare these treatment options.

When websites are being prepared, reference sources should be specified (attribution), and the date on which the information is uploaded and updated (currency) should be explicitly included on the website. According to JAMA benchmarks, the biggest shortcoming among websites were these two criteria. Only four of the websites met the criteria of reference, and two of them met the criteria of currency.

Sometimes different instruments can evaluate the same features. For example, DISCERN tool's 4th and 7th questions are parallel to the 2nd JAMA benchmark, and the 5th question is parallel to the 4th benchmark. However, JAMA is mainly evaluating the reliability of websites, whereas the DISCERN instrument is evaluating the quality of information, meaning reliability, and accuracy of content. Even in websites that met three benchmarks of JAMA in this research, DISCERN tool average score was low. For this reason, using more than one tool was considered to be useful for the objective evaluation of websites.

There are geographical and timewise limitations of research about the internet. Because the search was performed in the Turkish language, the research had validity only in this geography. Because the search was done in March 2017, new websites may have appeared, some may have been updated, or have been out of view. Another limitation is that only the top 10 websites for each keyword and search engine were evaluated, presuming this is the predominant behavior of the common internet user.

For this reason, it would be advisable to have conduct such research regularly by the relevant associations or organizations (e.g., Turkish Orthodontic Society [TOD]) and publish the results. Since TOD's page is not among the top 10 sites in the internet, it might be beneficial in TOD's and public interest to have prepared a web page with detailed and objective information on lingual orthodontics.

In order to provide quality health care services in the future, the knowledge of orthodontics needs to be improved continuously. Orthodontists should help patients get accurate and reliable information by directing them to evidence-based educational materials on the internet.

CONCLUSION

The quality of information on the internet related to lingual orthodontic treatment is poor. In the light of these results, patients should be cautious about trusting information on the internet on lingual orthodontics. Orthodontists should use these or similar tools as a guide, when creating an informative website.

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REVIEW

Cone Beam Computed Tomography in Orthodontics

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ABSTRACT

Orthodontists treat malocclusions by applying three-dimensional forces. For years, the diagnosis of this three-dimensional condition and the related treatment plan has been based on two-dimensional imaging. Lateral and anteroposterior cephalometric, panoramic, and periapical radiographs are some of the two-dimensional radiographs routinely used in orthodontics. Despite being highly beneficial in evaluating skeletal and dental relations, these radiographs fail to provide sufficient two-dimensional information in certain cases. The purpose of this compilation is to review the use of cone-beam computed tomography in orthodontics.

Keywords: Cone-beam computed tomography, lateral cephalometry, anteroposterior cephalometry

CONVENTIONAL COMPUTED TOMOGRAPHY

Computed tomography (CT) was developed by Sir Godfrey Hounsfield in 1967. Six generations of these systems have been developed since 1967. The system classification is based on the pieces of the devices and the physical movements of the X-ray. There was a single radiation source and a detector in the first-generation tomographies. An image was taken in sections. In the second-generation tomographies, there were a number of detectors. However, these detectors were unable to display the entire object. In the third generation, on the other hand, great improvements were provided in the detectors and data gathering technology. The large detectors reduced the requirement of a radiation source to move around the object and were called "fan beam CT." However, ring shaped artefacts and distortions usually occur on the generated images. Fourth-generation tomographies were developed to address this issue. A moving radiation source and a fixed detector were created. This indicated considering modifications in the angle of the radiation source; hence, there was a more reflected radiation. Finally, fifth and sixth generation tomographies were developed to diminish the movement and reflection artefacts. In both the generations, the detector is fixed and the electron ray scans the semicircular tungsten strip anode. Radiation is generated at the point where the electron ray hits the anode and is transmitted to the object through a rotating X-ray source (1).

Conventional computed tomographies have certain restrictions. Owing to very large size, tomography machines require huge physical spaces where they are located. They are much more expensive than conventional radiography machines. Images are made of a number of sections, and it consumes immense time and money to obtain a final image. The main reason restricting the use of CT in orthodontics is however the high dose of radiation (1).

CONE-BEAM CT

CBCT Technique

Cone-beam CT (CBCT) was introduced in the market with an aim to bring a solution to the disadvantages of con-

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ventional CT in Europe in 1998 (NewTom QR-DVT 9000, Quantitative Radiology Srl, Verona, Italy) and in the USA in 2001 (2).

