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

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

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

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ORIGINAL ARTICLE

Differential Benefit of Two Different Tooth-Borne Rapid Maxillary Expansion Appliances in Female Subjects

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ABSTRACT

Objective: The aim of the present study was to evaluate the effects of tooth-borne acrylic-bonded rapid maxillary expansion (RME) appliances with or without the anterior teeth anchorage on the skeletal and dentoalveolar structures, as well as soft tissues.

Methods: This study included 44 patients who were treated with two different tooth-borne bonded acrylic RME appliances. Lateral cephalometric radiographs were taken before the treatment (T0) and in the post-retention (T1) phase of the RME treatment. The posterior-bonded RME appliance group and full-bonded RME appliance group were created as the two different groups of treatment. The following statistical analyses were performed: intra- and inter-group comparisons were made using the paired t-test, Wilcoxon test, independent t-test, and Mann-Whitney U-test for normal and non-normal distribution data.

Results: Significant increases were observed in R1-A, R1-ANS, R1-U1, R1-AR, R1-St, R1-Li, and R1-Pn in both groups. R1-PNS, R1-Ls, R1-Sn, and R1-B' were found to be significantly larger at T1 than at T0 in the posterior-bonded RME appliance group. R2-A, R2-ANS, R2-L1, R2-A', and R2-Pn were significantly larger at T1 than at T0 in the full-bonded RME appliance group. The R2-A' was significantly different between the groups.

Conclusion: The soft tissue A point appears to be the most important differing matter between the two different RME appliances, and a full acrylic-bonded RME appliance may be beneficial for subjects with a maxillary retrognathic profile.

Keywords: Rapid maxillary expansion, growing subjects, tooth-borne expander, soft tissue profile

INTRODUCTION

Maxillary transverse deficiency is one of the most common skeletal and dental problems and may be observed as posterior cross-bite at the primary, mixed, or permanent dentition at an incidence of 9.6%, 12%, and 14%, respectively (1, 2). When maxillary narrowing is diagnosed, treatment should be started as soon as possible to provide a normal growth and development of the craniofacial structures and soft tissue (3).

Treatment of maxillary transverse deficiency was conducted with appliances which use the orthopedic forces demonstrated by Angell (4) during 1860s. About 100 years after these studies, Haas's (5) work has increased the interest in RME. To date, many different types of appliances have been used to treat transverse skeletal disharmonies. The overall objective of these appliances is to create a force greater than the optimum amount to accomplish the opening of the median palatine suture. Although there are varying designs, a tooth-borne appliance, as opposed to an implant-borne appliance, has historically been the appliance most widely used (6). Studies showed that changes occurred in the maxilla, dentoalveolar structures, bone associated with the maxilla, and the surrounding soft tissues after the RME treatment (6, 7). The design of the RME device may sometimes cause undesirable changes in the anchorage area (8).

The aim of the present study was to assess the effects of tooth-borne acrylic-bonded RME appliances with and without inclusion of the anterior teeth on the skeletal structures, dentoalveolar structures, and soft tissues.

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METHODS

This study was approved by the Ethical Committee of Gazi University (10.09.2015/08).

A sample of 44 female subjects treated with tooth-borne acrylic-bonded RME appliances was included from the Department of Orthodontics, Gazi University. Inclusion criteria of the subjects were as follows:

- No history of orthodontic or orthopedic treatments
- Age of the subjects between 9.5 and 13.5 years
- Female subjects with bilateral cross-bite

Two groups were created according to inclusion of the anterior teeth in the acrylic block for the RME treatment; Group1 (n=22) included the subjects treated with the posterior acrylic-bonded tooth-borne RME appliance (Figure 1a), whereas Group2 (n=22) included subjects treated with the full acrylic-bonded tooth-borne RME appliance (Figure 1b). The acrylic part of the appliance was extended over the occlusal, palatinal, and vestibular surfaces of the included teeth. The vertical height of the occlusal acrylic was limited to the freeway space with the occlusal acrylic having a contact with all lower teeth except the anterior teeth in Group1. The standardized lateral cephalometric radiographs were taken in the pre-treatment (T0) and post-retention (T1) phases of RME (Orthophos XG 5 DS/Ceph, Sirona Dental System, Bensheim, Germany).

After all the RME appliances were installed, the screws were activated as one turn/day until the palatal cusp of the maxillary first molar occluded on the most superior portion of the lingual-buccal incline of the corresponding mandibular tooth. All the patients underwent retention, and the appliances were removed approximately 6 months after the active expansion phase.

The measurements were made according to the R1 and R2 coordinate system. R1 was constructed 7° to the SN plane, and R2 was constructed perpendicular to R1 at sella (Figure 2) (9). For didactic purposes, the cephalometric measurements were presented as in the following three groups:

1. Skeletal values: SN-GoGn, SNA, SNB, ANB, R1-A, R1-ANS, R1-PNS, R2-A, R2-ANS, and R2-PNS
2. Dental values: R1-U1, R1-Ar, R1-L1, R2-U1, R2-Ar, and R2-L1
3. Soft tissue values: R1-Ls, R1-St, R1-Sn, R1-A', R1-B', R1-Li, R1-Pn, R2-Ls, R2-St, R2-Sn, R2-A', R2-B', R2-Li, R2-Pn, and NLA

Statistical Analysis

All the analyses were performed through the Statistical Package for Social Sciences (SPSS) statistical software program version 20 (IBM Corp.; Armonk, NY, USA). Descriptive statistics and the mean and standard deviations were calculated for all measurements.

The Shapiro-Wilk test was performed to test the normal distribution of the data. The data were not normally distributed in certain cases. Therefore, we used the Wilcoxon test and paired t-test for the normal and non-normal data within group comparisons, respectively. We also used the independent t-test and Mann-Whitney U-test for the normal and non-normal data between group comparisons, respectively.

The values were considered statistically significant at $p \leq 0.05$.

Table 1. Descriptive statistics of the groups

	Groups	N	Mean±SD	p
Chronological age (year)	1	22	11.54±1.5	†0.861
	2	22	11.63±1.5	
Treatment duration (months)	1	22	8.09±2.6	*0.3
	2	22	8.95±3	
SN-GoGn	1	22	35.2±4.8	†0.462
	2	22	34.1±5.2	
ANB	1	22	3.07±2.2	†0.67
	2	22	2.77±2.3	

*The Mann-Whitney U-test was used because the treatment duration was not normally distributed; †Other variables were analyzed with an independent t-test; p≤0.05.

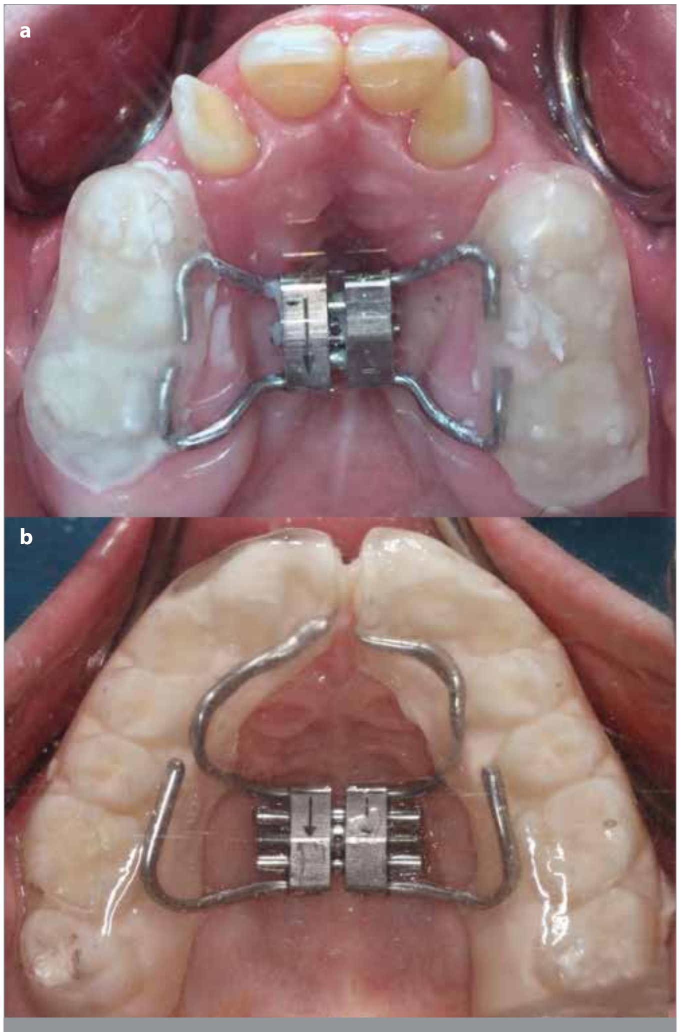

Figure 1. a, b. Posterior acrylic-bonded tooth-borne RME (Group1) (a); full acrylic-bonded tooth-borne RME (Group2) (b)

RESULTS

A power analysis showed that 22 patients would be required for each group for a power of 0.93 at α=0.05.

The two groups analyzed were homogeneous, and there were no statistically significant difference in terms of chronological

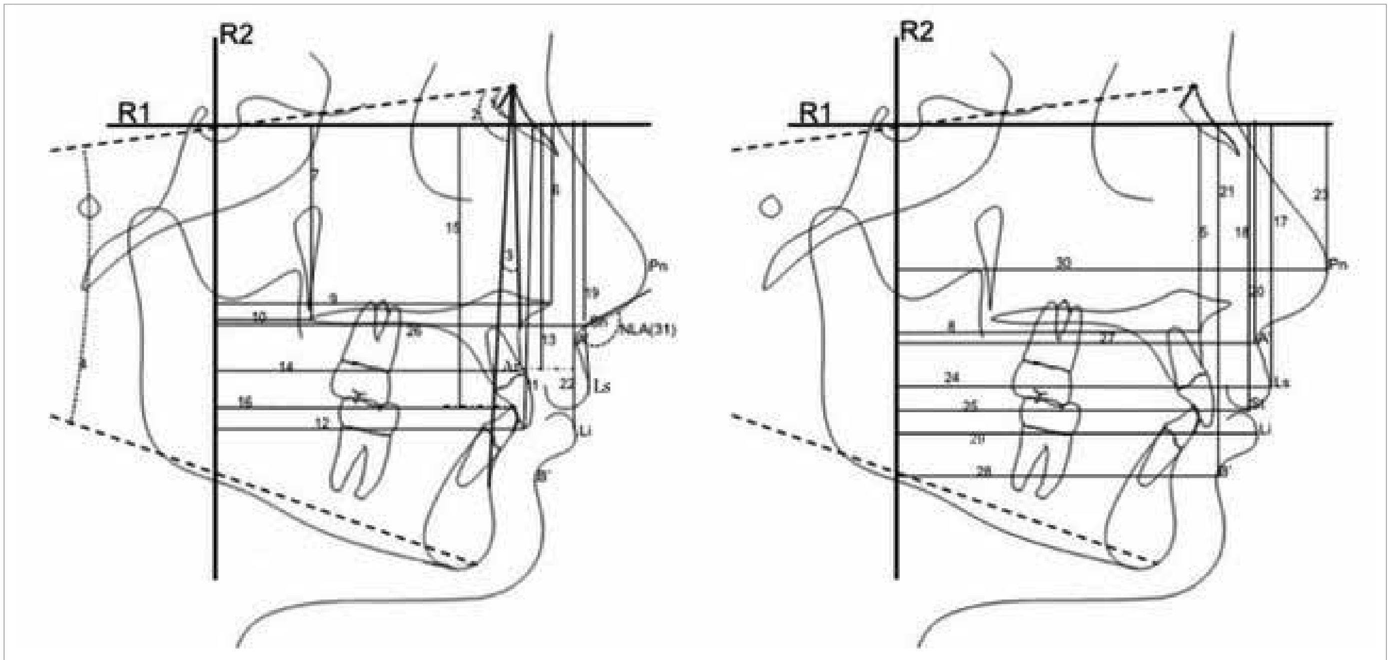

Figure 2. Reference line, landmarks, and measurements
SNA(°)(1), SNB(°)(2), ANB(°)(3), SN-GoGN(°)(4), R1-A(mm)(5), R1-ANS(mm)(6), R1-PNS(mm)(7), R2-A(mm)(8), R2-ANS(mm)(9), R2-PNS(mm)(10), R1-U1(mm)(11), R2-U1(mm)(12), R1-Ar(mm)(13), R2-Ar(mm)(14), R1-L1(mm)(15), R2-L1(mm)(16), R1-Ls(mm)(17), R1-St(mm)(18), R1-Sn(mm)(19), R1-A'(mm)(20), R1-B'(mm)(21), R1-Li(mm)(22), R1-Pn(mm)(23), R2-Ls(mm)(24), R2-St(mm)(25), R2-Sn(mm)(26), R2-A'(mm)(27), R2-B'(mm)(28), R2-Li(mm)(29), R2-Pn(mm)(30), NLA(°)(31)

age, duration of treatment, vertical growth pattern, and skeletal sagittal relationships (Table 1).

The descriptive statistical values and comparisons of the craniofacial, dentoalveolar, and soft tissue changes between Group1 and 2 at T0-T1 are presented in Table 2.

Skeletal Changes: Significant increases were observed in R1-A and R1-ANS in both groups. R1-PNS (p=0.004) was found to be significantly larger at T1 than at T0 in Group 1. R2-A (p=0.021) and R2-ANS (p=0.044) were found to be significantly larger at T1 than at T0 in Group2.

Dental and Dentoalveolar Changes: Significant increases were found in R1-U1 and R1-Ar in both groups. R2-L1 (p=0.049) was found to be significantly larger at T1 than at T0 in Group2.

Soft Tissue Changes: Significant increases were found in R1-St, R1-Li, and R1-Pn in both groups. There were significant increases in R1-Ls (p=0.005), R1-Sn (p=0.003), and R1-B′ (p=0.007) in Group1. R2-A′ (p=0.015) and R2-Pn (p=0.018) were found to be significantly greater in Group2 at T1 than at T0.

R2-A′ was significantly different between the groups.

DISCUSSION

The RME treatment is useful for the correction of a narrow transverse maxillary width, unilateral or bilateral posterior cross-bite, and severe maxillary crowding. Many different designs exist for RME, including tissue-borne, tooth-borne, and bone borne, depending on the age, the cooperation of the patient, and indication (10-13).

In the previous RME studies, the complexity of the groups might have prevented the detection of the pure effects of the appliance. The growth pattern and potential of the patients are the major impediments to determine the pure effects of the RME appliance (7, 14).

In the present study, we preferred to include only female subjects to eliminate the differential growth potentials and craniofacial structures between the genders. The SN-GoGn angle has been used for assessment of the vertical growth, whereas the ANB angle has been used for the prediction of the sagittal skeletal relationship. To identify the sole effects of the RME appliance, the SN-GoGn and ANB angles, duration of the treatment, and the chronological age were matched.

