Review Article

Soft Tissue Changes Following the Extraction of Premolars in Nongrowing Patients With Bimaxillary Protrusion

A Systematic Review

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ABSTRACT

Objective: To quantify the amount of perioral tissue changes following the extraction of four premolars in patients with bimaxillary protrusion who had nearly completed active growth.

Materials and Methods: A literature search was conducted to identify clinical trials that assessed cephalometric perioral soft tissue changes in patients affected by biprotrusion and treated with extractions. Electronic databases (PubMed, ISI WoS Science Citation Index Expanded, and HubMed) were searched. Abstracts that appeared to fulfill the initial selection criteria were selected, and the full-text original articles were retrieved and analyzed. Only articles that fulfilled the final selection criteria were finally considered. Their references were also hand-searched for possible missing articles from the database searches.

Results: Nine abstracts met the initial inclusion criteria and these articles were retrieved. From these, five were later rejected mostly because the sample dealt with growing subjects. Four articles remained and they showed that the upper and lower lips retracted and the nasolabial angle increased following premolar extraction. Upper lip retraction ranged from 2 mm to 3.2 mm, lower lip retraction ranged from 2 mm to 4.5 mm.

Conclusions: The lip procumbency improves following the extraction of four premolars and this improvement is predictable. However, the changes are small and do not dramatically modify the profile. A ''dished in'' profile is not to be expected. Individual variation in response is large. (*Angle Orthod* 2010;80:211–216.)

KEY WORDS: Extraction; Premolars; Bimaxillary; Protrusion; Profile

INTRODUCTION

Bimaxillary protrusion is a condition characterized by protrusive and proclined upper and lower incisors and an increased procumbency of the lips. This condition generally is seen in African American[1–4] and Asian[5–7] populations, but it can be found in almost every ethnic group.

Because the teeth have a normal molar relationship and a relatively normal overbite and overjet, some clinicians in the past[8] considered these cases to be in perfect harmony and balance with their physiognomy. Actually, in most cultures, the negative perception of protruding lips and an overly protrusive dentition leads many patients with bimaxillary protrusion to seek orthodontic care to decrease this procumbency. To achieve this objective, four-premolar extraction is planned to create room for retraction of the anterior teeth.[9]

However, it is a debatable issue whether or not there is an exact relationship between the changes in hard and soft tissue.[10] Current orthodontic literature can be categorized into two major schools of thought.[11] Some studies have reported a high degree of correlation between upper incisor and lip retraction, suggesting a close relationship between soft tissue and the underlying hard tissue.[12–22] Others have found that a definite proportional change in the soft tissue does not necessarily follow changes in the dentition.[23–30]

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Table 1. Initial Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
Four premolars extracted	Lateral cephalograms with lips closed
Pretreatment and posttreatment cephalometric x-ray with the patient's lip at rest	Patients with crowding
Findings on upper lip and lower lip retraction and nasolabial and labiomental angle changes	Functional appliance therapy
Cephalometric findings on soft tissue changes	Headgear therapy
	Combined surgical treatment
	Congenitally missing teeth (excluding third molars)
	Long-term facial effects
	Case report

Indeed, several variables may have adversely affected the results of previous studies; the most important variable among these is the choice of study sample and in particular, the skeletal age of patients, as normal growth changes in the soft tissue profile could explain the discrepancy between the different studies.[31] In fact, the nose and the chin move forward gradually, leading to a lesser protrusive profile.[32]

A systematic review of the available literature on this topic could be of help in decision making regarding extraction for patients affected by bimaxillary protrusion and in determination of the amount of incisor retraction required to reduce lip procumbency, but such a review has never been published.[33] In this respect, because of the increasing demand for orthodontic treatment in nongrowing patients for esthetic reasons, and the need on the other hand for clinicians to somehow forecast therapy outcomes, it seems useful to summarize the existing literature on the topic. Therefore, the present study was undertaken to evaluate short-term perioral soft tissue changes on lateral cephalograms in patients with bimaxillary protrusion who had nearly completed active growth and were treated by extraction of the four premolars.

MATERIALS AND METHODS

Search Strategy

To identify all the studies that dealt with patients affected by biprotrusion and treated with extractions, a literature survey was carried out in the following electronic databases: PubMed (http://www.ncbi.nlm.nih.gov), ISI WoS Science Citation Index Expanded (http://portal.isiknowledge.com), and HubMed (http://www.hubmed.org/). The survey covered the period from September 1960 to March 2009 for PubMed, from January 1986 to March 2009 for ISI, and from December 1968 to March 2009 for HubMed.

The MeSH (Medical Subject Heading) database was used to look for MeSH terms for ''protrusion.'' According to this search, the term ''protru*'' was added to a combination of the following key words to find articles pertaining to the therapeutic procedure in question: extraction*, premolar*, bicuspid*, bimaxillary, biprotru*.