During a CBCT scanning, the X-ray source and sensor usually revolve 360 degrees on an orbit around the object. A number of images (approximately 150-599) are obtained during the scan. The scan time varies as 5-40 s depending on the CBCT unit and protocol configurations. The size of the ray radiated by the X-ray source is restricted by a round or rectangle collimator. The ray is restricted by the collimator in conformity with the sensor size, but in certain cases, it can be restricted depending on the size of the region of interest. Following the scan, raw data are transformed into voxels and digitally stored in computers (digital volumes). These volumes are then transformed into a format that can be monitored using special software. Voxels are the smallest sub units of a digital volume. CBCT voxels are generally isotropic, i.e., they have equal sizes in all three dimensions of space. The size of the edges comprising the voxels varies between 0.07 and 0.4 mm. Each voxel absorbs a certain amount of X-ray and corresponds to a gray-scale value (3). Last generation CBCT units generate 12- or 14-bit images (12 bit=2^{12}=4096 gray tone, 14 bit=2^{14}=16.384 gray tone). The computer monitors used to display 12- or 14-bit images have a maximum 8-bit (256 gray tone) display capacity. A technique called "windowing and leveling" is used to display the entire image in the software. Windowing allows moving the data in a three-dimensional way so that low-density air and soft tissue and high-density bones and teeth are displayed as 8 bit at once. When optimal windowing level is provided, contrast and brightness (leveling) of the image is configured by the clinician to provide the best display. A higher number of voxels and a higher bit value are associated with a better display of the anatomic structures (2, 4, 5).

The imaging protocol varies depending on the field of view (FOV), voxel size, scan time, milliampere and kilovolt settings, sensor sensitivity, and patient immobilization methods. FOV can be small, medium, or large scale. In small scale FOV, impacted teeth, root morphology, supernumerary teeth, and areas of implants or orthodontic mini implants can be viewed. In medium scale FOV, the mandible, maxilla, or both can be evaluated. In large scale FOV, the entire head area can be evaluated. The operator can control FOV, milliampere settings, and scan time. Diminishing these values decreases the effective radiation, but the image quality scales down accordingly (2).

The voxel volume can be viewed using different imaging options. Imaging options can be in multiplanar (MPR) or orthogonal (i.e., coronal, axial, and sagittal) angles. The obtained data can be sorted as a single voxel line or column. The displayed voxel layers are used to form a larger unit. Thus, clinicians can provide a whole image and display it from the desired angle. Different techniques, such as shaded surface display (SSD) and volume rendering (VR) can be used to display voxel volume by using the aforementioned imaging options (2).

Shaded surface display allows displaying the data with a certain density value. While displaying soft tissues, a low-density range is selected and tissues outside this range (hard tissues) are not displayed. While displaying hard tissues, a high-density range is selected and tissues outside this range (soft tissues) are not displayed. VR is a technique that can use all the voxels but does not allow the operator to change the translucency value using the density level. When superficial soft tissues are made pellucid by 70%, the underlying skeletal structure becomes visible (2). For example, the Hounsfield unit of air is -1000, and the Hounsfield unit increases as the density of the tissues increases. By considering the fact that the Hounsfield unit of all soft and hard tissues in the human body is higher than air and by changing the threshold settings of the CBCT unit, it is possible to provide a clearer view of the tissues.

Every CBCT system has its own software. However, if the data collected by the CBCT software is stored in the Digital Imaging and Communications in Medicine (DICOM) format, the obtained data can be viewed in other CBCT software. Therefore, an interactive imaging system can be created and diagnosis and treatment plans can be developed (6).

With regard to radiation calculation in CBCT, dose applications are generally performed in a dosimetry phantom: a skull placed in a material equivalent to the soft tissue in radiologic terms. Phantoms are divided into several layers throughout the axial plan. Non-calibrated thermoluminesence dosimetries (TLDs) are located in radiosensitive regions in the phantom; these radiosensitive regions are the ramus, thyroid gland, salivary gland, bone marrow, esophagus, brain, and right and left eye. The radiation dose is calculated via these TLDs. The CBCT system obtains images of the phantoms by changing FOV, scan time, milliampere setting, and voxel size every time. The dose absorbed by TLD is calculated depending on the 1990 or 2007 International Commission on Radiological Protection tissue weight factors to detect the effective dose (2, 7). Radiographical imaging should be executed if the expected benefits would outweigh the concerned risks as per the As Low as Reasonably Achievable principle (8). A study ascertained that 87-206 microsievert (μSv) radiation is taken up by CBCT; 14.2-24.3 μSv by panoramic radiography; 10.4 μSv by lateral cephalometry; and 13-100 μSv with full mouth periapical radiography (9). Another study found out that 139 μSv radiation is utilized during a round trip between Paris and Tokyo (10). However, the ionizing feature of the radiation uptaken during the flight is much lower when compared to a CT. As devices conveying direct X-rays emit ionizing radiation, they have more dangerous effects on tissues and cells. In CTs, the dose was reduced from 6000 to 2600 μSv (11). It is not possible for any CBCT system equipped with the highest milliampere and kilovolt setting and with the highest image quality to even achieve these values (1). Thus, it is far more reasonable to prefer CBCT than CT.

The CBCT systems available in the market are different from each other in terms of the patient position during imaging (lying, standing, or sitting), sensor type, FOV, X-ray source, and imaging software (12).