The initial aim of the RME treatment is to obtain the opening of the mid-palatal suture. The researchers paid close attention to the different developmental stages shown by the maturation of the mid-palatal suture (15). The general belief is that the opening ability of the mid-palatal suture decreases after 14-15 years of age (16-18). In the present study, the opening of the mid-palatal suture of all subjects was achieved because the mean age was 11 years 5 months for Group1 and 11 years 6 months for Group2. A diastema between the central incisors was observed in all the subjects at the end of treatment. There were no problems, such as pain, oral hygiene, feeding, or cooperation, concerning the RME appliances.

Table 2. Intragroup and inter-group statistical comparison of variables

		Group 1 The Posterior-Bonded RME			Group 2 The Full-Bonded RME			Differences Between the Groups
		T0	T1		T0	T1		T1-T0
		Mean±SD	Mean±SD	p	Mean±SD	Mean±SD	p	p
Skeletal Values	SNA	78.5±3	78.6±3.5	0.71**	79.7±3.9	80±3.7	0.561**	0.924*
	SNB	75.1±3.7	75.4±4.4	0.607**	76±3.5	76.3±3.6	0.608∞	0.636*
	ANB	3.07±2.2	3.14±2.1	0.684∞	2.77±2.3	2.73±2.2	0.863**	0.755†
	SN-GoGn	35.2±4.8	35.7±5.8	0.272**	34.1±5.2	34.6±5.5	0.289**	0.914†
	R1-A	52.4±4.77	53.83±4.8	0.001**	51.45±4	52.3±3.7	0.040**	0.522*
	R1-ANS	45.5±4.1	46.7±4.4	0.001**	44.8±3.1	45.7±2.8	0.001**	0.981*
	R1-PNS	43.9±2.8	44.6±3	0.004**	43.5±3.2	43.9±3	0.168**	0.827*
	R2-A	66±3.7	66±4.2	0.833**	67.5±5.2	68.2±5.3	0.021**	0.086†
	R2-ANS	73.4±3.8	73.7±3.9	0.527**	73.9±5.4	74.9±5.4	0.044**	0.438*
	R2-PNS	18.5±3.8	18.3±4.2	0.56**	19.7±3.4	20.2±3.8	0.083∞	0.135*
Dental and Dentoalveolar Values	R1-U1	73.7±5.5	75.3±6.2	0.001**	72.4±4.1	73.8±4.3	0.001**	0.689†
	R1-Ar	60.5±5.9	62±6.3	0.001**	59.7±4	60.7±4	0.001**	0.2†
	R1-L1	71.2±6.1	72.1±7.4	0.168**	70.1±5.4	71.1±4.5	0.127**	0.671*
	R2-U1	69.5±5.8	68.7±6.5	0.127**	71.8±5.8	72.1±5.4	0.612**	0.098*
	R2-Ar	68.5±4.3	68.1±4.8	0.32**	69.9±6	70.6±5.4	0.1∞	0.06†
	R2-L1	64.6±4.6	64.5±5.6	0.866∞	66.3±6.4	67.2±6.1	0.049**	0.14†
Soft Tissue Values	R1-Ls	64.9±5.3	66.6±5.7	0.005**	64±4.5	64.5±3.8	0.294**	0.435*
	R1-St	70.8±5.4	72.6±5.8	0.001**	69.7±4	70.7±3.7	0.028**	0.421*
	R1-Sn	50.3±5.2	52.2±5.9	0.003**	48.8±4.7	49.7±4.4	0.075**	0.286*
	R1-A'	56.6±5.4	57.6±6	0.061**	55±4.4	55.3±4.1	0.42**	0.321*
	R1-B'	88.3±6.7	89.9±7.8	0.007**	87.3±4.6	88.2±4.7	0.074**	0.339†
	R1-Li	78.8±5.9	80.5±6.7	0.005**	77.8±4	79±4.4	0.007**	0.465†
	R1-Pn	38.6±4.6	39.9±5	0.019**	37±3.5	38±4.2	0.001**	0.516*
	R2-Ls	84±4.9	83.6±5.6	0.548**	86.1±6.1	86.8±5.6	0,078**	0.141†
	R2-St	76.9±5.1	76.2±5.8	0.288**	79.5±6	79.8±5.9	0.432**	0.183†
	R2-Sn	83.4±4.1	83.6±4.5	0.757**	85.7±6	86.2±5.4	0.221**	0.54†
	R2-A'	81.7±4.6	80.7±5.3	0.233**	83±5.8	83.8±5.3	0.015**	0.05*
	R2-B'	71.5±6.7	70.7±8.2	0.584∞	72.3±8.1	73.3±7.8	0.09**	0.169*
	R2-Li	79.7±4.8	79.4±5.6	0.646**	81.8±7	82.5±6.6	0.326∞	0.278†
	R2-Pn	97.5±4.1	98.2±4.1	0.59**	99±7	99.9±6.5	0.018**	0.715†
	NLA	110.9±12.4	113.5±12.6	0.264**	113.2±9.5	112.6±9.3	0.594**	0.223†

*Mann-Whitney U-test; †Independent t-test; **Paired sample t-test; ∞Wilcoxon test; p≤0.05
S: sella; N: nasion, A: skeletal A point; B: skeletal B point; ANS: anterior nasal spine; PNS: posterior nasal spine; Ar: alveolar ridge; U1: the most occlusal tip of the upper incisor; L1: the most occlusal tip of the lower incisor; Ls: labiale superior; Li: labiale inferior; St: stomion; Sn: subnasale; A': soft tissue A point; B': soft tissue B point; Pn: pronasale; NLA: nasolabial angle

The application of an acrylic-bonded RME generates a force to the anchor teeth transmitted to the corresponding alveolar bone. This force is translated to the mid-palatal suture as the periodontal ligaments of the anchor teeth are compressed. The tipping of the teeth and bending of the alveolar process occur, and gradual separation is observed (19).

Skeletal Changes

Various movements of the skeletal point A were reported after the application of the RME device. The skeletal point A has been shown to mostly move to the posterior in patients treated with bonded RME appliances at the end of the retention phase (3 months) (20). On the contrary, it has been declared that immediately after using the full- and posterior-bonded RME appliance, the skeletal point A showed a forward movement according to the SNA (21, 22). Furthermore, treatment with the conventional Haas-type RME appliance showed that the SNA angle increased during the active phase, whereas it decreased at the retention phase because of the sutural fusion between the maxilla and the craniofacial bones (5, 6).

The sagittal position of the skeletal point A (SNA, R2-A, and R2-ANS) did not show significant changes at the end of the retention phase, which was 6 months on average in Group1, whereas the skeletal point A (R2-A and R2-ANS) showed significant increases in Group2. The SNA angle did not show any changes, but the growth of nasion may have prevented the sagittal movement of the skeletal point A from being noticed.

Differences in the measurement methods, appliance design, retention time, sample's age, and gender can affect the results and be confusing. Varying results concerning the skeletal point A may be observed in the same study according to the different measurement methods used (21). This situation makes the evaluation of the effects of the used devices even more complicated.

Lateral cephalometric radiographs were taken at the end of the retention period, and not the treatment period, because of ethical reasons in the present study. There are some different results presented between immediately after the active expansion phase and retention phase outcomes in literature (5, 6, 20-22). The pure outcome following this treatment should be obtained before beginning the fixed appliance therapy to reduce the relapse.

Vertical changes of the point A were noted in line with previous studies (1, 5), and point A moved downward in both groups. However, a downward movement of the PNS was observed only in Group1. Vertical movement was only seen at point A and ANS, whereas it was not seen in Group2. Therefore, we interpreted this result as a maxillary posterior rotation of Group2. Despite the maxillary posterior rotation in Group2, the skeletal point A moved forward. This is very useful for specific treatments, especially maxillary deficiency.

Dental and Dentoalveolar Changes

The upper teeth showed a downward movement, and maxillary alveolar bones followed the upper incisors in both groups. Although the anterior teeth were not in contact with each other during the RME treatment in Group1, the extrusion of the anterior teeth including the upper anterior alveolar ridge was not significantly different between the groups. The extrusion of the upper incisors in Group2 may have been affected by the downward movement of the ANS point and, at the same time, the unchanging vertical position of the PNS point. Therefore, this can be interpreted as the posterior rotation of the maxilla. This residual effect was not differentiated in previous studies and should be considered with caution especially in the presence of "gummy smile," as emphasized in this study where specific details in the appliance design have been discussed.

Although there were no changes in the sagittal position of the upper teeth in our study, extrusions of the upper teeth were observed. No significant differences were found in previous studies regarding the vertical or sagittal position of the upper and lower incisors after treatment with an acrylic-bonded full tooth- and tissue-borne RME appliance (12, 23). Unlike the design of the appliance in the presented study, a tissue-borne portion of the RME appliance in the previous studies may have created an intrusion effect via tongue; as a result, the vertical growth of the dentoalveolar region may have been inhibited even though the acrylic part thickness was within the freeway space (12, 23).

Protrusion of the lower teeth was seen in Group2, but it was not seen in Group1. This may have occurred because of the anterior acrylic part of the full acrylic-bonded RME appliance.

In line with the findings of our study, researchers (22, 24) showed that there was a retrusion of the upper incisors at the end of the retention phase in Group1.

Soft Tissue Changes

There is a complex relationship between the orthodontic treatment and soft tissue changes. Researchers especially evaluated the effects of the extraction orthodontic treatment on soft tissues (25-27). Soft tissue changes were neglected when the RME effects were assessed in the majority of the previous studies (10, 14, 24, 28). The various results declared in the studies are as follows. The upper lip did not move forward after the RME, although the maxilla showed an anterior movement (12). The H angle increased after the RME treatment. It is not clear whether this increase in the H angle was a result of the forward movement of the lips (7); in addition, there were no changes in the sagittal position of the skeletal point A and the upper lip, despite the protrusion of upper incisors (21). Conversely, the lips followed the maxilla and mandible, which moved posteriorly in hypothetic skeletal changes associated with the posterior-bonded RME appliance (20).

In the present study, the increase in the vertical growth of the upper lip and subnasale may be the result of sole vertical maxillary growth in the subjects from Group1 and the release of anterior teeth.

The soft tissue point A moved forward in Group2 compared with Group1. This result is an important finding, especially in the maxillary deficiency Class 3 patients. The posterior rotation of the maxilla and a forward movement of the soft tissue point A will be beneficial for maxillary protraction treatment.

Tooth-borne acrylic-bonded RME appliances are the most commonly used expansion devices in the orthodontics practice for narrow upper arch corrections owing to their easy and inexpensive laboratory steps, simple, and non-invasive bonding procedure, and successful patient compliance. For impressive smiles and appealing profiles, it is essential to start treatment at a suitable age while growth and development are continuing and to use the most beneficial appliance design for the patient. Treatment with the specific target related expansion device would help to decrease the complexity of the orthodontic problem and anxiety due to the unpleasant appearance, providing a better social orientation.

CONCLUSION

The differential results of the RME treatment reveal the complexity of the response of midfacial structures depending on the stimulated areas; the soft tissue A point appears to be the most important matter between the two different RME appliances in this study. The vertical effects were apparent around the upper lip and subnasale in the posterior acrylic-bonded RME, whereas the sagittal changes in the soft tissue point A and pronasale and rotational maxillary movement were observed in the full acrylic-bonded RME.

As a recommendation, full acrylic-bonded RME appliance may be beneficial for subjects with maxillary retrognathic profile, whereas posterior acrylic-bonded RME appliance may be advantageous for subjects with a short upper lip.

Ethics Committee Approval: Ethics committee approval was received for this study from the Ethical Committee of Gazi University (10.09.2015/08).

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

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - L.T., G.M.G.; Design - L.T., G.M.G.; Supervision - L.T., G.M.G.; Data Collection and/or Processing - G.M.G., N.D.S.D.; Analysis and/or Interpretation - G.M.G., N.D.S.D.; Writing Manuscript - L.T., G.M.G.

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ORIGINAL ARTICLE

Analysis of Six Orthodontic Journals in Science Citation Index and Science Citation Index Expanded: A Bibliometric Analysis

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ABSTRACT

Objective: To analyze the article type, origin, main affiliation, number of publications, authors, and affiliations of six orthodontic journals during two intervals of 5 years each (2006-2010 and 2011-2015).

Methods: In total, 4879 articles examined in this study were screened online at the individual journal's website. The types of articles and their authorship characteristics in the six orthodontic journals [three journals indexed by Science Citation Index (SCI) and the others indexed by Science Citation Index Expanded (SCIE)] were recorded. Parameters were tested using the Pearson chi-square for independence at a 0.05 level of significance.

Results: Among all the article types, research articles were the most published in the orthodontic journals indexed by SCI and SCIE in the first (2006-2010; 88.1% and 77.6%, respectively) and second periods (2011-2015; 84.4% and 74.6%, respectively). In the first and second intervals, the European Union was the most common origin among articles accepted by the journals listed in SCI (30.1% and 29.2% respectively), whereas Asia/Oceania was the common origin among articles accepted by the journals listed in SCIE (44.1% and 43.4%, respectively).

Conclusion: The articles published in the orthodontics journals listed under SCI and SCIE for 2006-2010 and 2011-2015 were significantly different in terms of numbers and characteristics.

Keywords: Article characteristics, bibliometrics, orthodontic journals

INTRODUCTION

In scientific fields, several statistical methods have been used to compare the effectiveness of journals and articles, including bibliometric analysis. Bibliometrics is used to assess the direction of research activities and publication trends of journals by quantitatively analyzing publication in a certain field in a certain time period regarding author, journal, subject, number of citations, and references cited; it emerges as an important tool in the orthodontics field that facilitates management, storage, and classification of information (1-3).

Advances in techniques and applications have led to a marked increase in international studies on orthodontics. It was reported that between 1981 and 2016, the total number of the published orthodontic articles continuously increased (4, 5). The features characterizing these publications, such as authorship, demographics, constituent components of affiliation, and origin, provide insight about the current trends on the acceptance of articles for

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publication (6). In a bibliometrics study, Mavropoulos and Kiliaridis (4) found that a majority of articles published in orthodontics journals focus on the diagnosis and treatment methods and that studies about novel treatment techniques have markedly decreased in the last two decades, highlighting the increased need for high-quality studies producing reliable evidence. According to the previous studies evaluating the literature of orthodontics between 1998 and 2012, a significant increase was detected in original articles compared with review articles and case reports (5, 7-9).

Features determining characteristics of a journal include the impact factor, which represents the extent of citation for an article, and the circulation rate, which indicates the measurement of recognition among others (10). Although the citation index is not a measure that demonstrates quality and significance, it is widely accepted as a measurement of recognition (11). The analysis of citation characteristics reveals useful and interesting information about the impact of an article, a researcher, a country, or the year and has been used to project the future influence of articles (12, 13).

In our study, we aimed to identify how characteristics of articles have changed during the last decade by evaluating features of articles, such as type of article, number of authors, origin of article, main affiliation of authors, and number of affiliations in three journals listed in Science Citation Index™ (SCI Ex; WoS, Thomson Reuters, New York, NY) and three journals listed in Science Citation Index Expanded™ (SCIE; WoS, Thomson Reuters, New York, NY) published in the orthodontics field during 2006-2010 and 2011-2015. We used the SCI and SCIE databases to identify a means of assessing the present status of available researches and analyzed the publication performance of these researches with respect to authors, institutions, and countries.