Inclusion and Exclusion Criteria

The following inclusion criteria were chosen by two reviewers for initial selection of potential published abstracts: bimaxillary dentoalveolar protrusion (bimaxillary protrusive profile), four premolars extracted, and pretreatment and posttreatment lateral cephalometric radiographs taken with the lips relaxed. All studies on adults were included without regard to gender and ethnicity. In fact, if the systematic review is limited to a very restricted population, it probably will provide very little new information.

Exclusion criteria were as follows: congenitally missing teeth (excluding third molars), long-term facial effects, combined orthodontic and surgical treatment, treatment with functional appliances or headgear therapy, tooth-size-arch-length discrepancies (crowding), and case reports (Table 1). No language restriction was applied during the identification process of published studies. Most often, retrospective studies were likely to be available to fulfill the aim of the study as taken into consideration. Moreover, articles in various stages of publication were included.

Assessment of Relevance

All article abstracts that seemed to meet the initial inclusion criteria were selected, and the actual articles were collected. The articles ultimately selected were chosen with the following additional inclusion criteria: a minimum subject age of 15 at the beginning of treatment (to reduce growth effects), four premolars extracted, cephalometric measurements of upper lip retraction, lower lip retraction (measured as the distance from the upper and the lower lip to the E-line, or to a line perpendicular to the Frankfort horizontal passing through the nasion), and the nasolabial angle (the angle between a line tangent to the base of the nose and a line tangent to the upper lip). Treatment was completed in no longer than 36 months, and no treatment involved serial extractions.

Reference lists of retrieved articles were also handsearched for additional relevant articles that might have been missed in the database search. Hand searching was conducted on the following journals: *European Journal of Orthodontics*, *American Journal of Orthodontics and Dentofacial Orthopedics*, *British*

Table 2. List of Rejected Studies

Authors	Sample	Age	Race	Premolars Extracted
Keating[19]	13 m, 17 f	11. 8 ± 1.5	Caucasian	4 first
Bravo[12]	16 f	13. 6	Caucasian	4 (3 first + 1 second)
Diels et al[15]	30 m, 30 f	13. 2 m 13. 7 f	African American	4 first
Kasai[10]	32 f	20. 1	Japanese	4 first
Kusnoto et al[9]	6 m, 34 f	18	Indonesian	4 first

Journal of Orthodontics, *International Journal of Adult Orthodontics and Orthognathic Surgery* (first published in 1986), *Journal of Clinical Orthodontics*, and *Clinical Orthodontics and Research* (first published in 1998).

Two independent reviewers assessed all the articles separately, while respecting the inclusion and exclusion criteria. Data regarding the following items were collected from the retrieved studies: year of publication, study design, subjects, orthodontic technique, soft tissue cephalometric measurements, and authors conclusions.[34] The ratio between upper lip (UL) retraction and upper incisor (UI) retraction and between lower lip (LL) retraction and lower incisor (LI) retraction was recorded if described. Data were extracted from each article without blinding the authors. The Kappa score measuring the level of agreement between reviewers was 0.92 (very good). Bimaxillary protrusion was declared when the selected studies explicitly indicated this condition, justifying the reasons for extractions.

Assessment of Validity

A quality assessment checklist was devised to document the methodologic soundness of each article. This list consisted of a modified checklist as previously described.[34,35] The following characteristics were used: defined objective of the study, sample size justified by power calculation, description of inclusion and exclusion criteria, description of the intervention, control sample, and descriptive statistical analysis. Scores of 0,1 and 2 were assigned to each item, and scores were summed to obtain the final score. Then the quality of the retrieved studies could be categorized. Article quality was judged as low (sum 0–4), medium (sum 4–8), or high (sum 8–12).

RESULTS

Depending on the electronic database selected, numerous articles were found. PubMed identified 76 articles, ISI WoS Science Citation Index Expanded 20, PubMed Central 45, and HubMed 76. The PubMed database search included all references found in Web of Science, PubMed Central, and HubMed. From the total number of abstracts identified in the electronic databases, only a small percentage fulfilled the initial inclusion criteria. PubMed obtained the greatest diversity of abstracts and included all abstracts from other databases. Any study could be identified by hand search.

Nine article abstracts fulfilled the initial selection criteria. These were not clinical trials, but rather retrospective studies. Of these, some investigations[9,10] (Table 2) were later rejected because they did not agree with additional inclusion or exclusion criteria.

Three of nine investigations[12,15,19] were rejected because the sample dealt with growing subjects and/or subjects who had had teeth extracted, other than the first four premolars, as stated in Table 3. Two additional articles were rejected because of other methodologic issues. In the study by Kasai,[10] not every patient was biprotrusive. The investigation by Kusnoto et al[9] was rejected because of the reference line established. This line was perpendicular to sella-nasion minus at 7 degrees passing through the sella.