CBCT Systems with Large FOV

These are used to evaluate the entire head-neck area. Currently,

there are 12 different brands of these devices in the market with the FOV size varying between 16×18 and 19×24 cm, and the voxel size varying between 0.08 and 0.20 mm (1, 13).

CBCT Systems with Medium FOV

These are used to evaluate the mandible, maxilla, or both. Currently, there are 19 different brands of these devices in the market whose FOV size varies between 7×12 and 14×24 cm, and the voxel size varies between 0.07 and 0.40 mm (13).

CBCT Systems with Small FOV

These are used to evaluate impacted teeth, root morphology, supernumerary teeth, and areas of implants or orthodontic mini implants. Till date, there are 25 different brands of these devices in the market whose FOV size varies between 3×4 cm 10×10 cm, and the voxel size varies between 0.07 and 0.20 mm (1, 13).

Advantages of CBCT (14)

- Three-dimensional display,
- Real-size data,
- Optional two-dimensional display (posteroanterior cephalogram, lateral cephalogram, TME imaging, and panoramic radiography),
- Isotropic voxel size,
- High resolution image,
- Radiation dose lower than CT. It has been proved that the CBCT radiation dose is lower than that of CT by up to 98%. A study obtained 44 μSv as the highest effective dose for the Accuitomo system and 26.6 for the Scanora system with medium FOV in a high resolution mode. These values are 2-4 times the panoramic radiography with an effective dose of 4.7-14.9 μSv (3),
- Probability of metal artefact is much lower than CT,
- Much cheaper than CT,
- Magnification, distortion, superimposition of structures, and rational errors in two-dimensional imaging are eliminated (15, 16),
- Easy access and use,
- Easy use at clinics,
- Compatible with DICOM files,
- Consumes less energy than CT.

Disadvantages of CBCT (14)

- Low contrast range depending on the detector type,
- Restricted detector size causes restricted FOV and scanned area,
- Although CBCT can view hard tissues and most soft tissues, it cannot display muscles and connections (1),
- Involuntary muscle movements, such as breathing during the long scan (30-40 s), results in movement artefact. For this reason, the patient should remain motionless. It is recommended that patients do not breathe and keep their eyes closed (1).

USE OF THE CBCT IN ORTHODONTICS

A study on CBCTs conducted between May 2004 and January 2006 showed that 51% of them required maxillofacial surgery specialists and 17% required periodontology specialists; 40% of CBCTs were required for implant planning, 24% for a suspected pathology, and 16% for a TME analysis. Apart from these, CBCTs were needed the most for the evaluation of the impacted teeth and for orthodontic evaluations (17). However, it should be considered that if conventional radiographies do not provide enough diagnostic information, CBCT should be performed.

Evaluation of Impacted Teeth and Oral Anomalies

Studies found the impacted maxillary canine prevalence to be 0.9%-6% (18, 19). The ratio of palatal impaction to labial impaction can be as high as 9:1 (20). The traditionally used method in the detection of impacted teeth is the tube shift (parallactic technique) method. In this technique, two periapical radiographies are taken with different ray angles, and it is determined whether the impacted tooth is labial or palatal to the roots of the incisors (21). Apart from the parallactic technique, panoramic radiography and/or panoramic radiography along with lateral cephalometric radiography can be used (22, 23). However, in CT operations, it was found that the positions of the impacted teeth and pathologies they caused were much different from the aforementioned techniques (24). In a study executed using CT, Ericson and Kurol researched about the incisor resorption due to ectopic maxillary canines and observed resorption in 3% of the lateral incisors and in 9% of the central incisors (25). However, in a study by Walker and colleagues executed using CBCT, resorption in 66.7% of the lateral incisors and in 11.1% of the central incisors were detected (26). Absolute localization of impacted teeth with the use of CBCT allows determining the existence of resorption in the neighboring roots, the type of resorption, the root with resorption in multiple root teeth, the amount of the bone surrounding the impacted tooth, the development phase of the tooth, the treatment with minimal invasive surgery, and the most effective orthodontic treatment. A study was conducted on the effects of CBCT on decisions of orthodontists for treatment of impacted teeth with panoramic, occlusal, and parallactic techniques (27). About one-fourth of the treatment plans with two-dimensional radiographies was subjected to change when CBCT was reviewed (e.g., pulling a lateral tooth with a resorbed root instead of pulling a premolar tooth for the eruption of the impacted tooth). Orthodontists could provide a more reliable diagnosis with CBCT than that with the two-dimensional radiograph.

With CBCT, it is possible to detect anomalies, such as oral cysts, supernumerary teeth, enostosis, condensing osteitis, dense bone islands, and osteopetrosis. An absolute localization of supernumerary teeth can be provided, and the clinician can decide which tooth or teeth to extract and the proper surgical approach to achieve it (28). Tooth movement can be extremely hard and gap filling or torque control may not be possible in patients with lesions such as dense bone islands and enostosis. If the force applied to the tooth is in direct position to this dense lesion, external apical root resorption may occur (8).