METHODS

This was a retrospective and observational study planned to disclose the types of published articles by comparing two groups (n=3 per group) of orthodontic journals over two different time periods. In the present study, all articles published in Angle Orthodontist (AO), American Journal of Orthodontics and Dentofacial Orthopedics (AJODO), European Journal of Orthodontics (EJO), Australian Orthodontic Journal (AOJ), and Orthodontics & Craniofacial Research (OCR) during two consecutive periods (2006-2011 and 2011-2015) were reviewed through an online web edition. Since Korean Journal of Orthodontics (KJO) was first introduced in 2008, the articles published in 2008-2011 and 2011-2015 were reviewed. The reviewed articles were classified according to the status of journals where they were published as follows: the journals listed in SCI (AO, AJODO, and EJO) and SCIE (AOJ, KJO, and OCR).

For each article, the following parameters were evaluated:
(1) Article type: Research, review, case report, and other (unclassified)
(2) Number of authors: ≤3 or >3
(3) Origin: Stratified based on the data regarding geographic origin of the first author. The categories included the United States/Canada, European Union, non-European Union, Asia, Oceania, and others (unclassified). The origins of articles are classified as shown in Table 1.
(4) Main affiliation: Stratified based on the affiliation of the first author. The categories included orthodontic (research conducted in orthodontics department), nonorthodontic (research conducted in other teaching facilities), and nonacademic (research conducted in private practice or private facilities).
(5) Number of affiliations: Stratified as ≤3 or >3 based on the number of author affiliations. Since authors may have more than one affiliation in some studies, the number of affiliations can be higher than the total number of authors in such articles.

Data analysis was performed using Statistical Package for Social Sciences (SPPS) version 19.0 (IBM Corp.; Armonk, NY, USA). The Pearson's chi-square test was used to analyze parameters. A p-value of <0.05 was considered statistically significant.

Table 1. Geographic origins of articles

Code	Country	Code	Country
3	Albania	2	Malta
5	Argentina	5	Mexico
4	Australia	5	Morocco
2	Austria	4	Nepal
2	Belgium	2	Netherlands
5	Brazil	4	New Zealand
1	Canada	5	Nigeria
2	Czech Republic	3	Norway
5	Chile	4	Pakistan
4	China	5	Palestine
5	Colombia	5	Peru
5	Costa Rica	4	Philippines
2	Croatia	2	Poland
2	Denmark	2	Portugal
5	Egypt	5	Qatar
2	Finland	2	Romania
2	France	3	Russia
2	Germany	5	Saudi Arabia
2	Greece	5	Senegal
4	Hong Kong	3	Serbia
2	Hungary	5	Sicily
3	Iceland	4	Singapore
5	India	2	Slovenia
4	Indonesia	5	South Africa
5	Iran	4	South Korea
2	Ireland	2	Spain
5	Israel	5	Sudan
2	Italy	2	Sweden
4	Japan	3	Switzerland
5	Jordan	5	Syria
4	Korea	4	Taiwan
5	Kuwait	4	Thailand
2	Latvia	3	Turkey
5	Lebanon	5	United Arab Emirates
5	Libya	2	United Kingdom
2	Lithuania	1	United States
4	Malaysia	5	Venezuela
		5	West Indies

1: United States/Canada; 2: European Union countries (European Union membership according to 2015 status); 3: non-European Union; 4: Asia/Oceania; 5: other

RESULTS

In total, 4879 articles including 4053 from SCI and 826 from SCIE were published during 2006-2015. The productivity of SCI was higher than that of SCIE in both periods. Tables 2 and 3 show the analyses' results.

Characteristics of Articles Published in the First Period (2006-2010)

In the first period, research articles were the leading article type published in the journals listed in SCI and SCIE (84.4% and 74.6%, respectively). The European Union (30.1%) and Asia/Oceania (44.1%) was the most common origin among articles accepted by the journals listed in SCI and SCIE, respectively.

Articles from orthodontic departments comprised 72% of all articles published in the journals listed in both SCI and SCIE. Articles with >3 authors comprised 60% of articles published in the journals listed in SCI but comprised 55.7% of those listed in SCIE. Articles with ≤3 affiliations comprised 94% of articles listed in SCI and 83.8% of those listed in SCIE. The findings for the first period are presented in Table 2.

Characteristics of Articles Published in Second Period (2011-2015)

As in the first period, in the second period, research articles were the leading article type published in the journals listed in SCI and SCIE (88.1% and 77.6%, respectively). The rate of articles with >3 authors was 71.1% and 69.1% in the journals listed in SCI and SCIE, respectively. The European Union (29.2%) and Asia/Oceania (43.4%) was the most common origin among articles accepted by the journals listed in SCI and SCIE, respectively. In journals listed in both SCI and SCIE, a majority of studies were conducted

Table 2. Article type, origin, main affiliation, number of publications, authors, and affiliations per journal per interval

	SCI 2006-2010	SCI 2011-2015	SCIE 2006-2010	SCIE 2011-2015
Number of Publications	2126 Share, %	1927 Share, %	370 Share, %	456 Share, %
Article Type				
Research	88.1% (1873/2126)[a]	84.4% (1627/1927)[a]	77.6% (287/370)[a]	74.6% (340/456)[a]
Review	3.1% (67/2126)[c]	4,6% (89/1927)[c]	13.8% (51/370)[b]	1.7% (49/456)[b]
Case report	8% (171/2126)[b]	9,3% (180/1927)[b]	7.8% (29/370)[b]	13.2% (60/456)[b]
Other	0.7% (15/2126)[d]	1,6% (31/1927)[d]	0.8% (3/370)[c]	1.5% (7/456)[c]
p	0.000***	0,000***	0.000***	0.000***
Number of Authors				
1-3	39.7% (843/2126)[b]	28.9% (556/1927)[b]	44.3 % (164/370)[b]	30.9% (141/456)[a]
4-	60.3% (1282/2126)[a]	71.1% (1371/1927)[a]	55.7% (206/370)[a]	69.1% (315/456)[a]
p	0.000***	0,000***	0.000***	0.59
Origin				
United States/Canada	20.3% (432/2126)[b]	18.6% (359/1927)[c]	14.9% (55/370)[b,c,d]	10.1% (46/456)[c]
European Union	30.1% (639/2126)[a]	29.2% (563/1927)[a]	16.8% (62/370)[b]	21.5% (98/456)[b]
Non-European Union	12.1% (257/2126)[c]	9.1% (175/1927)[d]	8.6% (32/370)[d]	14% (64/456)[b,c]
Asia/Oceania	23.1% (491/2126)[b]	23.8% (458/1927)[b]	44.1% (163/370)[a]	43.4% (198/456)[a]
Other	14.4% (307/2126)[c]	19.3% (372/1927)[c]	15.7% (58/370)[b,c]	11% (50/456)[c]
p	0.000***	0.000***	0.000***	0.000***
Main affiliation				
Orthodontic	72% (1530/2126)[a]	68.6% (1322/1927)[a]	72.2% (267/370)[a]	70.4% (321/456)[a]
Non-orthodontic	17.3% (370/2126)[b]	21% (404/1927)[b]	23.5% (87/370)[b]	23.5% (107/456)[b]
Non-academic	10.6% (226/2126)[c]	10.4% (201/1927)[c]	4.3% (16/370)[c]	6.1% (28/456)[c]
p	0.000***	0.000***	0.000***	0.000***
Number of affiliations				
1-3	94.1% (1999/2126)[a]	90% (1735/1927)[a]	83.8% (310/370)[a]	80.3% (366/456)[a]
4--	5.9% (127/2126)[b]	10% (192/1927)[b]	16.2% (60/370)[b]	19.7% (90/456)[b]
p	0.000***	0.000***	0.000***	0.000***

Different letters indicate statistically significant differences between periods (table columns; p<0.05)
SCI: Science Citation Index Orthodontic Journals; SCIE: Science Citation Index Expanded Journals; p: statistical significance

Table 3. Article type, origin, main affiliation, number of publications, authors, and affiliations per time interval

	SCI 2006-2010 Share, %	SCI 2011-2015 Share, %	SCIE 2006-2010 Share, %	SCIE 2011-2015 Share, %	p
Article Type					
Research	45.4% (1873/4127)[a]	39.42% (1627/4127)[b]	7% (287/4127)[c]	8.2% (340/4127)[c]	0.000***
Review	26.2% (67/256)[a,b]	34.8% (89/256)[b]	19.9% (51/256)[a]	19.1% (49/256)[a]	0.000***
Case report	38.9% (171/440)[a]	40.9% (180/440)[a]	6.6% (29/440)[b]	13.6% (60/440)[c]	0.000***
Other	26.8% (15/56)[a]	55.4% (31/56)[b]	5.4% (3/56)[c]	12.5% (7/56)a,[c]	0.000***
Number of Authors					
1-3	49.5% (843/1704)[a]	32.6% (556/1704)[b]	9.6% (164/1704)[c]	8.3% (141/1704)[c]	0.000***
4--	40.4% (1282/3174)[a]	43.2% (1371/3174)[a]	6.5% (206/3174)[b]	9.9% (315/3174)[c]	0.000***
Origin					
United States/Canada	48.4% (432/892)[a]	40.2% (359/892)[b]	6.2% (55/892)[c]	5.2% (46/892)[c]	0.000***
European Union	46.9% (639/1362)[a]	41.3% (563/1362)[b]	4.6% (62/1362)[c]	7.2% (98/1362)[d]	0.000***
Non-European Union	48.7% (257/528)[a]	33.1% (175/528)[b]	6.1% (32/528)[d]	12.1% (64/528)[c]	0.000***
Asia/Oceania	37.5% (491/1310)[a]	35% (458/1310)[a]	12.4% (163/1310)[b]	15.1% (198/1310)[b]	0.000***
Other	39% (307/787)[b]	47.3% (372/787)[a]	7.4% (58/787)[c]	6.4% (50/787)[c]	0.000***
Main affiliation					
Orthodontic	44.5% (1530/3440)[a]	38.4% (1322/3440)[b]	7.8% (267/3440)[c]	9.3% (321/3440)[c]	0.000***
Non-orthodontic	38.2% (370/967)[a]	41.8% (404/967)[a]	9% (87/967)[b]	11.1% (107/967)[b]	0.000***
Non-academic	48% (226/472)[a]	42.7% (201/472)[a]	3.4% (16/472)[b]	5.9% (28/472)[b]	0.000***
Number of affiliations					
1-3	45.3% (1999/4410)[a]	39.3% (1735/4410)[b]	7% (310/4410)[c]	8.3% (366/4410)[c]	0.000***
4--	26.9% (127/469)[b]	41% (192/469)[a]	12.8% (60/469)[d]	19.2% (90/469)[c]	0.000***

Different letters indicate statistically significant differences between periods (table columns; p<0.05)
SCI: Science Citation Index Orthodontic Journals; SCIE: Science Citation Index Expanded Journals; p: statistical significance

in orthodontics departments. Articles with ≤3 affiliations comprised 90% of articles listed in SCI and 80% of those listed in SCIE. The findings for the second period are presented in Table 2.

Differences between the First and Second Periods

Although the number of research articles decreased in the journals listed in SCI and showed no significant difference compared with those listed in SCIE, the highest rate of research articles was found in the journals listed in SCI in the first period (45.4%). There was no significant difference in the rate of reviews published in the journals listed in SCI or SCIE. Case reports showed a significant increase in the journals listed in SCIE. Other types of articles showed a significant increase in the journals listed in SCI in the second period.

In the second period, there was a decrease in the number of articles with ≤3 authors in the journals listed in SCI, whereas the number of articles with >3 authors increased in the journals listed in SCIE.

In the journals listed in SCI, the rate of articles from the United States/Canada, European Union, and non-European Union origins decreased, whereas there was no significant difference in the rate of articles from Asia/Oceania in the second period compared with the first period. However, the rate of articles from other countries significantly increased in the second period compared with the first period. In the journals listed in SCIE, there was an increase in the rate of articles from the European Union, whereas a decrease in articles from the non-European origin in the second period compared with the first period was noted. However, no significant difference was detected in the rate of articles from the Unites States/Canada, Asia/Oceania, and other origins.

Although there was a decrease in the articles from orthodontics department published in the journals listed in SCI during the second period, the rate of articles from orthodontics department was the highest in the journals listed in SCI and SCIE during both periods. The rate of articles with ≤3 affiliations decreased in the journals listed in SCI during the second period, whereas an increase was detected in the articles with >3 affiliations in the journals listed in SCI and SCIE.

DISCUSSION

Bibliometric analyses can be helpful regarding access to the information and classification of studies (14). The reputation of a journal can be assessed by several methods including the citation index or impact factor (15). Although the citation index has not been accepted as a measurement of quality or importance, it is accepted as a measurement of recognition (11). In recent years, there is a considerable increase in studies about bibliometrics and citation analyses in orthodontics (4, 7, 8, 14, 16, 17). We aimed to identify how characteristics of articles published in the orthodontics journals listed in SCI and SCIE during previous 10 years (2006-2015) changed using bibliometric analysis and to guide researchers with their investigations.

In a longitudinal study comparing three major orthodontics journal (AJODO, AO, and EJO) during a 10-year period (1998-2002 and 2008-2012), it was found that the rate of articles from the nonEuropean origin was 2-fold higher than those from other origins in all reviewed journals in during both periods (5). In our study, it was found that the rate of articles accepted from the European Union was the highest by the journals listed in SCI, whereas the rate was highest for those accepted from Asia/Oceania by the journals listed in SCIE in both the periods. It can be suggested that the origin of articles published in orthodontics journals listed in SCI shifted from non-European to European Union origin during the last decade.

In our study, it was found that the orthodontics department mainly contributed to the publications in both periods and types of journals. Baumgartner et al. (5) found that the majority of articles published in three major orthodontics journals listed in SCI were from the orthodontics department during 1998-2002 and 2008-2012.

In the journals listed in SCI and SCIE, the articles with a higher percentage in the first period and >3 authors showed a further increase in the second period. Today, multidisciplinary and interdisciplinary approaches are preferred in terms of scientific improvement and producing high-quality studies. Thus, the number of authors in an article increases (18). Coauthorship will not only provide different perspectives but also help to minimize potential errors. In particular, collaboration of inexperienced researchers with experienced ones will contribute to the quality of future studies (19). Current orthodontic literature interacts with other fields of science, such as biology, otorhinolaryngology, and engineering (20). In our study, the higher rate of articles with ≤3 affiliations in both periods and types of journals indicates that the accepted articles were conducted with the common effort of authors in the same facility. In the second period, the number of studies with >3 affiliations increased in parallel to the increase of the number of authors. The increased number of scientists with multi-country affiliations might be related to the different disciplines (sciences, biology, otorhinolaryngology, and engineering), cross-appointed faculty or researchers, with multi-country affiliations (20).

