The extraction–nonextraction dilemma as it relates to TMD

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In the 1980s some authors discussed premolar extraction in relationship to TMD. For example, Larsson and Rönnerman[1] studied 23 Swedish adolescent patients who had been treated orthodontically 10 years previously—18 with fixed appliances and 5 with functional appliances (activators). They recorded mild dysfunction in 31% of the subjects and severe dysfunction in only one subject, according to the Helkimo index.[5] In comparing the results with other published epidemiologic studies, they concluded that extensive orthodontic treatment could be performed without fear of creating complications of TMD. Janson and Hasund[2] in Norway studied 60 patients who were an average of 5 years out of retention. These patients presented with Class II, division 1, malocclusions and they were treated as adolescents. Thirty of the patients were treated with the extraction of first premolars and 30 were treated on a nonextraction basis. A sample of 30 untreated patients was used as the control. Anamnestic symptoms were found in 42% of subjects overall (treated and untreated), with similar findings for the Helkimo index. The symptoms were mostly mild to moderate. These authors also concluded that there was not a significant risk

Abstract

Extraction has been a controversial subject for as long as the specialty of orthodontics has existed. Some authors believe that the extraction of premolars leads to temporomandibular disorders. This occurs, they say, because the vertical dimension collapses. Concomitantly, over-retraction and retroclination of the incisors cause the facial profile to flatten, bring about premature anterior contacts, and distally displace the mandible and mandibular condyle. Numerous correlation studies in the dental literature do not support this contention. There appears to be no higher incidence of temporomandibular disorders in patients treated with the extraction of premolars than in nontreated patients or those treated without extractions. Analysis of premolar extraction cases reveals that there is no collapse of the vertical dimension; on the contrary, the vertical dimension is either maintained or slightly opened. Similarly, there is no evidence that premolar extraction causes undesirable flattening of the facial profile. The facial profile established during treatment is primarily the result of diagnosis and treatment mechanics. Excessive anterior interferences resulting in possible posterior condyle displacement are the result of treatment mechanics. When arches are leveled properly and space closure and overjet reduction are adequately controlled, there is no reason that such interferences should occur.

Key Words

Extraction • Nonextraction • Temporomandibular joint dysfunction

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of developing TMD when undergoing orthodontic treatment with or without premolar extractions. Kirveskari and Alanen[3] analyzed the distribution of tooth loss in 521 subjects who lost between 1 and 14 teeth. They observed a statistically significant association between the loss of maxillary first premolars and the presence of TMD but they could not explain how the loss of these teeth predisposed the patient to TMD. However, they did point out that previous studies indicated that, on hinge closure, maxillary first premolars frequently show prematurities, and they concluded that TMD predisposes the patient to the loss of these teeth rather than visa versa.

Witzig and Spahl[4] were critical of premolar extraction, stating that this method of treatment "was a technique that was never designed with the face, the stability of the occlusion, nor the health of the TMJ in mind, merely the decrowding of arches."

They proposed that premolar extraction led to a reduction in vertical dimension, over-retraction of the premaxilla, retroclination of the upper incisors, deepening of the bite, and anterior incisal interferences. This in turn led to distalization of the mandible, posterior displacement of the condyles and TMD. They recommended that when relief of crowding required extractions, it was not premolars but second molars that should be removed. This would purportedly result in an increase in vertical dimension, a pleasing full face, and healthy temporomandibular joints.

Correlation studies do not support the accusations against premolar extraction. For example, in 1991 Sadowsky[6] published a study of 160 patients before and after orthodontic treatment. He concluded that "no statistically significant difference could be found in the change in occurrence of joint sounds between patients treated with extraction and nonextraction strategies. Fewer patients had joint sounds at the end of the active stage of treatment than before treatment, as determined objectively by audiovisual (videotape) examination. Fewer patients demonstrated reciprocal clicking after treatment than before treatment. Therefore, orthodontic treatment did not appear to pose an increased risk for development of TM joint sounds or symptoms, irrespective of whether extraction or nonextraction treatment strategies were used. A progression of signs or symptoms to more serious problems was not apparent, at least over the time period studied."