Deep bite is another frequently observed condition in patients in orthodontics. The intrusion of the anterior teeth and extrusion of the posterior teeth is possible in these patients by using ante-

rior bite planes. The bone in the apical portion of the maxillary central teeth can be evaluated by a cross section from the incisor area with CBCT. Intrusion should not be executed on these teeth if there is insufficient bone because it can cause harm to the tooth apex if a counter force is applied to the dense bone of the bottom of the nose. Therefore, it is necessary to provide extrusion of the posterior teeth during treatment (8).

Evaluation of the Airway and Sinus

Mouth breathing and airway obstructions are some of the malocclusion etiologies. Therefore, evaluation of the airway and the sinus constitutes great importance in orthodontic terms. This evaluation is traditionally performed by lateral cephalometric radiography. However, operations with this radiography are generally insufficient due to small number of examples, lack of control group, lack of standardization in head position of patients, and weak operation designs (29). In the end, it is impossible to get efficient anatomic measurements from lateral cephalometric radiographies (8). A study executed on 11 samples using lateral cephalometric radiography and CBCT showed that different results were obtained by the two radiography techniques for the measurement of the upper airway area and volume (30). It is possible to display the upper airway, soft palate, and tongue and hypopharyngeal structures with CBCT, and more healthy results are obtained compared with the two-dimensional analyses (12). These three-dimensional analyses would be very beneficial in comprehending the effects of obstructive sleep apnea and adenoids on malocclusions and planning proper treatment (1).

El and Palomo (31) in their upper airway volume measurements compared three DICOM viewers [Dolphin3D (version 11, Dolphin Imaging & Management Solutions, Chatsworth, CA), InVivoDental (version 4.0.70, Anatomage, San Jose, CA), and OnDemand3D (version 1.0.1.8407, CyberMed, Seoul, Korea)] with a program of which accuracy was previously tests named OrthoSegment (OS; Developed by Department of Orthodontics at Case Western Reserve University, Cleveland, Ohio) in terms of reliability and accuracy. Thirty CBCT scans were randomly selected and the volume of the oropharynx and the nasal passage area was measured. Reliability was found to be high for all programs. The highest correlation for the oropharynx volume was between Dolphin3D and OS and for the nasal passage volume between InVivoDental and OS. The three DICOM programs were found highly reliable in airway volume measurements, but they showed weak accuracy due to systematic errors.

In another study, El and Palomo (32) researched whether nasal passage and oropharyngeal airway measurements varied between patients with different skeletal patterns. The oropharyngeal volume was found to be smaller in Class II patients compared to Class I and Class III patients. According to the skull base, the position of the mandible had an effect on the oropharyngeal airway volume. Nasal passage volume is lower in Class II patients than in Class I.

Kim et al. (33) compared three-dimensional pharyngeal airway volume in 27 children with retrognathic mandibles and normal craniofacial growth. The total airway volume was found to be smaller in retrognathic individuals than those with normal anteroposterior skeletal relation.

Iwasaki et al. (34) studied the characteristic shape of the oropharyngeal airway in children with Class III malocclusion and found a larger and flatter airway compared to Class I malocclusion.

Evaluation of the Alveolar Bone Height and Volume

Computed tomography scans were used especially by implantology specialists to evaluate the alveolar bone size and quality. However, the use of CBCT has increased because of reduced cost and radiation dose (35). Bone volume, quality, roots of the neighboring teeth, and localization of neighboring anatomic structures are important for mini-screw placement in orthodontics. It was reported that CBCT images provided more accurate and reliable information in viewing inter-radicular relations compared to panoramic radiography (36). Thus, both accurate placement of orthodontic mini screws and application of proper force vectors for these screws can be provided (21). Besides, surgical guidelines can be created for placement of orthodontic mini screws by using high-definition CBCT scans (37). However, it should be considered that although CBCT provides accurate information for evaluating the alveolar bone height, it gives substantial errors in the evaluation of fenestration and dehiscence. Therefore, caution should be maintained while evaluating such defects (38, 39).

TMJ Evaluation

Temporomandibular joint (TMJ) changes that occur as a result of orthognathic surgery, distraction osteogenesis, and orthopedic treatments require detailed studies. As the panoramic radiographies used to evaluate TME have certain restrictions and CTs have high level of radiation doses, they are not recommended for use. Hence, the use of CBCTs is highly suggested (21). A study confirmed that CBCT images are more reliable and accurate in condylar erosions compared to panoramic and tomographic radiographs (4). As temporomandibular dysfunctions constitute an important problem in certain orthodontic patients, TMJ evaluations before, during, and after orthodontic treatment are highly important (21). Furthermore, large FOV CBCT devices allow the display of neighboring structures reflected on TMJ (stylohyoid ligament, cervical spine, or other anatomic structures) that can cause pain.