Gibson et al. found that 42.6% of all clinical studies published in Journal of Orthodontics and EJO between 1999 and 2008 were case reports or case series (17). McDermott et al. (21) reported that the rate of case reports decreased from 30% to 4% in medical journals in the last two decades, whereas Tulloch et al. (22) stated that the most common type of clinical trials was the longitudinal or cross-sectional research. We also found that the research article was the most common type published in the orthodontic journals listed in SCI and SCIE in both periods. No significant difference was detected regarding the type of articles accepted between the first and second periods, whereas it was found that the number of case reports increased in the orthodontics journals listed in SCIE in the second period. It can be suggested that the fact that the journals that mainly accept research articles for publication have attenuated the motivation of the researchers to perform reviews or case reports. Case reports and series are studies assessing the diagnosis and treatment of diseases, defining interesting findings, and providing treatment protocols. Considering that case reports and series supported by literature data and visual materials are helpful to the researchers and clinicians at the beginning of their academic careers, it will be more beneficial to feature case reports in journals more frequently (23, 24).

CONCLUSION

- In our study, it was found that there were significant differences in the characteristics of articles, such as type of article, number of authors, origin of article, main affiliation of authors, and number of affiliations, which were published in the orthodontics journals listed in SCI and SCIE in 2006-2010 and 2011-2015. In the journals listed in SCI, articles from the United States/Canada, European Union, and non-European Union origins significantly increased in the second interval. In the second interval, fewer articles from the non-European countries but more publications from the European Union countries were found in the journals published in SCIE. In both periods, Asia/Oceania was the most common origin among articles accepted by the journals listed in SCIE.
- Research articles were the most commonly published article type in the journals listed SCI and SCIE in both periods, and these journals mainly published studies conducted by orthodontics with academic affiliation. The highest rate of research articles were observed in the journals listed in SCI in the first period.
- In the second period, the articles with >3 affiliations were increased in the journals listed in SCI and SCIE. The percentage of articles from orthodontics department was the highest in all journals during both periods.

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

Peer-review: Externally peer-reviewed.

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ORIGINAL ARTICLE

Assessment of the Quality of Life in Moroccan Patients Undergoing Orthognathic Surgery

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ABSTRACT

Objective: Dentofacial deformities can affect patient "quality of life" (QoL), and orthognathic surgery can improve this QoL. The aim of the present study is to assess changes in QoL in Moroccan adult patients with dentofacial deformities undergoing orthodontic surgical treatment.

Methods: 32 patients (21 females and 11 males; mean age 27±5.96 years) completed a specific questionnaire of QoL once the surgical phase is completed. The questionnaire includes 22 questions marked on a 4-point scale depending on how much the question covered by the statement disturbs the respondent. The 22 questions contribute to four aspects: social aspects of dentofacial deformities, facial aesthetic, oral function, and awareness of dentofacial aesthetics.

Results: A significant difference in QoL was observed before surgery between men and women. On the other hand, 73.6% stated of patients said that they were uncomfortable by their dentofacial appearance before surgery, and almost half of the patients have made functional limitations before surgery. After surgery, 85.42% of patients reported a positive change in their QoL. Class III patients reported greater pre-surgical aesthetic and functional restrictions than Class II skeletal patients. In post-surgery, patients in both skeletal classes showed significant improvement in their QoL, so improving the aesthetics, oral functions and self-confidence are the main motivators to seek orthognathic treatment for our patients.

Conclusion: Improving the aesthetics, oral functions and self-confidence are the main motivators to seek orthognathic treatment for Moroccan patients.

Keywords: Quality of life, satisfaction, orthodontics, orthognathic surgery

INTRODUCTION

The notion of the "quality of life" (QoL) was defined by the World Health Organization (1993) as the perception of people in terms of their situation in life, in the cultural context, and in values with whom they live according to their objectives, expectations, models, and concerns (1). QoL is essentially a subjective concept that cannot be judged by others. It is a broad concept that has been affected in a complex way by physical health, psychological state, level of independence, social relations, personal beliefs, and their relation to the specificity of their environment (2).

The issue of QoL is attracting increasing interest from many researchers. It is a concept that groups together different areas of life and is strongly subject to individual experiences. This QoL is defined as a sense of well-being associated with satisfaction or dissatisfaction in the important aspects of individual life (3).

Even though hardware tools can measure QoL, it is accessible to other means of evaluation questionnaires. This QoL is open from different angles, that is, psychological well-being, ability to function properly, participation in different aspects of life, quantity and quality of relationships with other people, and physical conditions (4-6).

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In 2000, Cunningham et al. (7, 8) have developed a self-assessment questionnaire especially in response to the inadequacy of existing instruments to measure QoL of patients with severe dentofacial skeletal malformations and 22 questions on QoL. Orthognathic surgery was consolidated by a 4-point scale as part of a development phase and complex validation.

The planning and the results of orthognathic surgery must be compatible with the objectives and normative values, which may differ from the perceived improvement in patients after surgery and overall QoL (8).

Over the years, studies have shown that most patients with dentofacial deformities seek treatment to improve facial and dental aesthetics (9). In addition, some studies report that the primary motivation includes improvements in masticatory function rather than changes in appearance (10).

Patients also seek treatment in order to obtain psychosocial benefits including improvements in relationships and psychological well-being through improving their self-esteem (11).

Hence, the aim of the present study was to assess the changes of QoL in patients undergoing orthognathic surgery for the correction of skeletal malformations. Furthermore, the study intended to improve the ability of clinicians to explicitly analyze the perceptions of patients in improving QoL in orthognathic surgery.

METHODS

The protocol of our study has been validated and approved by the ethics committee of our institution. Patient consent for the present study was obtained from all patients. The questionnaires were distributed to 32 patients when surgical phase has been completed, and all questionnaires were returned and fully completed.

Patients

All subjects who fulfilled the following criteria were approached and asked to participate in the study:

- patients over 18 years,
- patients who will benefit from orthodontic and surgical treatment for maxillo-mandibular disharmony regardless of severity,
- patients undergoing orthognathic surgery (osteotomy of the maxillary and/or mandibular osteotomy).

Patients with clefts, specific syndromes, and facial deformities due to trauma or congenital malformation were not included. All subjects were asked to complete the condition specific questionnaire (QoL) (7).

Questionnaires

The Orthognathic Quality of Life Questionnaire (OQLQ) consists of two parts. The first part contains the general and specific information of the patient: age, gender, occupation, type of skeletal abnormality, and type of surgery performed. The second part consists of 22 questions with a 4-point scale rating according to how much the issue covered by the question bothers the respondent.

The 22 items contribute to four sections: social aspects of dentofacial deformities (questions 15-22), facial aesthetics (questions 1, 7, 10, 11, and 14), oral function (questions 2-6), and awareness of dentofacial aesthetics (questions 8, 9, 12, and 13).

Before providing answers regarding the pre-surgical part, the patient was asked to see his or her photos before surgery in order to remember facial condition as all the questionnaires were distributed after the surgical phase of the treatment has been achieved.

Statistical Analysis

Analysis of data was carried out using the statistical software Excel 2010 and EPI version 7.1.3.10. The descriptive analysis with Pearson's chi-square test was used to compare the different cohort categories of patients (age, sex, type of skeletal abnormality, and type of surgery) before and after surgery and also to compare inter-sex results, inter-classes of abnormality, and different types of surgery. A p value of less than 0.05 is considered as statistically significant.

RESULTS

All of the questionnaires distributed to the patients were filled out in their entirety. No one remarked that they had been unable to or inadequately understand the questions. Thirty-two patients (21 females and 11 males) with a mean age of 27±5.96 years completed the study. Skeletal class II was present in 25% of surveyed patients, whereas skeletal class III in 75% of main patients. A total of 6.25% of patients underwent surgery only in the upper jaw and 31.25% underwent surgery of the lower jaw, whereas a bimaxillary surgery was carried out in 62.5% of our patients (Table 1).

Table 1. Distribution of age, gender, occupation, skeletal abnormality, and type of surgery realized among sample patients (n=32)

		Frequency n=32	Percentage
Age	Mean+SD	27±5.96	
	Range	19-43	
	≤27 years	17	53.40%
	>27 years	15	47.60%
Gender	Female	21	65.60%
	Male	11	34.40%
Occupation	Student	12	37.50%
	Employee	15	46.88%
	Other	5	15.62%
Abnormality	Class II	8	25%
	Class III	24	75%
Surgery	Upper jaw	2	5.25%
	Lower jaw	10	31.25%
	Both	20	62.50%

Table 2. Percentage of orthodontists/residents who responded to questions regarding infection control procedures according to the place of work

	1: Bothers you a little +				2 ++				3 +++				4: Bothers you a lot ++++				N/D: The statement does not apply to you or does not bother you at all				
	Before		After		Before		After		Before		After		Before		After		Before		After		
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	p
Question 1	4	12,50	12	37,50	6	18,80	2	6,30	8	25,00	1	3,10	12	37,50	0	0,00	2	6,30	17	53,10	0,332
Question 2	4	12,50	12	37,50	5	15,60	4	12,50	11	34,40	1	3,10	9	28,10	1	3,10	3	9,40	14	43,80	0,737
Question 3	5	15,60	10	31,30	5	15,60	4	12,50	11	34,40	1	3,10	8	25,00	1	3,10	3	9,40	16	50,00	0,822
Question 4	5	15,60	12	37,50	8	25,00	3	9,40	10	31,30	1	3,10	5	15,60	0	0,00	4	12,50	16	50,00	0,095
Question 5	8	25,00	9	28,10	8	25,00	2	6,30	7	21,50	2	6,30	5	12,50	0	0,00	5	15,60	19	59,40	0,174
Question 6	13	40,60	9	28,10	5	15,60	8	25,00	2	6,30	1	3,10	2	6,30	0	0,00	10	31,30	14	43,80	0,001
Question 7	3	9,40	5	15,60	1	3,10	1	3,10	3	9,40	0	0,00	22	68,80	0	0,00	3	9,40	26	81,30	0,464
Question 8	3	9,40	9	28,10	9	28,10	1	3,10	4	12,50	2	6,30	11	34,40	9	28,10	5	15,60	11	34,40	0,005
Question 9	5	15,60	8	25,00	7	21,90	3	9,40	7	21,90	3	9,40	9	28,10	6	18,80	4	12,50	12	37,50	0,517
Question 10	3	9,40	9	28,10	2	6,30	1	3,10	4	12,50	0	0,00	17	53,10	0	0,00	6	18,80	22	68,80	0,425
Question 11	4	12,50	10	31,30	2	6,30	1	3,10	4	12,50	0	0,00	16	50,00	0	0,00	6	18,80	21	65,60	0,533
Question 12	6	18,80	8	25,00	2	6,30	7	21,90	14	43,80	2	6,30	5	15,60	0	0,00	5	15,60	15	46,90	0,004
Question 13	5	15,60	9	28,10	1	3,10	6	18,80	12	37,50	1	3,10	7	21,90	0	0,00	7	21,90	16	50,00	0,053
Question 14	3	9,40	4	12,50	3	9,40	0	0,00	1	3,10	0	0,00	22	68,80	1	3,10	3	9,40	27	27	0,533
Question 15	5	15,60	4	12,50	6	18,80	0	0,00	6	18,80	0	0,00	6	18,80	0	0,00	9	28,10	28	87,50	0,371
Question 16	4	12,50	7	21,90	3	9,40	2	6,30	8	25,00	0	0,00	9	28,10	0	0,00	8	25,00	23	71,90	0,345
Question 17	3	9,40	7	21,90	3	9,40	2	6,30	8	25,00	0	0,00	10	31,30	0	0,00	8	25,00	23	71,90	0,599
Question 18	4	12,50	8	25,00	5	15,60	5	15,60	9	28,10	2	6,30	6	18,80	0	0,00	8	25,00	17	53,10	0,260
Question 19	2	6,30	5	15,60	5	15,60	0	0,00	6	18,80	2	6,30	12	37,50	0	0,00	7	21,90	25	78,10	0,796
Question 20	4	12,50	6	18,80	4	12,50	1	3,10	8	25,00	0	0,00	11	34,40	0	0,00	5	15,60	25	78,10	0,559
Question 21	5	15,60	8	25,00	3	9,40	3	9,40	10	31,30	6	18,80	10	31,30	0	0,00	4	12,50	15	46,90	0,022
Question 22	3	9,40	10	31,30	2	6,30	2	6,30	9	28,10	1	3,10	10	31,30	0	0,00	8	25,00	19	59,40	0,317

Absolute and relative frequency distributions of the responses to questions 1-22 are presented in Table 2.

Twenty patients reported that they dislike the appearance of their teeth. More than half of all patients felt very limited by dentofacial deformity when they are biting and chewing. A total of 46.9% of patients said that they avoid foods often or very often (question 4). At least 34% of patients reported restrictions in eating in public because of malocclusion (question 5). The degree of perception of aesthetic impairment (question 14) was negative for 71.9% of patients. A total of 56% of patients reported that they avoid smiling when they meet people. A total of 65.6% of patients said that they hated taking pictures (question 10), and 62.5% reported that they hated being taken in videos (question 11). However, only 12.6% of patients complained of pain in the face or jaw (question 6).

After surgery treatment, 85.42% of patients reported positive changes in their QoL. In fact, 84.40% of patients said that they are not bothered anymore by the appearance of their faces (question 14), whereas 87.50% claimed that they do not cover their mouths any more when they meet people for the first time (question 15). A very large percentage of patients said that they do not lack confidence when they are in a social environment and that they always smile when they meet people (questions 19 and 20 with 78.10%). A total of 81.30% of patients said that it does not bother them to see a side view of their face (question 7). However, 46.90% still spend a lot of time studying their faces and teeth in the mirror (questions 8-9). On average, before surgery, female patients were more likely to say that they avoided taking photos, pictures, or videos owing to their appearance or were most hurt by remarks about their appearance. Regarding patients questioned after surgery, a significant percentage of female patients said that they spend a lot of time studying their faces in the mirror after surgery.

The difference in frequency distribution before and after surgery of class III patients showed significant improvement in the assessment of facial aesthetics.