At last, only four articles[5,6,13,14] qualified for the final analysis, as they fulfilled all selection criteria and finally were used for this systematic review. The study design of the four articles is given in Table 3, and the results are summarized in Table 4. Assessment of validity showed that research quality and methodologic soundness were low in one study[6] and medium in three studies.[5,13,14] No study justified sample size by

Table 3. List of Selected Studies

Authors	Sample	Age, y	Race	Premolars Extracted	Appliance	Study Design
Lew[5]	12 m, 20 f	18–26	Chinese	4 first	Begg	Case series
Tan[6]	21 m, 29 f	18–25	Chinese	not reported	Edgewise	Retrospective
Caplan et al[14]	28 f	15–34	African American	4 first	Edgewise	Retrospective
Bills et al[13]	10 m, 38 f	15–38	Ethnically diverse patients	4 first and 3 first plus 1 second	Edgewise	Retrospective

Table 4. Pretreatment and Posttreatment Cephalometric Measurements[a,b]

	Upper Lip Retraction,[c]		Lower Lip Retraction,		Nasolabial Angle,		
Authors/No. of Subjects	Mean Value	SD	Mean Value	SD	Mean Value	SD	Ratio,
Lew[5]/32 (12 m, 20 f)	−2.6	2.2	−3.8	0.4	10.0	1.8	UL:UI = 1:2.2 LL:LI = 1:1.4
Tan[6]	−2.7	nr	−2	nr	10.5	nr	UL:UI = 1:2.5 LL:LI = 1:6.2
Caplan et al[14] /28 f	−3.23	1.75	−4.54	2.21	9.39	8.6	UL:UI = 1:1.75 LL:LI = 1:1.2
Bills et al[13]	−2.4	1.6	−3	2	3.1	9	UL:UI = 1:0.45

[a] Mean value and standard deviation (SD) and differences between them of individuals with bimaxillary protrusion.
[b] UL indicates upper lip; LL, lower lip; UI, upper incisor; LI, lower incisor; m, male; and f, female; nr, not reported.
[c] Lip retraction is measured in millimeters; nasolabial angle is measured in degrees.

power calculation, nor did any investigation show control sample data. A summary of the sample size, race, study design, and orthodontic technique for each of these studies is presented in Table 3.

The study by Caplan et al[14] indicated that a significant retraction of the upper and lower lip occurred with treatment, and the nasolabial angle became more obtuse (Table 4). In the investigation carried out by Tan et al[6] a mean increase of 10.5 degrees was noted in the nasolabial angle. A reduction in lip protrusion (on average, 2.7 mm for upper lip and 2 mm for lower lip) in relation to the E line was recorded. The study by Lew[5] showed that the nasolabial angle became more obtuse, increasing from 80.7 to 90.7 degrees, because of the reduction of upper lip protrusion. The lower lip retracted too by 3.8 mm on average (Table 4). The study by Bills et al[13] showed that premolar extraction can be successful in reducing soft tissue procumbency in patients with bimaxillary protrusion. On average, the lower lip retracted by 2.4 mm and the upper lip showed a 3 mm retraction. On the other hand, no particular change in the nasolabial angle was recorded (3.1 degrees).

The ratio between lip change and incisor retraction ranged from 1:0.45 to 1.25 for the upper lip and from 1:1.1.2 to 1:.6.2, but correlation coefficients in some studies were very weak.

DISCUSSION

Bimaxillary protrusion is characterized by protrusive teeth in both jaws and a greater, rather than average, degree of lip prominence.[2,4] The goals of orthodontic treatment for bimaxillary protrusion include the retraction and retroclination of maxillary and mandibular incisors to decrease soft tissue procumbency and convexity,[6,19,29,36] and extractions are often planned to create room for anterior teeth retraction. Several studies have been carried out with the aims of (1) forecasting the number of perioral soft tissue changes that occur following premolar extractions in biprotrusive patients, and (2) establishing a reliable ratio between incisor retraction and lip retraction. These studies, obviously, would be of help for the clinician who predicts soft tissue changes as a result of incisor retraction. This, in turn, would assist the clinician in making extraction decisions and in determining the amount of incisor retraction required to reduce lip procumbency.[15]

However, conflicting results have been reported in the literature. In fact, published studies on the amount of profile improvement in patients treated with four premolar extractions have presented results that vary greatly. These contrasting findings and therefore the varying ratios of incisor retraction to lip retraction have been attributed to several factors, among these lack of standardization regarding lip position during radiography,[5] no control of anchorage, variation in lip morphology,[11] and lip tonicity,[34] but most of all to the fact that studies were conducted on subjects who were still in their growth phase.