Three-dimensional Display of Dentition

Cone-beam computed tomography displays dental morphology, in other words, roots and crowns, missing, supernumerary or abnormal teeth, localization of teeth and roots, and eruption process in a mixed dentition phase as three-dimensional and without distortion (8). This provides information to the clinician about the dental development phases and proper treatment strategy (guidance of eruption, serial extraction, and various orthodontic mechanics). A panoramic view of dentition captured with CBCT is similar to the conventional panoramic view, but a healthier display of dentition is provided because the contralateral side and the vertebrae do not have a superimposition and projection artefact (12). In cross sections, the right and left tooth pairs, asymmetries, and position of teeth and roots against the buccal and lingual cortical bones. Occasionally, a very thin alveolar bone may be present in this area, and the condition that

cannot be detected with conventional orthodontic records may allow the orthodontist to ensure a better treatment plan (12).

Kamburoğlu et al. (40) evaluated the precision and repeatability of dental volumetric tomography in the measurement of the length of cadaver teeth. Eighteen healthy teeth of two cadaver mandibles were displayed in the study by using 6- and 9-inch scan areas with the help of dental volumetric tomography (NewTom 3G Plus). After the digital lengths of teeth were measured over sectional displays, their real lengths were measured with the help of a digital caliper. While the average difference between the length measurements with digital caliper and images taken with 6-inch scanning area was 0.17 mm, this difference was 0.16 mm in images taken with the 9-inch scanning area. These differences are statistically insignificant. Precise and repeatable results were obtained in tooth length measurements by using dental volumetric tomography.

Digital models can be obtained from CBCT data. Thus, the need for measurement is eliminated. Erupted and unerupted teeth and roots, alveolar bone, and supernumerary teeth can be displayed in these models (41, 42). Measurement accuracies of the models obtained from CBCT data and OrthoCAD digital models were compared in a study. It was reported that linear measurements in models obtained from CBCT were the same as that with OrthoCAD models (42).

Orthognathic Surgical Applications

It is possible to generate virtual anatomic models using CBCT volumes. These virtual models can then be used to simulate treatment options in a virtual environment. Therefore, they become an important tool in the surgical procedure. These databases can be used to simulate the response of tissues to growth, treatment, and functional conditions in a virtual environment through anatomic models created with the help of CBCT volumes; for example, facial soft tissues can be correlated with viscoelastic structures and connected with hard tissues lying at the bottom. Therefore, virtual manipulation of hard tissues allows observation of the change in the concerned soft tissues (28).

Evaluation of Asymmetries

It is very hard to evaluate bone asymmetries by using cephalometric or panoramic radiographies. Structure superimposition, standardization of the head position, and distortion can create substantial problems. However, bilateral structures (such as the corpus, ramus, and condyl) can be evaluated with CBCT images, and the mandibular asymmetry can be detected. Softwares allow differentiation between the maxilla or the mandible from other images and their evaluation separately. Moreover, it can be determined whether the unilateral crossbite is real or is a result of dislocation of the mandible while entering the centric occlusion. The clinician can display the maxilla and the mandible in various angles and evaluate them in terms of asymmetry with the CBCT image that is taken only once instead of taking numerous two-dimensional radiographs (21).

Evaluation of Cleft Lip and Palate and Alveolar Bone Grafts

Cone-beam computed tomography allows displaying the morphology of the bone defect, closeness of the neighboring teeth to the defect, and supernumerary or malformed teeth around the cleft. The bone amount necessary for the treatment of the defect and the proper surgical treatment plan is determined. Success of the located bone graft, relations of neighboring teeth with this graft, and periodontal conditions of teeth are evaluated. Therefore, it is determined whether the neighboring teeth can be moved or whether it is possible to place an implant (12). A study evaluated the success of alveolar bone grafts by using CBCT and panoramic radiography and reported that it was possible to evaluate the vertical bone height of the panoramic radiography, but it did not give an idea about the bone amount in the buccopalatal direction (43). For this reason, it is recommended to take images using CBCT in cleft lip and palate patients.

Facial Analyses

Two-dimensional or three-dimensional facial images can be superimposed on CBCT images. Thus, the face can be displayed as frontal, lateral, or from any desired angle. By changing the translucency of the image, relations between soft and hard tissues can be evaluated. This is highly important in planning teeth movements, orthognathic surgery, or other applications that can change the facial view. However, it should be considered that the soft tissue view can change depending on the patient immobilization technique (supine position, sitting, or standing). Furthermore, the forehead or jaw retainer tools used in stabilization of the head can cause distortion in the soft tissues (12).