The comparison between responses to questions between class II and III patients before surgery shows that class III patients reported more restrictions than class II patients. Whatever type of surgery (uni or bimaxillary surgery), patients did not show significant differences in their answers to questions before surgery. Furthermore, patients who underwent bimaxillary

Table 3. Mean (M) and standard deviation (SD) in the four categories

	Our study (n=32)		Cunningham et al. (8) (n=65)		Bock et al. (10) (n=50)	
	M	SD	M	SD	M	SD
Function	6.60	1.13	8.23	5.51	12.08	5.63
Aesthetics	11.51	7.67	13.27	5.92	11.48	5.48
Social aspects	7.17	2.35	15.07	10.39	14.73	8.94
Awareness of dentofacial deformity	6.59	1.95	7.20	5.40	9.86	3.81

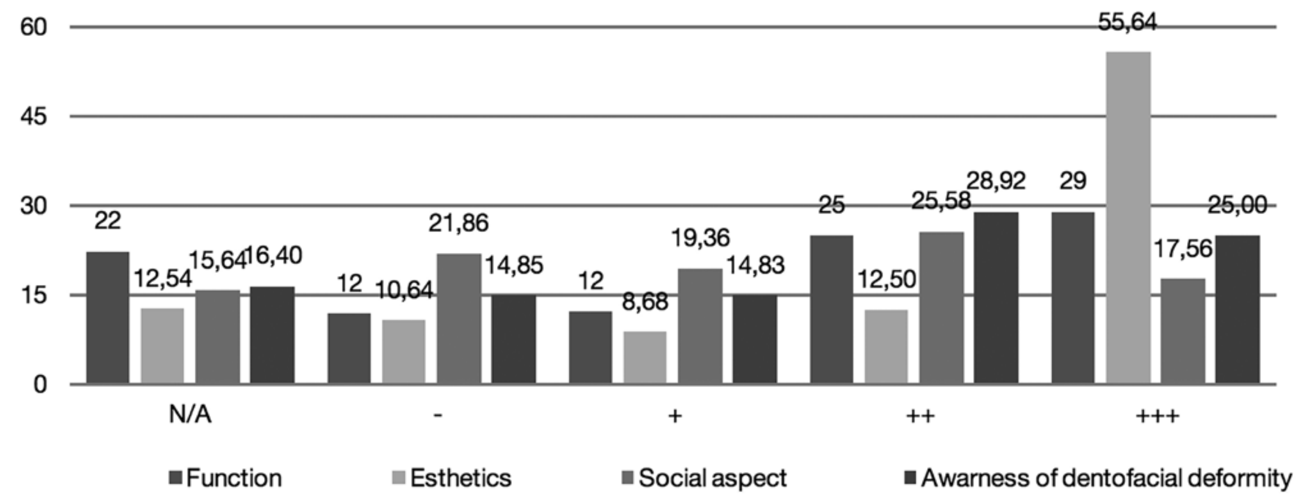

Figure 1. Summary of responses before surgery in four categories. Average frequency in %. Scale ranges from not bothered (-) to bothered a lot (+++)

surgery did not report significantly different functional restrictions. No statistical differences were apparent in the responses to questions after surgery.

As suggested by Cunningham et al. (7), we have grouped the responses of patients before and after surgery into four categories:

- the social aspects of dentofacial deformity (questions 15-22),
- the facial aesthetics (questions 1, 7, 10, 11, and 14),
- the oral functions (questions 2-6),
- the awareness of dentofacial aesthetics (questions 8, 9, 12, and 13).

In Table 3, the average values of the four categories of our study showed increasing satisfaction especially for aesthetic.

DISCUSSION

Measuring QoL for the evaluation of health care is a growing field with more than 1000 new items every year, indexed under the term "quality of life" (12). The researchers found that the outcomes of patient-based healthcare measures, including QoL, are a very important contribution, unlike traditional measures that are not relevant to the patient (13). When oral health is compromised, health and overall QoL may be affected. 14).

The QoL tests integrate in a single point different physical, social, psychological, emotional, or spiritual criteria. We distinguish between generic tests and specific tests. Currently in the field of dentistry, the best known of these measures is the impact of the profile on oral health or the oral health impact profile, which was designed for patients to determine the perception of the social impact of oral diseases. Other instruments include the social impact of dental diseases, which was one of the first socio-dental indicators; index of geriatric/general assessment of oral health (General Oral Health Assessment Index and Dental Impact Profile) (15). Cunningham et al. (7, 8) used a stepwise process to develop the questionnaire used in our study. In their first study, their questionnaire demonstrated a high level of validity and reliability (16). They produced a more specific evaluation for patients undergoing orthognathic surgery by comparing two general questionnaires evaluating QoL (Short-Form Health Survey, EuroQol) (7).

Patients with severe dentofacial deformities may require an orthognathic surgical approach in addition to orthodontic treatment. Improving QoL is one of the objectives of this form of intervention. Patients requiring this form of treatment are generally young and fit, which limits the relevance of existing instruments. This was the basis for the development of a questionnaire specifically designed for this group of patients. This instrument is known as OQLQ (7).

Our study was a retrospective study for the assessment of QoL in patients undergoing orthognathic surgery for the correction of skeletal malformations with a sample of 32 patients. This is

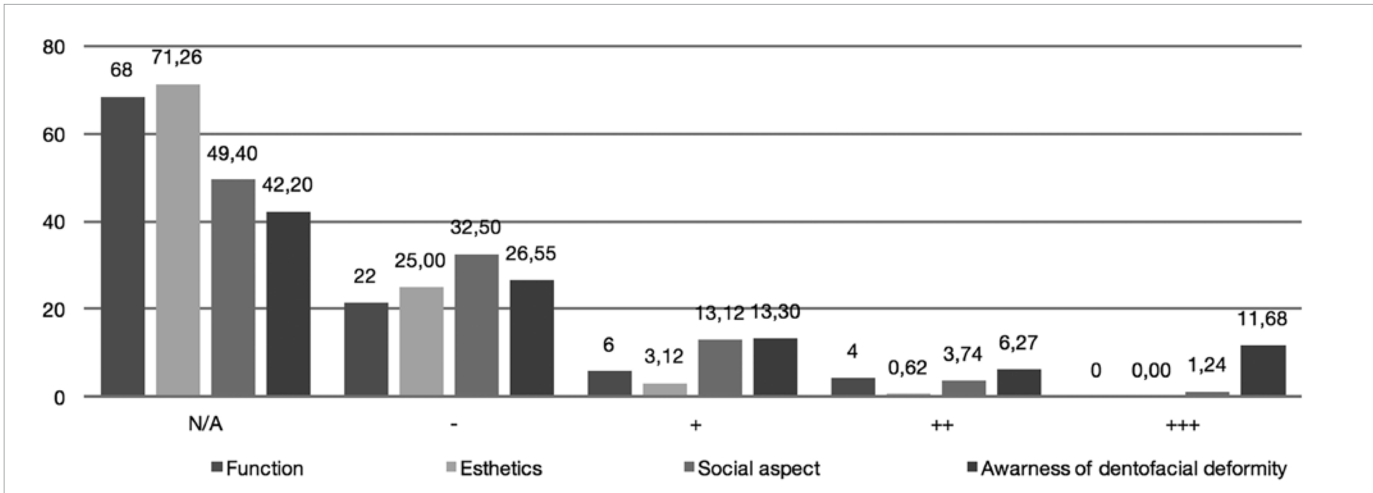

Figure 2. Summary of responses after surgery in four categories

justified by the difficulty of accepting this treatment modality in our socioeconomic and cultural context and also because of the disparity of the periods of care and the treatments between the different orthodontists. On the other hand, a prospective longitudinal study with an evaluation at the beginning and the end of the treatment would have been more relevant. Furthermore, no similar studies have been conducted at the national level.

Our sample included more women than men. Several authors reported similar gender distribution, offering also a reason that female patients were more likely to perceive a skeletal malocclusion as an aesthetic compromise (17). Therefore, Kroger et al., (18) and Schmidt et al. (6) are more motivated to follow the treatment (19). Studies also show that women tend to give greater priority to the aesthetics and are more likely to feel disabled by compromised appearance than men owing to the need to meet certain expectations, be attractive, and take into account characteristics such as prestige, usability, and intelligence in our society. (20, 21). Furthermore, in our study, female patients showed a better satisfaction after surgery than male patients unlike in the study of Emadian et al. (22) who found a similar satisfaction score in males and females and concluded that QoL was not related to gender.

The potential of orthodontic surgery to improve facial aesthetics, orofacial functions, and psychological well-being was reported in several studies. These results are essential because the orthodontic surgical treatment is complex and expensive. In the present study, patient demand for orthognathic surgery appears to be largely related to the desire to improve their physical and facial appearance. Thus, 73.6% of patients reported that they are embarrassed by their dentofacial aesthetics. Previous studies revealed that the motivations of patients seeking treatment were mainly related to appearance and self-image rather than functional reasons (16, 23, 24). In 2005, Sadek and Salem (25) conducted a study of 114 Egyptian patients. The present study showed that 95% of patients have shown that improving the appearance and facial aesthetics was the main objective for their choice of orthognathic surgical treatment, against 6% of patients for functional problems. In 2008, Al-Ahmad et al. (26) achieved a satisfaction survey of 38 patients who underwent an orthognathic surgical treatment at the university hospital in Amman, Jordan. A total of 50% of patients reported that dissatisfaction with their aesthetic appearance was the main reason for seeking treatment, 42.1% mentioned a combination of aesthetic and functional problems, and only 7.9% for functional reasons.

In our study, patients with abnormal skeletal class III showed greater aesthetic and functional impairment prior to surgery patients as class II. Furthermore, their postoperative satisfaction showed no significant difference. The type of malocclusion is related to the perception by patients of their own attractiveness. Cunningham et al. (27) reported that the patient's perception of his malocclusion was a significant predictor of body image. In the study by Johnston et al. (28) including 162 patients, 95 with Class II and 67 with Class III, 67.97% of Class II subjects and 86% of Class III subjects wanted to improve their appearance. This difference was statistically significant. Indeed, older patients, female patients, and Class III patients were less likely to be satisfied with their profiles.

Patients with Class III skeletal malocclusion had more negative preoperative opinions about their own attractiveness and self-confidence than patients with Class II skeletal malocclusion (29). Postoperatively in the study of Espeland et al. (30), patients with both Class II and Class III anomalies reported improvement of their attractiveness and self-confidence, with a noticeable improvement in Class III patients. The results agree well with those of our study.

Bock et al. (10), and Cunningham et al. (8) have observed considerable restrictions on QoL (Table 3) in their patients' follow-up study before orthognathic surgery. The average values for the four categories were similar to the results of our study. Although data vary widely, the relationships are generally similar. Our patients were more likely to complain about the aesthetic appearance of their face, whereas the oral functions and social aspects appeared less important for our patients, unlike the study of Abdullah (31) who concluded that the social aspects domain was shown to be more important for patients than facial aesthetics and oral function. In 2003, Motegi et al. (32) used a specific questionnaire on QoL with a 7-point scale and observed a primarily aesthetic restriction, as opposed to functional reasons in 93 patients.

To study QoL in patients with dentofacial disharmony, various approaches have been undertaken, but a consensus on a standard method of assessing is not yet established, and limited responsiveness of generic measure to assess oral diseases stresses the importance of developing specific QoL measures to oral conditions. (33).

CONCLUSION

At the end of our work, we can conclude that:

- The study of the relationship between maxillofacial disharmony and the patient's QoL in Moroccan patients is of major interest.
- Moroccan women give greater priority to their dentofacial aesthetics owing to an increased need to meet certain social requirements.
- Moroccan patient's demand for orthodontic surgical treatment is largely linked to the desire to improve their physical and facial appearance.
- Patients with Class III skeletal abnormalities had greater aesthetic and functional impairment than patients with Class II skeletal abnormalities.
- Orthodontic surgical treatment has a positive impact on QoL of Moroccan patients.

Ethics Committee Approval: Ethics committee approval was received for this study from the Ethics committee of the Casablanca School of Dentistry.

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

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - L.O.; Design - L.O.; Supervision - L.O.; Resources - L.O., L.E.; Materials - L.O., L.E.; Data Collection and/or Processing - L.O., L.E.; Analysis and/or Interpretation - L.E.; Literature Search - L.E.; Writing Manuscript - L.E.; Critical Review - L.O.

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REVIEW

Three-Dimensional Imaging in Orthodontics

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ABSTRACT

Orthodontic records are one of the main milestones in orthodontic therapy. Records are essential not only for diagnosis and treatment planning but also for follow-up of the case, communicating with colleagues, and evaluating the treatment outcomes. Recently, two-dimensional (2D) imaging technology, such as cephalometric and panoramic radiographs and photographs, and plaster models were routinely used. However, after the introduction of three-dimensional (3D) technologies (laser scanner, stereophotogrammetry, and computed tomography) into dentistry, 3D imaging systems are more and more commonly preferred than 2D, especially in cases with craniofacial deformities. In fact, 3D imaging provided more detailed and realistic diagnostic information about the craniofacial hard as well as soft tissue and allowed to perform easier, faster, and more reliable 3D analyses. The purpose of this review is to provide an overview of the 3D imaging techniques, including their advantages and disadvantages, and to outline the indications for 3D imaging.

Keywords: Three-dimensional, imaging, orthodontics, laser scanner, stereophotogrammetry, computed tomography

INTRODUCTION

Orthodontic records are one of the main milestones in orthodontic therapy. Records are essential not only for diagnosis and treatment planning but also for follow-up of the case, communicating with colleagues, and evaluating the treatment outcomes. Recently, two-dimensional (2D) imaging technology, such as cephalometric and panoramic radiographs and photographs, and plaster models were used routinely. However, there are some limitations of 2D imaging systems as significant amount of radiographic projection error, enlargement, distortion, exposure to radiation, weaknesses of landmark identification, inaccurate duplication of measurements, significant variation in the position of reference points, such as sella turcica, and extreme limitations in assessing soft tissue balance (1). When the clinician uses 2D imaging to view three-dimensional (3D) anatomical craniofacial structures, some cephalometric structures and landmarks that do not exist in the patient appear such as mandibular symphysis, articulare, pterygoid fossa, and "key ridges." Averaging bilateral structures (such as the right and left inferior borders of the mandible) to create a unified anatomic outline (mandibular plane) results in loss of parasagittal information and, if present, asymmetry of the patient. In summary, 2D imaging systems are not able to overcome the fact that reduction of a 3D object to a 2D view will cause data loss (2).

After the introduction of 3D imaging systems, it was possible to evaluate structures in real three anatomical dimensions. In addition, not only the hard but also the soft tissues of the craniofacial region can be observed in three dimensions. These new systems have several other advantages. First, most of these systems are non-invasive, and, therefore, repeat of images are not of ethical matter. Second, all images may also be stored in digital forms, consequently archiving is much more practical, and extra space need for storage is handled in this way. The development of software programs enables to precisely and reliably analyze the 3D data. Furthermore, thanks to opportunities such as zooming and rotation function, software programs are really user-friendly (3, 4).

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Table 1. Comparison of cost, radiation dose, and indications of 3D imaging systems

Imaging techniques	Cost	Radiation dose	Indications
CBCT	High	Dentoalveolar 11-674 µSv	Craniofacial deformities (other indications with caution)
		Maxillofacial 30-1073 µSv	
Laser scanner	High	Non-invasive	May be recommended in every patient
Stereophotogrammetry	High	Non-invasive	May be recommended in every patient
MRI	High	Non-invasive	Airway assessment
Intraoral scanner	High	Non-invasive	May be recommended in every patient

Table 2. Comparison of 2D and 3D imaging systems

Imaging techniques	Effective dose (µSv)	Cost
Periapical radiograph	<1.5*	X
Panoramic radiograph	2.7-24.3	2X
Cephalometric radiograph	<6	2X
CBCT		
Dentoalveolar CBCT	11-674 (61)	
Maxillofacial CBCT	30-1073	10-20X
MSCT maxillo-mandibular	280 - 1410	10-20X

3D imaging systems are especially favorable for patients with craniofacial syndromes and anomalies such as cleft lip and palate (CLP) (Table 1). This patient group is frequently treated for a long period starting in infancy and not finishing until adulthood, undergoes several surgeries, and requires treatment from specialists of several disciplines or, in other words, interdisciplinary approaches.