Given this, the practice of dentistry and orthodontics is now increasingly defined by an evidence-based approach to treatment; relatively little has been published to provide concrete evidence on the efficacy of incisor retraction in patients with bimaxillary protrusion. Therefore, this review was carefully designed in the selection of included papers so as to reduce many of the variables that could adversely affect the results. The authors recognize the difficulty inherent in doing such systematic reviews from the published dental literature over the past 30 years, that is, relatively recent changes to research design made according to the evidence-based approach.

In fact, none of the four selected studies,[5,6,13,14] which evaluated the effects of extraction of four premolars on the perioral soft tissue of bimaxillary protrusive patients, was a randomized clinical trial, but all were retrospective studies. No control sample was included in the studies.

Of the initially selected investigations for this systematic review, one third did not isolate the effects of treatment from growth in the evaluation of profile

changes. This was based on the rationale that it is important to determine the combined effects of both, because most orthodontic patients are growing.[15] However, it should be understood that this assumption can be true only when described changes are observed during the posttreatment period until the completion of growth. This will verify whether or not the amount of soft tissue change is maintained if a nontreated control sample with the same malocclusion is not included. Unfortunately, most of the studies on this topic did not consider the above problems. We thus were obliged to exclude these studies from our systematic review, on the basis that an accurate determination of the effects of treatment on the intertegmental profile can be accomplished with consideration of patients who had nearly completed active growth, so as to reduce growth effects. To avoid significant growth changes that would affect results, a minimum age of 15 years at the beginning of treatment was chosen for this systematic review. However, it should be underlined that soft tissue changes have been shown to occur significantly even up to adulthood.[36]

A very interesting article on the comparison of extraction versus nonextraction treatment effects on soft tissue in matched samples of African American patients was not included in this systematic review because it was a long-term study.[37]

Therefore, even the investigation (retrospective study in which admission criteria were similar to those of conventional prospective trial) was well designed, the long-term effects of premolar extraction on facial profile could not be compared directly with short-term effects. Anyway, findings from this study claim that extraction treatment tends to flatten the profile, whereas nonextraction treatment tends to make it more protrusive.

The four studies included in this systematic review demonstrated that during the orthodontic therapy, upper and lower lips retract and nasolabial angle increases following premolar extraction in biprotrusive patients. Thus extraction reduced protrusion of perioral soft tissue to a small varying extent according to the study. In fact, a minimum of 2.4 mm and a maximum of 3.2 mm retraction was reported for the upper lip. On the other hand, the lower lip retracted by a minimum of 2 mm and a maximum of 4.5 mm. An increase in nasiolabial angle was observed in three of four studies. These small differences in profile improvements according to different studies may be explained in nongrowing patients on the basis that the lips respond differently (ie, in some patients, the lips retract more, and in others, lengthening rather than retraction of lips occurs). Thus, somehow, individual variations are noted, especially for the lower lip. This statement is also supported by high standard deviations reported for upper and lower lips. Moreover, the inconsistency of some findings can be attributed to the use of different statistical analyses.

Even though it was not the aim of this study and data collected from two of four studies demonstrated a clear relationship between incisor retraction and lip retraction, it must be noted that means 1:1.4 of 1:1.2 were reported for lower lip/lower incisor retraction in these studies, while means of 1:2.2 and 1:1.75 were documented for upper lip/upper incisor retraction. Therefore, the wide variability claimed by each of the previous studies seems considerably reduced, and more consistent ratios have been established in nongrowing patients. However, it should be underlined that because of the small amount of lip retraction that occurs, often lip position does not reach the ideal norm, and therefore a ''dished-in'' profile is an unlikely outcome.

Two other important points to be considered when soft tissue profile changes are determined are the presence of a small number of incisors crowding and the loss of anchorage. No investigation has quantified the amount of incisor crowding, and only one assessed the loss of anchorage.[5] These factors may have affected the results obtained.

Even if more consistent, these results should be applied with caution when individual response to treatment is predicted, owing to the fact that they were obtained from only four studies. Moreover, clinicians should think of factors such as interlabial gap, lip redundancy, quality of the lip musculature, and outside growth changes in the body mass index as possibly masking, exaggerating, or reducing labial changes. Careful evaluation of patients with bimaxillary protrusion is needed to gain more information on the possible consequences of incisor retraction. Last but not least, one should bear in mind that individual variation in response is great. Therefore, it would be prudent to inform the patient of average changes to expect, while also informing the patient that in his or her particular instance, this could be different. Future studies are needed to evaluate and compare these variables.

CONCLUSIONS

- Some evidence is available about the quantity of soft tissue changes attainable following premolar extraction in nongrowing patients.
- Upper lip retraction ranged from 2 mm to 3.2 mm, and lower lip retraction ranged from 2 mm to 4.5 mm, with an increase noted in the nasolabial angle.
- Soft tissue changes involve small entities and do not dramatically modify profile. Therefore, a ''dished in''

profile is not expected following premolar extraction in biprotrusive patients.

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