Cephalograms Obtained from CBCT

Lateral cephalometric radiographies can be generated from CBCT data and conventional measurements can be conducted and compared with two-dimensional norms. Conventional cephalometric radiographies are taken with a technique called perspective projection, and the magnification occurs depending on the distance between the object and film (12). The part close to the film is magnified less compared to the part far from the film, and a double edge view occurs on the mandible (8). There is no magnification in CBCT because the three-dimensional view is generated from raw data with a mathematical algorithm and this algorithm, even if the X-rays are not parallel, has the ability of eliminating the occurring magnification (8). Judging by the other advantages of this method; even if the patient's head is not positioned appropriately during scanning, it can be repositioned in a digital environment, and the image quality can be increased by excluding the structures that are not related to the scan area and are superimposed; separate images can be created for the right and the left side (8).

No difference was detected between the lateral cephalometric films generated from CBCT and conventional cephalometric films with linear and angular measurements (44, 45).

Anteroposterior cephalometric radiographies can be obtained from CBCT data. The advantages of this method are the ability of positioning the head in a digital environment and preventing superimposition of the vertebra and the occipital bone (3, 11).

Cephalometric landmarks can be created on three-dimensional data using recently developed software. Thus, it will be possible

to use new anatomic landmarks that are not visible on two-dimensional cephalometric films and to measure new angles and distances. A three-dimensional norm can be created by morphometric characteristics and three-dimensional images taken from patients can be superimposed on this norm. Superimposition can be made on CBCT images taken from the same patient at a different time and changes occurring due to growth or the effect of the treatment can be determined (8, 12). This superimposition is made on the entire cranial bottom surface in patients who have completed their growth, and it is performed on the anterior surface of the cranial bottom in patients who have not yet completed their growth (46).

Three-dimensional measurements on CBCTs can be made in various imaging modes. These are MPR, VR, and SSD modes (47, 48). A measurement is made between points in MPR, and it is highly accurate when compared to direct measurements on skulls. In the VR and SSD modes, the surface anatomy is measured, and a 2.3% measurement error was detected when compared to direct physical measurements (48, 49). These findings indicate that landmark identifications should be made in MPR mode.

CONCLUSION

CBCT accurately and comprehensively defines the proper diagnosis, treatment, and craniofacial anatomy for a good prognosis. CBCT, used in many branches of dentistry, has found itself a broad place in orthodontics in recent years. Orthodontics shifts from lines, lengths, and angles to spaces, surfaces, and volumes. Numerous developments are expected in this field in the future. However, as CBCT generates a high level of radiation despite being a highly beneficial tool, it should only be applied when conventional radiography is insufficient to provide the required information.

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CASE REPORT

Lingual Treatment of an Adult Patient with a Simplified Extraction Protocol

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ABSTRACT

Successful orthodontic treatment of adult cases depends on the biological, mechanical, and esthetic requirements of patients. While customized lingual appliance systems meet the esthetic expectations of the patients, they provide improved patient comfort, have three-dimensional mechanical control, and can be used for the treatment of all types of malocclusions. This report demonstrated the use of fully customized lingual orthodontic brackets for treating an adult case with extraction.

Keywords: Customized lingual orthodontics, adult orthodontics, fixed lingual orthodontics

INTRODUCTION

Visible orthodontic appliances are challenging for adult patients. In a recent study, 33% and 62% adults refused orthodontic treatment using a visible appliance (1). With the increasing esthetic demands of adult patients, lingual orthodontics and clear aligners have recently become popular (2). Lingual orthodontics provides the best esthetic option for complex cases with three-dimensional control (3). Customized lingual appliance systems have improved patient comfort, provided accurate bracket positions, and produced similar treatment outcomes as labial orthodontics.

The objective of this case report was to present the treatment results of an adult patient treated with extraction using fully customized lingual brackets.

CASE PRESENTATION

A male patient 43 years 4 months of age was referred to our clinic with the chief compliant of dental crowding. Diagnostic records showed that he demonstrated Class II molar and canine relationships on the left side and Class I canine relationship on the right side with retrusive upper, protrusive lower incisors, normal overjet, and mildly increased overbite (Figure 1, 2). Upper right first molar had previously been extracted. There was an ectopic canine tooth with an unesthetic veneer crown on the upper left quadrant. According to dental cast analysis, dental arch discrepancies were measured as 9.2 mm in maxilla and 4 mm in mandibula. Cephalometric measurements are presented in Table 1.

Treatment goals were to eliminate dental crowding, obtain Class I canine relationship on both sides, and also achieve ideal overjet and overbite. The treatment plan was to extract the buccally positioned upper left canine and use upper left first premolar as canine substitution. The color and shape of the premolar were noted as suitable for the canine substitution. A dental implant was planned for replacing the upper right first molar. Written informed consent was obtained from the patient.