The treatment plans have to involve the dentition, the hard tissue jaw position, as well as the facial bone position, and the covering soft tissue. Although the Eurocleft and Americacleft studies proposed documentation at certain time periods, the guidelines are based on 2D records except the 3D dental casts. However, more and more studies have been published about the introduction, the advantages over 2D, and the indications of 3D imaging systems of craniofacial patient treatment teams. However, compared with 2D systems, the cost and also radiation dose of some of these 3D imaging systems are high and should be considered by the specialists before indicating (Table 2). Therefore, the aim of the present review is to summarize the 3D imaging system in daily orthodontic practice and to emphasize the indication areas especially in patients with craniofacial anomalies.

To be able to understand 3D imaging systems, some of the terminology should be familiarized. There are two axes (the vertical and the horizontal axes) in 2D images. In 3D images, the Cartesian coordinate system is used, and it consists of the x-axis (or the transverse dimension), y-axis (or the vertical dimension), and the z-axis (the anteroposterior dimension "depth axis"). There are several steps in generating 3D models. The first one is "modeling". Mathematics is used in this step in order to describe the physical properties of an object. After this step, the modeled object is called as a "wireframe" (or a "polygonal mesh").

In the modeling procedure, surface is added to the object by placing a layer of pixels. This is called "image" or "texture mapping". In the second step, to bring more realism to the 3D object, some shading and lighting is applied. "Rendering" is the final step. The anatomical data collected from the patient are converted into a lifelike 3D object by the computer, and it can be viewed on the computer screen (5).

3D imaging methods can be summarized as follows:

- conventional computed and cone-beam computerized tomography (CT/CBCT)
- laser scanning (3D laser scanning)
- vision-based scanning techniques
- 3D orthognathic surgery planning
- intraoral scanning
- magnetic resonance imaging (MRI) and surface scanning
- video camera (four-dimensional (4D) imaging and video stereophotogrammetry).

CT

CT, also named computerized axial tomography, consists of a 3D view using cross-sectional images of the body. This scan contains 3D information about especially hard but also soft tissues. Tomography is divided into fan beam and CBCT. Traditional tomography is fan beam tomography and has a high radiation dose. Additionally, it is expensive and not available in every health care hospital. Hence, the high radiation dose, it is not suitable for routine orthodontic applications. However, owing to the informative data about orofacial pathologies, maxillary sinus, temporomandibular joint (TMJ), orofacial trauma and fractures, airway volumes, anatomical variations, and craniofacial syndromes, it is used widely in dentistry (Figure 1).

Craniofacial CBCT was introduced approximately 20 years ago and was designed to overcome some of the limitations of conventional CT scanning (6). The cost of CBCT imaging is very low compared with CT, and more importantly, the 3D visualization with much more less radiation dose is possible. However, the lower radiation dose is still much higher than conventional 2D imaging systems (Table 2).

CBCT allows realignment of 2D images in coronal, sagittal, oblique, and various inclined planes. With CBCT devices, all raw data are obtained in a single turn. In this way, the patient's length of hospital stay is reduced, and the device increases patient satisfaction. The most important advantage of CBCT is its possibility to display and arrange 3D data in personal computers. Various comprehensive softwares for orthodontic measurements are available.

CBCT can be used for several approaches in orthodontic patients. According to Kapila and Nervina (7), CBCT should be preferred:

- if it enhances diagnosis such as identification of the location of impacted (8, 9, 10) and supernumerary teeth (10-12) (Figure 2)
- if it quantifies the magnitude of the defect such as in patients with CLP (13, 14) (Figure 3, 4)
- if it improves differential diagnosis of malocclusions such as craniofacial anomalies and syndromes (15)
- if determination whether the discrepancy is uni- or bilateral is required such as facial asymmetry especially for patients with orthognathic surgery (16) (Figure 5)
- if it helps to identify the etiology of the malocclusion such as TMJ disorders (17)
- if it helps to assess treatment outcomes such as rapid maxillary expansion (18-20) and root angulations (21)
- if determination of the quality and quantity of bone and the anatomical structures is required for orthodontic device placement such as miniscrews
- if determination of alveolar boundary conditions is needed (22)
- if 3D airway morphology is needed especially for the therapy of obstructive sleep apnea (23).

CBCT has been usually used for diagnosis and treatment planning of impacted teeth (8-10). According to Lai et al. (10), CBCT improves exact localization of the impacted canines, assessment of the proximity to other structures and teeth, determining the existence of any pathology, and root resorption associated with impacted teeth and adjacent teeth. Furthermore, CBCT aids treatment planning of the impacted teeth, helps to determine surgical access and extrusion of the impacted teeth into the oral cavity. In addition, it is shown that CBCT scans contribute to more accurate image over 2D radiographs for root resorption associated with impacted teeth. In supernumerary teeth cases, the position of supernumerary teeth especially if it is impacted and describing the morphology of the supernumerary teeth is the most important points in treatment of these cases. CBCT provides the required 3D information involving the shape and position of the supernumerary tooth, any irregularities around the tooth, and root resorption of adjacent permanent teeth (10-12).

Even though the correlation between orthodontic treatment and TMJ has not been supported by most of the studies, examination of TMJ before beginning the orthodontic treatment is always advised. Studies showed that CBCT provides more specific anatomic imaging than 2D radiographs, and it is more effective than CT and MRI in detecting osseous changes (17). Using CBCT images when placing temporary anchorage devices (TADs) can be helpful for judgment of the surrounding tissues and anatomical structures such as tooth roots, sinuses, and nerves, preventing any complications (7). CBCT is not only used for treatment planning or diagnosis but also used for evaluating treatment outcomes. CBCT has been used in several studies for assessment of dental and skeletal effects of maxillary expansion (18, 19) and comparison of the periodontal, dentoalveolar, and skeletal effects of tooth-borne and tooth-bone-borne expansion devices (20), determining how expansion forces affect different regions of the maxilla (18).

Figure 1. 3D fan beam computerized tomography (CT) image

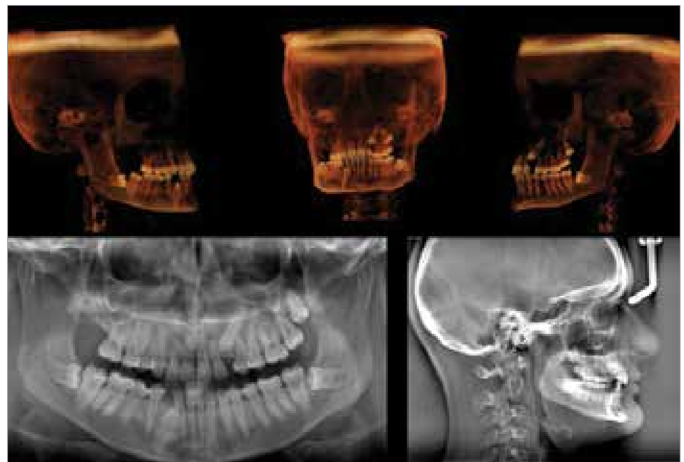

Figure 2. 3D cone beam computerized tomography (CBCT) image and 2D panoramic and lateral cephalometric radiography of a patient with impacted teeth

Figure 3. 2D intraoral photographs of a patient with right unilateral CLP

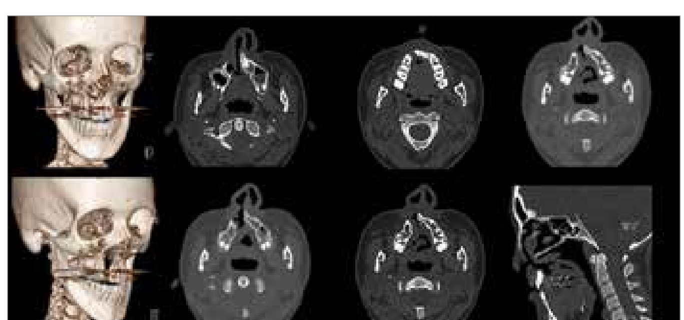

Figure 5. 3D CBCT images to evaluate hard and soft tissue facial asymmetries

After orthodontic treatment, root parallelism and angulations can be determined by using CBCT to aid post-treatment stability (22). CBCT imaging has been used to investigate the efficacy of rapid maxillary expansion (RME) and surgery as treatment options for a constricted airway (7). In summary, CBCT examination is recommended for evaluating airway volume (23). CBCT was also preferred in airway evaluation studies to evaluate the nose and sinuses as well as volumes of airway spaces at different levels; however, none of these studies had high-quality scores, and therefore, a real indication could not be stated according to Kujipers et al. (24).

In patients with craniofacial syndromes, impacted or supernumerary teeth are considerably prevalent; CBCT images have been found supportive in planning orthodontic treatment of the patient with syndrome who has impacted and supernumerary teeth (15).

3D imaging is especially usable for pre-treatment evaluation of the patients with craniofacial deformities such as patients with CLP, orthognathic surgery, syndromes, and facial asymmetries. De Moraes et al. (25) emphasized that CBCT provides better evaluation of craniofacial morphology than 2D images. Nur et al. (16) outlined that CBCT is a favorable diagnosis method in facial asymmetry to compare the right and left facial hard and also limits soft tissue measurements. Recent studies showed that CBCT provides valuable information in patients with CLP for determining the volume of the alveolar defect, location, proximity, eruption status, and paths of the teeth near the cleft site (13, 14). Therefore, CBCT improves the ability to understand the precise volume of the post-expansion defect and enables optimally planning and evaluating of outcomes of bone grafting. Overall, the SEDENTEXCT Consortium stated that CLP is one of the main reasonable indications for taking CBCT from the patients in dentistry and recommended to consider the other indications with caution (26).

Laser Scanning (3D Laser Scanning)

Laser scanning is a non-invasive technique for capturing facial morphology and soft tissue (Table 1). Validity of the method was proven in many studies (27, 28). According to Kau and Richmond (29), besides producing accurate 3D facial models, laser scanning devices are less expensive and easily handled.

Laser scanning can be used for the following reasons (Figure 6):

- 3D analysis of facial morphology (27, 28)
- evaluating facial symmetry (30, 31)
- cross-sectional growth changes (32)
- assessment of treatment outcomes (33)
- evaluating clinical outcomes for surgical cases (34)
- evaluating patients with CLP (31)
- soft tissue changes (35)
- scanning dental casts (36).

Laser scanning has been used for quantitatively evaluating facial symmetry in adolescents (30) and patients with cleft lip palate as well as the soft tissue changes after treatment (31). Moreover, Kujipers et al. (24) reported that laser scanner and stereophotogrammetry are reliable soft tissue imaging systems with a maximum measurement error of <1 mm.

The capturing time in this technique is the most prominent disadvantage. Therefore, it is inconvenient for pediatric cases (37). On the other hand, a study concluded that laser scanning might be a suitable method for pre-school children as long as they are well prepared (31). Apart from these, some other shortcomings of the method have been reported such as inability to capture soft tissue surface texture and safety issues due to exposing the eyes to the laser beam (5).

Vision-Based Scanning Techniques

Vision-based scanning techniques such as Moiré topography, structured light, stereophotogrammetry, and 3D facial morphometry are non-invasive and quite user-friendly techniques. Stereophotogrammetry has been shown to be the most frequently used in the orthodontic practice among vision-based scanning techniques.

Stereophotogrammetry

Stereophotogrammetry is based on photographing objects by a pair of configured cameras and combining photos taken from two different directions to create 3D models. Studies showed that stereophotogrammetry has many advantages:

- It is non-invasive and non-contact technique with no radiation exposure.
- It is good at capturing facial morphology and soft tissue changes (38-40).
- It has a short acquisition time and user-friendly (in pediatric patients especially infants).
- It can be combined with CBCT images.
- 3D images can be viewed on a personal computer and can be used as communication tool between clinicians.
- 3D images can be rotated and viewed from any direction, thus stereophotogrammetry is very useful for orthognathic surgery and (5, 41) patients with craniofacial anomalies (CLP) (24, 42, 43) (Figure 7, 8).

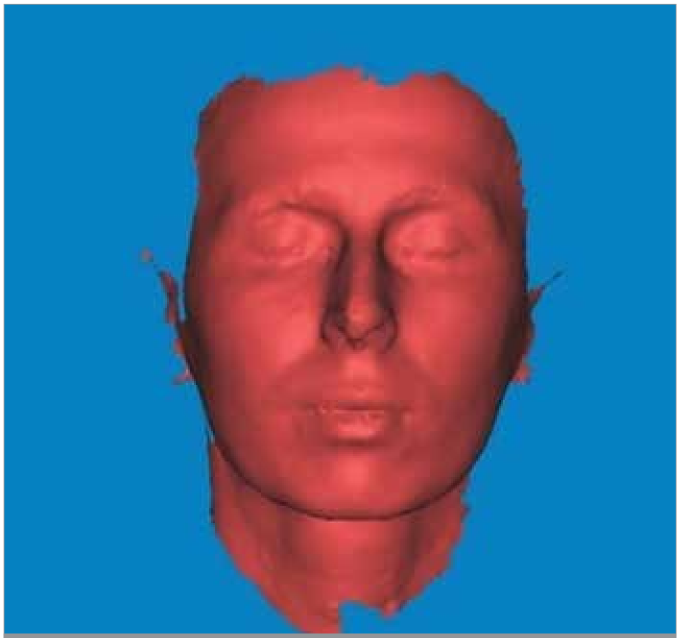

Figure 6. 3D laser scanning image

Figure 7. Different views of 2D photographs and 3D stereophotogrammetric images of an infant with bilateral CLP by multiple and one capture, respectively

In a thesis, stereophotogrammetry has also been used for scanning dental casts to evaluate the intraoral changes after nasoalveolar therapy (44). It was concluded that 3D data enabled rotating and zooming into the image, so that models can be viewed from any direction desired and hence performing more accurate measurement on the model (42). It is quite efficient in capturing facial morphology (38-40); however, tissue reflections, hair, eyebrow, and curved surfaces such as the eyes and ears can influence the image process (45). Stereophotogrammetry allows orthodontists to evaluate the face from every direction with only one capture, and this makes stereophotogrammetry useful for patients with orthognathic surgery and craniofacial deformities (5, 41). Stereophotogrammetry has also been preferred for making superimpositions after orthognathic surgery (5).

Stereophotogrammetry is the most frequently used 3D techniques in patients with CLP for soft tissue evaluation. As it is a non-invasive technique and patients are not exposed to radiation, it can be safely used in pediatric patients. Another reason for preferring stereophotogrammetry on little children is short capturing time and simple utilization of the device. Hence, it is favorable in the infancy period as the infants receive pre-surgical orthopedic treatment to document the follow-ups as well as the outcomes of the treatment. The digital archiving of the soft tissue data at the first surgery enables the follow-up of soft tissue growth differentiations due to the surgical approaches. By this way, the techniques and approaches may be enhanced and developed to overcome determined surgical side effects. Recently, to distinguish the physiological- from approached-based growth, several studies were performed on babies using stereophotogrammetry to establish superimpositions (42-44).