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Figure 1. a-h. Pretreatment (T0) extraoral and intraoral images: Pretreatment extraoral frontal rest image (a); pretreatment extraoral frontal smile image (b); pretreatment extraoral profile image (c); pretreatment intraoral right lateral image (d); pretreatment intraoral frontal image (e); pretreatment intraoral left lateral image (f); pretreatment intraoral upper occlusal image (g); pretreatment intraoral lower occlusal image (h)

Treatment Sequence

Fully customized lingual brackets (Incognito, TOP service, 3M Unitek, Bad Essen, Germany) were manufactured according to the patient's impressions and a digital setup was created (Figure 3). After the bonding of brackets, upper left canine was extracted. The arch-wire sequence was .014" SE (super-elastic) nickel titanium for levelling and alignment; .016"×.022" SE nickel titanium, .018"×.025" SE nickel titanium for correcting rotations and providing initial torque control; .016"×.024" stainless steel for torque control, and .018"×.018" TMA (titanium-molybdenum alloy) for finishing. Interproximal reduction was performed for the crowding of the mandibular anterior teeth during the treatment. An attempt was made to achieve mesial movement of the upper right second molar, but it failed due to pneumatization of the maxillary sinus. The patient refused to undergo a sinus lift surgery.

At completion of the treatment, Class II molar relationship on the left side and Class I canine relationships on both sides were obtained; also, a balanced and ideal occlusion was achieved (Figure 4). Post-treatment cephalometric radiographs are shown in Figure 5. Total treatment duration was 2 years and 8 months. Throughout this period, the attempt for molar mesialization took 10 months. After debonding, fixed retainers were bonded, and additional essix plates were fabricated for both arches. The cephalometric parameters for pre- and post-treatment are shown in Table 1. The superimposition of pre- and post-treatment lateral cephalometric radiographs showed the extrusion of upper molar and proclination of lower incisor (Figure 6).

DISCUSSION

The demand for adult orthodontic treatment has progressively in-

Table 1. Pre- (T0) and post-treatment (T1) cephalometric measurements

	Norm Values	T0	T1
Sagittal Analysis			
SNA (°)	80±2	78.5	77.5
SNB (°)	78±2	74.6	74.2
ANB (°)	2±2	3.9	3.1
GoGnSN (°)	32±6	27.5	28.5
Gonial Angle (°)	130±7	111	111
Dental Analysis			
U1 -NA (mm)	4	3	4
U1-NA (°)	22±5	12.5	16
L1-NB (mm)	4	5.1	5.3
IMPA (°)	90±3	102	106
Overjet (mm)	3	3.5	2.8
Overbite (mm)	3	4	2.8
Soft Tissue Analysis			
Upper Lip-E Line (mm)	-4	-6	-5
Lower Lip-E Line (mm)	-2	-6	-4.4

SNA: Sella-nasion-A point angle; SNB: Sella-nasion-B point angle; ANB: A point, nasion, B point; GoGnSN: angle that is measured at the junction of the planes Gonion to Gnathion and Sella-Nasion; IMPA: incisor mandibular plane angle; U1-NA (°): angle between upper incisor inclination and NA plane; L1-NB (°): angle between lower incisor inclination and NB plane

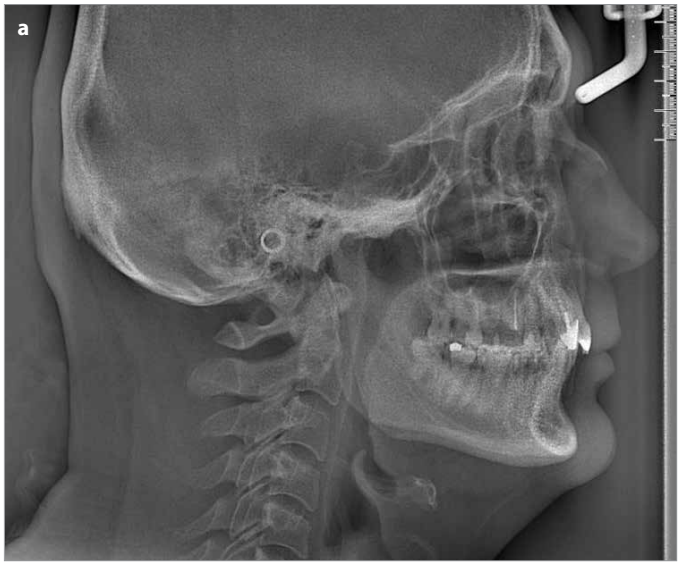

Figure 2. a, b. Pretreatment (T0) radiographic records: Pretreatment lateral cephalometric radiograph (a); pretreatment panoramic radiograph (b)

Figure 3. a-d. In-progress intraoral images: In-progress intraoral right lateral image (a); in-progress intraoral left lateral image (b); in-progress intraoral upper occlusal image (c); in-progress intraoral lower occlusal image (d)

Figure 4. a-h. Post-treatment (T1) extraoral and intraoral images: Post-treatment extraoral frontal rest image (a); post-treatment extraoral frontal smile image (b); post-treatment extraoral profile image (c); post-treatment intraoral right lateral image (d); post-treatment intraoral frontal image (e); post-treatment intraoral left lateral image (f); post-treatment intraoral upper occlusal image (g); post-treatment intraoral lower occlusal image (h)

creased in recent years, and reportedly 25% of orthodontic patients were adults in United States (4). A previous study showed that 90% of adult orthodontic treatments required fixed appliances (5).