MRI and Surface Scanning

MRI and surface scanning are non-invasive imaging techniques. MRI provides accurate and detailed information on abnormalities and disorders of craniofacial hard and soft tissues, especially the TMJ (46), and it has been used in craniofacial imaging for several years. MRI is mostly used for upper airway analysis and 3D imaging of TMJ morphology. Kujipers et al. (24) reported that studies about velopharyngeal function using MRI were scored high quality and, therefore, may be indicated for measuring airway space, motion, and function especially in patients with cleft to determine velopharyngeal incompetence. MRI has been thought to have some limitations due to limited usage area in

Figure 8. Different views of 2D photographs and 3D stereophotogrammetric images of a patient with right unilateral CLP by multiple and one capture, respectively

dentistry, cost of the device, and orthodontists' lack of experience in application (47). However, recent studies showed that MRI is useful in many orthodontic fields and compared MRI with conventional 3D imaging techniques (CBCT and CT) (Table 1). Detterbeck et al. (48) compared mesio-distal tooth width by using 3D imaging techniques with and without ionizing radiation and concluded that MRI offers equivalent measurements compared with CBCT, and tooth germs are better illustrated than erupted teeth on MRI. Whether MRI is comparable with cephalometric radiographs in cephalometric analysis was evaluated and confirmed that orthodontic treatment planning without radiation exposure is possible by using MRI technique (49). In conclusion, MRI has huge potential for usage in clinical practice in orthodontics with its benefits such as good contrast ratio and absence of ionizing radiation.

Video Camera (4D Imaging and Video Stereophotogrammetry)

The aforementioned methods are used to evaluate the facial morphology either two- or three-dimensionally. However, the human face is a dynamic structure especially the nose, lip, and mouth areas. The newest method is 4D video capturing, which can record dynamic movements of the human face and enable to analyze the dynamics of facial expressions (50). Several studies used 4D imaging in patients with CLP and orthognathic surgery to demonstrate asymmetry while making facial expressions, and differences in facial motion between individuals with and without CLP were evaluated (50). With these new technologies, new attempts have been performed to create virtual patients by superimposing facial skeleton, soft tissue, and/or dentition (51). Future planned studies to create a real-time 4D virtual patient in motion are needed in the literature.

3D Planning in Orthognathic Surgery

Facial soft tissues, facial skeleton, and dentition are the main elements of orthognathic surgery planning. Capturing these three important tissue groups can only be achieved by "image fusion" (52). 3D facial image capture and CBCT images can be combined to create a "virtual 3D patient" so the orthodontists and surgeons can evaluate the patient's craniofacial skeleton and the soft tissue together. These 3D models are interactive and can be rotated to any view for more complete diagnosis and treatment planning. All collected data can be stored in the computer files which can be easily managed online. It also helps orthodontists and surgeons to communicate and make interdisciplinary treatment plans.

Accurate treatment planning is vital for orthognathic surgery to achieve optimum aesthetic and occlusal results. 3D surgical planning can be performed on this virtual patient through the software programs. In addition, surgical splints can be manufactured by using Computer Aided Design/Computer Aided Manufacturing (CAD/CAM) technology (53). With these surgical guides, the virtual planning can be transferred to the operating room (52). It is possible to make predictions of the postoperative outcomes in soft and hard tissues by 3D surgery simulations. According to Centenero et al. (53), postoperative predictions are reliable in some areas, but further development is needed in representing the postoperative changes in facial soft tissue. This technology is available to:

- perform virtual osteotomies (52, 53)
- repositioning of osteotomized bony structures
- control intercuspation
- control interferences between osteotomized bony structures and regions at the base of the skull (53)
- perform virtual distraction osteogenesis (54)
- prediction of surgical outcome (52, 53)
- make multiple simulations of different osteotomies and skeletal movements (5)
- data management

- communication between orthodontists and surgeons
- manufacturing surgical splints.

However, 3D image fusion process is an expensive method, which requires equipment and time (approximately 1 hour to generate virtual patient) (52).

Intraoral Scanning

Intraoral scanner is an equipment that consists of an intraoral camera, computer, and software. It creates a digital 3D model of scanned objects that can be teeth, impression, or dental cast. With the introduction of intraoral scanning technique, disadvantages of conventional impression techniques such as dimensional changes of impression materials, storage problem, and dental stone errors are overcome. In addition, it is easier to take impressions from the patients with gag reflexes by using intraoral camera. The development of digital models allows to obtain 3D diagnostic information, communicate between laboratory and orthodontists, create virtual set-ups and treatment planning, and fabricate custom-made fixed or removable appliances. Orthodontists are able to plan the treatment on the digital model, control the bracket positioning, and superimpose the before and after models.

Intraoral scanning can provide:

- archiving study casts
- examine intra- and inter-arch relationships
- treatment planning
- virtual treatment and virtual set-ups
- 3D prefabrication of arch wires
- construction of 3D aligners
- CAD/CAM retainer
- fabricated lingual brackets
- indirect bracket bonding.

However, according to a systematic review, inter-arch measurements such as overjet, overbite, molar relationship, and canine relationship need to be verified on virtually occluded digital models (55). Moreover, the time requirement for full arch scanning in routine practice can be counted as disadvantage of this technique.

CONCLUSION

3D imaging techniques are very supportive for routine orthodontic practice. These techniques enhance treatment options enabling more detailed diagnostic information on the specific cases such as patients with craniofacial anomalies. CBCT has quite wide usage area especially to evaluate craniofacial skeleton and related pathologies; however, owing to the high radiation dose, it is recommended to consider the indications with caution. As aforementioned, CBCT use in patients with cleft is one of the main supportable indications. Although the non-invasive systems such as stereophotogrammetry, laser scanner, intraoral scanner, and MRI are suitable for every patient, the high cost has to be considered. Stereophotogrammetry is suggested for patients with craniofacial deformities (involving patients with CLP), and it is highly recommended especially in pediatric patients (infancy period) who are very hard to capture due to movements with conventional photographs. Some weaknesses of laser scanning, such as poorness of capturing soft tissue surface texture, make this technique more suitable for scanning dental casts. Digital dental casts are user-friendly tools to evaluate the dentition. MRI presented high reliability and may be indicated to determine velopharyngeal functions and airway space. Overall, as all 3D imaging techniques are developed and became a routine, chair time for full orthodontic records, record loss, and storage problem will be reduced, and the interdisciplinary communication enhanced. Whereas still evidence-based guidelines for 3D imaging were required to cooperate it into standard orthodontic record collecting phase, the future of 3D imaging offers clinicians dynamic 4D virtual patient in motion to recognize functional recovery after treatment.

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CASE REPORT

Patient with Severe Skeletal Class II Malocclusion: Double Jaw Surgery with Multipiece Le Fort I

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ABSTRACT

A 22-year-old woman with severe skeletal Class II malocclusion was referred to our clinic. A clinical examination revealed a convex soft tissue profile and increased teeth and gingiva exposure both while smiling and in the natural rest position. She had Class II molar and canine relationship with increased overjet, moderate crowding in both upper and lower jaws, and proclined upper and lower incisors. Skeletally, she showed transverse maxillary deficiency, maxillary vertical excess, and mandibular retrognathia. We planned orthodontic-orthognathic surgery with multipiece Le Fort I osteotomy and bilateral sagittal split osteotomy (BSSO) to achieve ideal occlusion, stability, and facial esthetics. During orthodontic decompensation to relieve the crowding and to gain an ideal incisor inclination, four bicuspid extractions were performed. Because we used continuous mechanics, at the end of the decompensation period, we cut the maxillary arch wire distal to the lateral incisors into three pieces and waited for 3 months for vertical and transversal dental relapse. During the double jaw surgical procedure, the maxilla expanded and impacted with multisegmented Le Fort I osteotomy and the mandible advanced with BSSO. After the orthodontic and orthognathic surgical treatment, the skeletal and dental imbalance was corrected, and functional occlusion and dental and skeletal Class I relationship were achieved. The treatment results were stable at the 1-year follow-up.

Keywords: Orthognathic surgery, skeletal Class II, multipiece Le Fort I

INTRODUCTION

In skeletal Class II patients, treatment alternatives vary according to the skeletal maturity level, severity of the malocclusion, facial appearance, and patient's expectations and cooperation (1-4). In growing patients, growth modification treatments either with removable or fixed functional applications, in which patient cooperation is the primary concern, are preferred (2-7). In adult patients, camouflage orthodontic treatment can be an option when there are mild-to-moderate anteroposterior (A-P) skeletal discrepancies with acceptable vertical facial proportions and no transverse skeletal problems (8-10). Camouflage treatment is mainly based on the retraction of the upper incisors by extracting the upper first premolars or whole maxillary arch distalization using temporary anchorage devices and protraction of the lower incisors to resolve increased overjet (8-14). In some instances, extractions of the mandibular second premolars are also performed for obtaining a Class I molar relationship by lower molar mesialization. However, this treatment is limited by tooth movements for compensating the underlying skeletal discrepancies (3). In severe cases, camouflage treatment means that fitting teeth on improper skeletal bases can lead to possible periodontal problems, such as gingival recession in the lower anterior region, root resorptions, worsening of facial esthetics, and occlusal instability (3, 4, 8-10). Therefore, in patients with

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severe A-P skeletal discrepancies, transverse maxillary skeletal constriction, airway problems, and improper facial esthetics, orthognathic surgery combined with orthodontic treatment is the best treatment alternative to gain ideal results regarding function, esthetics, and stability (4, 8-10, 12-18). During the presurgical orthodontic treatment, dental decompensation by moving teeth to a proper position relative the skeletal bases, which is just the opposite of the camouflage treatment, is performed (3, 4). During this phase of treatment, the aim is to remove dental interferences for the ideal correction of existing skeletal discrepancies. This case report describes the orthodontic-orthognathic surgery treatment in a 22-year-old woman with skeletal Class II malocclusion due to mandibular retrognathia.

CASE PRESENTATION

A 22-year-old woman with a complaint of mandibular retrognathia was referred to our clinic. Extraorally, she had a convex soft tissue profile and increased teeth and gingiva exposure both while smiling and in the natural rest position. Intraorally, she had the Class II molar and canine relationship and 10-mm overjet and 4-mm overbite. There was 6-mm crowding in the upper jaw and 7-mm crowding in the lower jaw. The upper midline was coincident with the face, whereas the lower midline was 2.5 mm deviated to the right. Transversally, a 4-mm maxillary constriction existed between the lower and the upper first premolars (Figure 1).

Skeletally, the patient had Class II malocclusion (ANB, 8°) due to mandibular retrognathia (SNB, 71.8°). The maxillary depth angle was increased (63.5°), indicating a vertically overdeveloped maxilla. Both upper and lower incisors were proclined with an angle of I-SN 112.2° and IMPA 101° (Table 1). The third molars were present (Figure 2).

Treatment objectives were the following: (1) relieving dental crowding and gaining an ideal dental arch alignment; (2) obtaining Class I dental and skeletal relationship with an ideal functional occlusion; 3) fitting maxilla and mandible transversally by maxillary expansion; (4) gaining ideal teeth and gingival exposure; and (5) improving facial esthetics. To achieve these objectives, an orthodontic-orthognathic combined treatment was planned.

For this patient, in the field of the orthodontic and orthognathic surgery approach, there were two treatment options, namely surgically-assisted rapid palatal expansion followed by fixed orthodontic treatment and final double jaw orthognathic surgery or orthodontic decompensation followed by double jaw surgery with multipiece Le Fort I osteotomy. Our patient's maxillary constriction was in the physiological limits of the multipiece Le Fort I

Figure 1. Pretreatment extra- and intraoral photographs

Table 1. Lateral Cephalometric Measurements

Cephalometric Measurement	Mean	Initial	Preoperative	Postoperative	1 Year After Treatment
VERTICAL ANALYSIS					
SN-GoGn	32°±8°	38.1°	37°	39°	39°
Saddle angle	123°±5°	137.6°	134.5°	139°	139°
Articular angle	143°±6°	144.2°	148°	136°	136°
Gonial angle	130°±7°	112.5°	110°	120.6°	120°
Sum of interior angles	396°±3°	394.3°	392.5°	395.6°	395°
Jarabak (SGo-NMe)	59%-63%	63.5%	64.6%	59%	60.8%
ANS-Me/N-Me	55%	58.4%	59.8%	61%	61.1%
Max. height angle	60°	63.5°	62°	58.5°	58.4°
Facial axis angle	90°	85.4°	85.6°	91°	91°
S-Ar/Ar-G (ramus)	75%	76.6%	72%	79%	80%
Gonial ratio	75%	59%	56%	66%	66%
FMA	25°	28.6°	29.4°	28.8°	28.5°
Y-axis angle	59.4°	76.5°	76.6°	72.7°	72.7°
Okl. plane/SN	14°	15.5°	20°	16.8°	15.8°
Okl. plane/Mand. plane	18°	24.2°	18.9°	24.4°	23.4°
SAGITAL ANALYSIS					
SNA	82°±2°	79.8°	80.2°	81.5°	81.5°
SNB	80°±2°	71.8°	71.4°	76°	75.8°
ANB	2°	8°	8.8°	5.5°	5.7°
Witt's	-1 mm	9.9 mm	8.1 mm	3.9 mm	4.5 mm
Ant. cran. base	73 mm	62 mm	62 mm	62 mm	62 mm
Mand. corpus length	80 mm	80.4 mm	80 mm	88 mm	88 mm
Postcranial base	37 mm	33.3 mm	33.3 mm	33.3 mm	33.3 mm
N-A per	-1 mm	-3.4 mm	-2.4 mm	-1.4 mm	-1.4 mm
Max. depth	90°	91.2°	90.4°	93°	94°
SL	51 mm	30.4 mm	30.5 mm	39.2 mm	39.2 mm
SE	22 mm	24.6 mm	22.8 mm	24.7 mm	24.7 mm
DENTAL ANALYSIS					
U1-SN	103°	112.2°	104°	98°	96°
U1-FH	112°	124.2°	114°	110°	108°
U1-Pal. plane	115°	123.3°	111.5°	104°	103°
U1-NA	22°	33°	23.4°	17°	16°
U1-NA	4 mm	8 mm	2.2 mm	1 mm	0.8 mm
IMPA	90°	101°	92.3°	85.4°	85.6°
L1-NB	25°	33.4°	22.9°	22.4°	22.7°
L1-NB	4 mm	8.5 mm	3 mm	5 mm	5 mm
Pog-NB	4 mm	4 mm	4.7 mm	5.5 mm	5.5 mm
Holdaway ratio	1/1	0.5	1.6	1.1	1.1
Interincisal angle	131°	105.6°	124.6°	136°	137.8°
SOFT TISSUE ANALYSIS					
Nasolabial angle	102° ± 8°	108.9°	117.9°	119°	117°
Holdaway angle	8°	16.7°	13.8°	7.5°	7°
Upper lip-E line	-4 mm	-1.6 mm	-3.2 mm	-6 mm	-6.4 mm
Lower lip-E line	-2 mm	0.4 mm	-0.6 mm	-3.5 mm	-3.6 mm
Soft tissue convexity	168°±4°	123.4°	121.6°	126.3°	125.4°

procedure; therefore, to avoid possible complications of the second surgery, we preferred maxillary expansion and repositioning with a multipiece surgical intervention.

Before starting the orthodontic treatment, a written informed consent was obtained from the patient. Following, the patient's third molars and upper and lower first premolars were extracted. All first and second molars were banded, and the remaining teeth were bonded with 0.022-in Roth metal braces. After leveling the dental arches, extraction spaces were closed by sliding mechanics to gain an ideal incisor inclination according to our cephalometric surgical prediction tracing (Figure 3-5). Because we worked with continuous mechanics, to be able to see the real skeletal problem, dental relapse in all dimensions (transversal, sagittal, and vertical) was needed. A 0.019 × 0.025-in stainless steel upper archwire was segmented into three pieces from distal to the lateral incisors (Figure 3). We waited for approximately 3 months for a possible dental relapse. After the decompensation period, orthognathic surgery, which involved maxillary multipiece Le Fort I osteotomy and mandibular bilateral sagittal split osteotomy, was performed. Virtual treatment planning was done using software (Dolphin Imaging and Management Solutions Chatsworth, California). The maxilla was expanded with segmental osteotomy, and the upper incisor tip moved 2.3 mm forward and 3 mm upward, whereas the lower incisor tip moved 11 mm forward, and mandibular counter-clockwise rotation was performed (Figure 6).

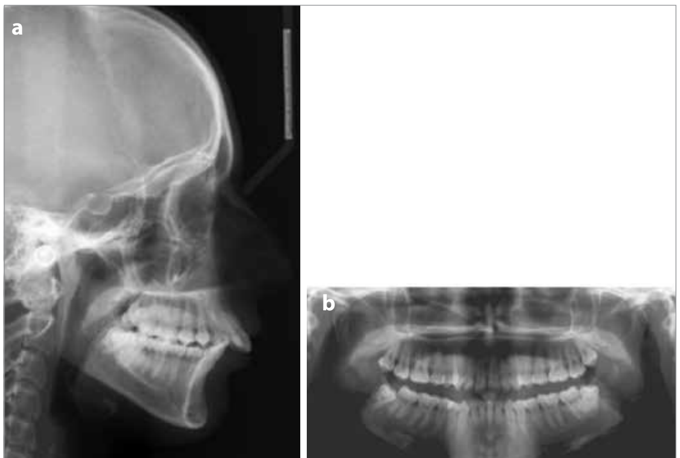

Figure 2. a, b. Pretreatment lateral cephalometric (a); panoramic radiographs (b)

To avoid early postoperative relapse, we bonded the segmented maxillary archwire with light-cure flowable composite during the surgery. Titanium plates were used for rigid fixation. A 10-day inter-maxillary fixation (IMF) was postoperatively performed. To prevent relapse, the final splint was left attached to the maxillary

Figure 3. Preoperative extra- and intraoral photographs

arch and patient individually continued the IMF application, except during meals and jaw exercises, for 6 more weeks. The final splint was removed 8 weeks after the surgery, and a long-armed transpalatal arch was bonded. The diastemas distal to the laterals were closed using the 0.019×0.025-in beta titanium alloy archwire with mushroom loops (Figure 7).

After debonding the braces, the upper and lower first bicuspid-to-bicuspid fixed lingual retainers were placed (Figure 8). A Hawley retainer for the upper jaw and a clear overlay retainer for the lower jaw were applied for approximately 1 year. The total treatment duration was 2 years.

After the orthodontic and orthognathic surgery, the skeletal and dental imbalance was corrected, and functional occlusion and dental and skeletal Class I relationship were achieved. A convex soft tissue profile, due to mandibular retrognathia, was corrected by mandibular advancement and counter-clockwise rotation. Ideal teeth and gingiva exposure were achieved by maxillary impaction. The patient had 2-mm overjet and 2.5-mm overbite. The lower dental midline was corrected and became coincident with the upper and facial midline Figure 6, 8, 9 (Table 1).

One-year after the treatment, a clinical and cephalometric analysis revealed that the skeletal and dental statuses were preserved Figure 10, 11 (Table 1).

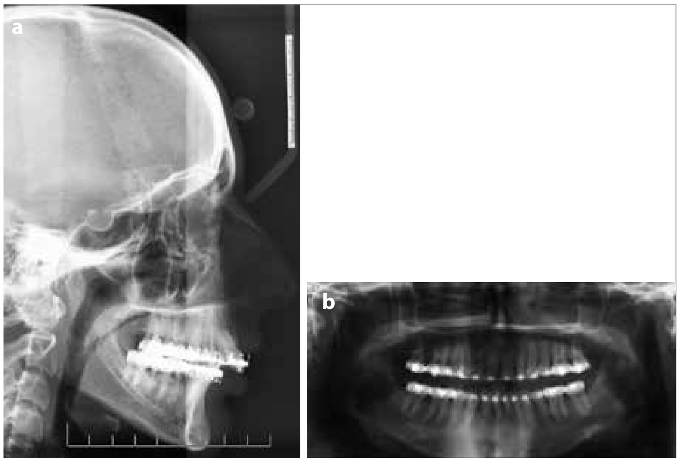

Figure 4. a, b. Preoperative lateral cephalometric (a); panoramic radiographs (b)

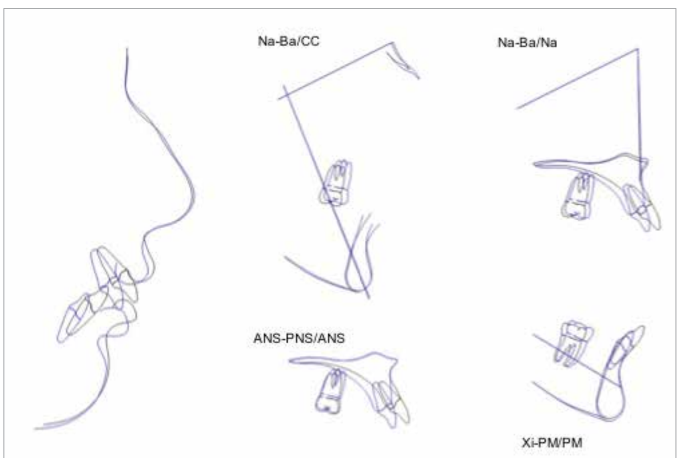

Figure 5. Initial and preoperative lateral cephalometric superimpositions Black: initial; blue: preoperative

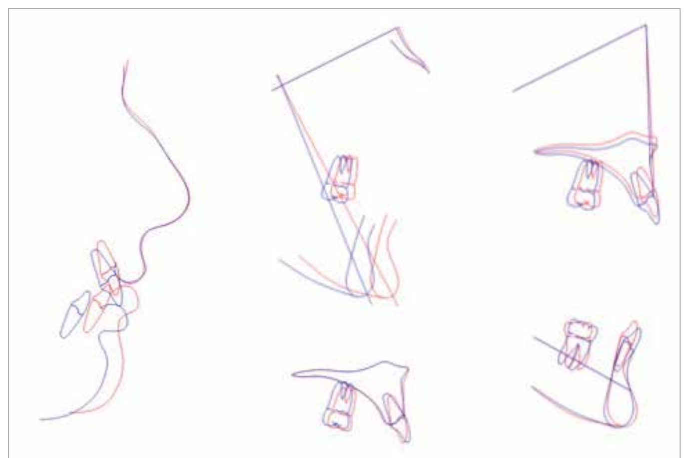

Figure 6. Preoperative and postoperative lateral cephalometric superimpositions Blue: preoperative; red: postoperative

Figure 7. Postoperatively 3 months, space closure with 0.019 × 0.025-in beta titanium alloy archwire with mushroom loops

Figure 8. Post-treatment extra- and intraoral photographs

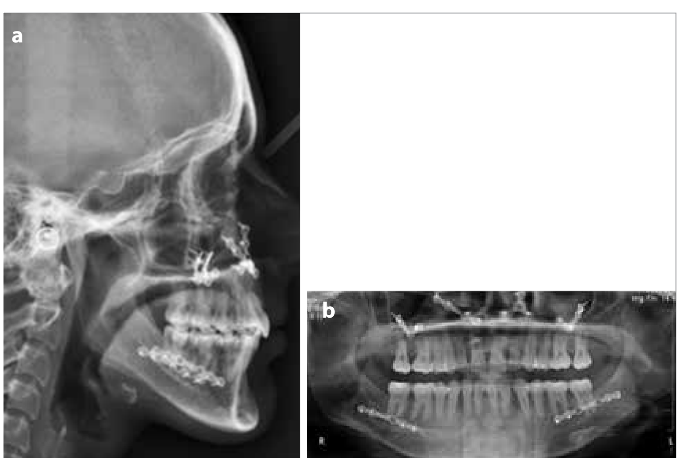

Figure 9. a, b. Post-treatment lateral cephalometric (a); panoramic radiographs (b)

CONCLUSION

Adult patients with skeletal Class II malocclusion can be treated using orthodontic (camouflage) or combined orthodontic-orthognathic surgery procedures. As Class II orthodontic camouflage treatments, the following can be performed: (1) for normalization of increased overjet, upper first premolar extraction and upper incisors retraction and/or lower incisors protraction; (2) to correct Class II molar relationship, lower second premolars extraction; (3) maxillary arch distalization with miniscrews; and (4) Class II elastics with/without extractions (8-15). Upper incisor retraction with maximum anchorage to reduce the increased overjet causes the flattening of the nasolabial angle, straightening of lips profile, and emphasizing of the nose (3, 4, 8, 12-14). A significant improvement in the soft tissue profile is not possible because the dental movement limits the effectiveness of camouflage treatment; in some cases, the situation may worsen. Because the camouflage treatment is limited by tooth movement, there will not be a pronounced improvement in the soft tissue profile, and it may also worsen in some cases. Besides, when attempting to fit the dental structures to the abnormal skeletal bases, the teeth move away from their ideal position within the jaw, resulting in stability and health problems (3, 4, 8-10). When all these limitations and disadvantages of camouflage treatment are taken into account, the orthodontic-orthognathic surgery combined treatment will be the best option in severe skeletal discrepancy cases. Because the present case had severe skeletal discrepancies such as maxillary constriction, vertical overdevelopment, and mandibular retrognathia (SNB, 71.8°), we planned orthodontic-orthognathic surgery.

Figure 10. Extra- and intraoral photographs 1 year after treatment

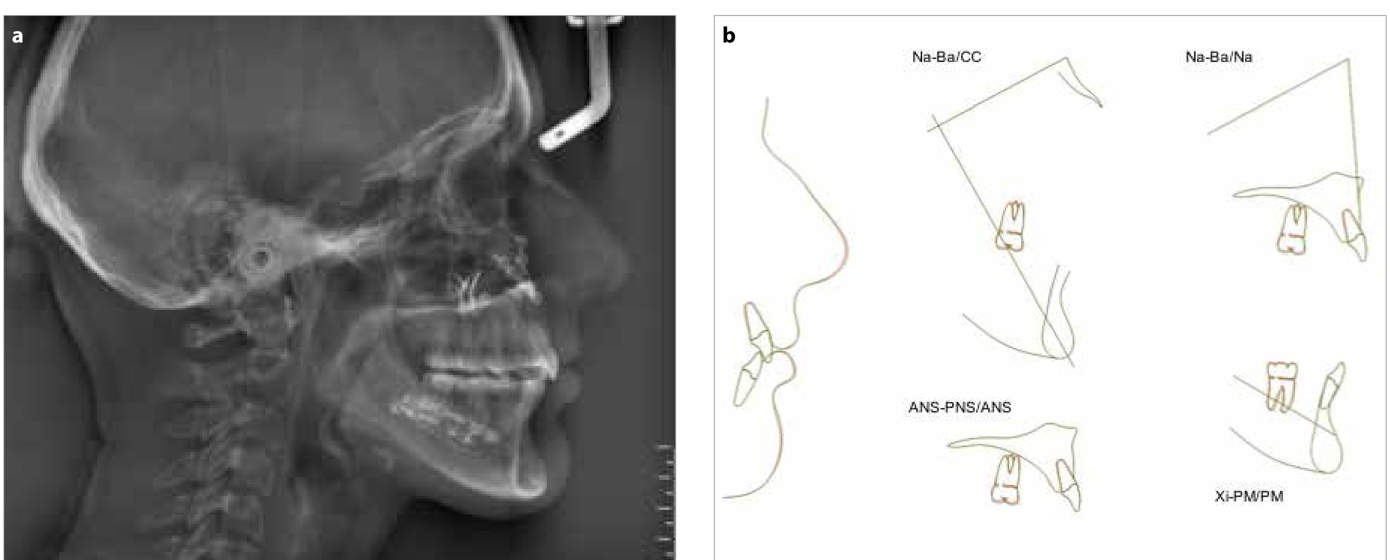

Figure 11. a, b. Lateral cephalometric radiograph 1 year after treatment Postoperative (a); 1-year post-retention lateral cephalometric superimpositions (b) Red: postoperative; green: 1-year post-retention

For the correction of the transversal maxillary constriction in adult patients, two options are commonly used, namely surgically-assisted rapid palatal expansion (SARPE) and (2) multisegmented Le Fort I osteotomy. The SARPE technique is mostly used in cases with severe transversal deficiencies (>7 mm) and no concomitant sagittal and vertical skeletal anomalies. In contrast, the multisegmented Le Fort I osteotomy procedure is preferred in cases with combined transversal constriction with anteroposterior and/or vertical discrepancies and a dual plane of occlusion (16-18). The present case required 4 mm of maxillary expansion and vertical repositioning to correct increased tooth and gingiva exposure both while smiling and in the natural rest position (maxillary vertical overdevelopment). Therefore, we preferred the multisegmented Le Fort I osteotomy technique.

In this case, during preoperative orthodontic treatment both relieving the crowding and obtaining the ideal incisor inclination, we decided to extract the upper and lower first premolars (3,4). Because we used continuous mechanics during the leveling and space closure period, we needed to cut the 0.019×0.025-in stainless steel upper archwire distal to the lateral incisors, and we waited for 3 months for dental relapse. After 3 months, we performed the surgery, and software (Dolphin Imaging and Management Solutions Chatsworth, California) was used for surgical planning. The patient underwent maxillary transversal, sagittal, and vertical repositioning using the multisegmented Le Fort I osteotomy and mandibular advancement with BSSO. Titanium plates were used for rigid fixation in surgery. IMF was performed 10 days postoperatively.

We extended the IMF application, except during meals and jaw exercises, to prevent relapse, which is mainly due to the maxillary expansion with the multisegmented Le Fort I osteotomy. Further, during the final splint removal, a long-armed transpalatal arch was immediately bonded. Post-treatment retention was done using the upper and lower bicuspid-to-bicuspid fixed lingual retainers, a Hawley retainer for the upper jaw, and a clear overlay retainer for the lower jaw. Skeletal and dental results were maintained at the post-treatment 1-year follow-up.

In a patient with severe skeletal Class II malocclusion with maxillary constriction, ideal results regarding function, esthetic, and airway can be achieved with orthodontic-orthognathic surgery using the multipiece Le Fort I osteotomy. Following dental decompensation with continuous mechanics, it is advisable to segment the archwire and wait for dental relapse. Preoperative dental relapse is necessary to obtain adequate skeletal correction and to distinguish the cause of postoperative relapse, whether skeletal or dental.

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

Peer-review: Externally peer-reviewed.

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