Customized lingual orthodontics is the most esthetic option for adult patients with three-dimensional control, and it is suitable for all types of malocclusions. Improved digital technology of customized lingual systems helps create a virtual set-up, customized bracket positioning, arch-wire, and bracket fabrication. These steps facilitate improvement in the of the treatment outcomes.

Adults generally have restored or endodontically treated teeth, which can complicate the treatment plan. In the patient in the present study, we extracted the buccally positioned upper left canine using endodontic treatment for correcting the dental crowding. We used upper left first premolar as canine. In literature, premolars are often used instead of canines, and it was suggested that premolars would effectively enhance esthetics in cases of orthodontic space closure (6, 7).

The upper molar was attempted to move mesially but because of the pneumatization of the maxillary sinus, this movement was not completed. Teeth can be moved if there is adequate bone in the direction of movement and it is challenging to move teeth through anatomic limitations such as maxillary sinus, sutural, or cortical barriers.

CONCLUSION

The treatment of adult cases with high esthetic concerns can be effectively performed using customized lingual brackets. Customized lingual appliance systems have the ability to treat complex cases, and advanced digital technology can help clinicians plan all the treatment steps.

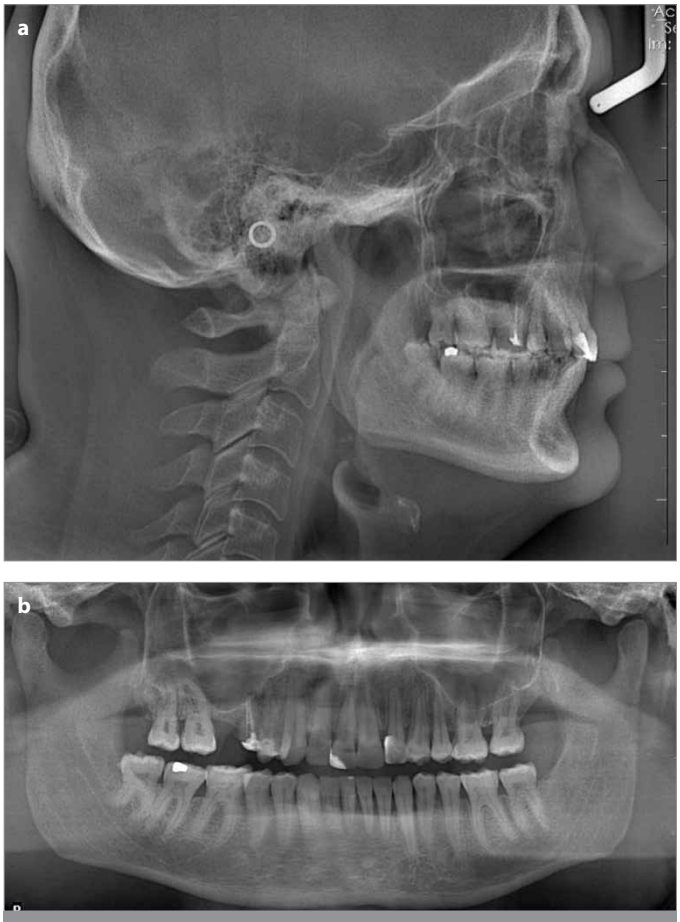

Figure 5. a, b. Post-treatment (T1) radiographic records: Post-treatment lateral cephalometric radiograph (a); post-treatment panoramic radiograph (b)

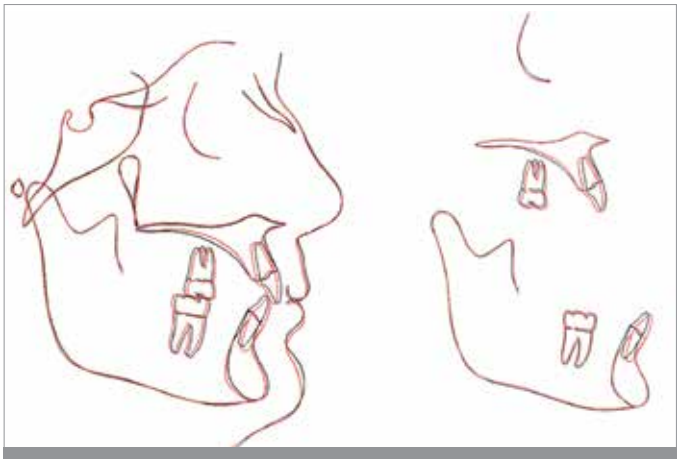

Figure 6. Superimposition of pre- and post-treatment lateral cephalometric films

Pre-treatment (T0): black line; post-treatment (T1): red line

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

Peer-review: Externally peer-reviewed.

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