Dibbets and Van der Weele[7] presented a 15-year study which evaluated signs and symptoms of TMJ pain and dysfunction in a sample of 172 patients treated orthodontically between January 1970 and April 1972. Fifty-five percent of these patients were females. The average age of the patients was 12.5 years, with 88% of them between 8 and 15 years old. Fourteen percent of these patients had Angle Class I , 69% had Angle Class II, and 17% had Angle Class III malocclusions. Thirty-nine percent of the patients were treated with functional appliances and the remainder were treated with fixed appliances. Thirty-four percent of the patients in the group were treated without extraction, 29% were treated with the extraction of four first premolars, and 37% were treated with the extractions of other teeth. The groups were subsequently evaluated for the presence of TMJ pain and dysfunction within these three categories over a 15-year period. The patients were evaluated for subjectively perceived symptoms and objectively identified symptoms.

Dibbets and Van der Weele stated:

> It is evident that over a 15 year period there exists no relationship at all between the choice of not to extract or to extract or to extract either first premolars or any other teeth and the registration of pain, limitation of mouth opening, crepitation, and radiological signs.

Kundinger et al.[8] radiographically (with corrected tomography) studied the condyle positions of 29 upper and lower premolar extraction cases and 29 untreated patients with no evidence of TMD. They found no statistically significant difference in condyle position between the two groups. They also used electomyography to evaluate the isometric contraction velocities and the relative contribution of the masseter and anterior temporalis muscles to the bite force developed during brief maximum voluntary tooth clenching. There were no statistically significant differences between the control group and the experimental subjects in this part of the study.

Kremenak et al.[9] presented a longitudinal study of orthodontic patients begun in 1983. By using Helkimo's method, data were collected on 65 patients before initiation of orthodontic treatment, between 0 and 12 months after debanding, and 12 to 24 months after debanding. Twenty-six patients were treated without premolar extractions, 25 had four premolar extractions, and 14 had two upper premolar extractions. Tests for significance of

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differences between mean Helkimo scores were conducted for the nonextraction group compared with the extraction groups, and between pretreatment and posttreatment Helkimo scores for each group. Results included: (1) no significant intergroup differences between mean pretreatment and posttreatment scores, and (2) small but statistically insignificant ($P<0.05$) differences (in the direction of improvement) between mean pretreatment and posttreatment scores for both the nonextraction group and for the four premolar extraction group. The authors concluded that over a 10 year period there existed only small differences between the frequency of subjective symptoms and the clinical signs of TMD in subjects with or without earlier orthodontic treatment on an extraction or a nonextraction basis.

Gianelly[10] evaluated the extraction of upper first premolars only to determine if this procedure led to posterior condylar displacement. In a study of 12 Class II patients treated with upper first premolar extractions, he observed that the condyles were in a similar position, an "anterior position," when compared with an untreated control sample.

Årtun et al.[11] tested the hypothesis that retraction of maxillary anterior teeth may lock the mandible in a posterior position and evaluated the relationship between condylar position and signs and symptoms of internal derangements in the temporomandibular joints. Their sample included 29 female patients treated for Angle Class II, division 1, malocclusion with extraction of maxillary first premolars and 34 female patients treated for Angle Class I malocclusion without extractions. They measured condylar position in percent anterior and posterior displacement from absolute concentricity on lateral, central, and medial tomographic sections of each joint. Mean condylar position was more posterior at right, central, and medial tomographic sections in patients treated with extractions. The difference was due to a higher frequency of anteriorly positioned condyles in the nonextraction cases. No intergroup differences in the sagittal occlusal slide from CR to CO and the number of patients with clicking were found. However, the condyles were located more posteriorly in all tomographic sections in patients with clicking than in those without clicking. The authors concluded that they could not rule out the possibility that some patients acquire a more posterior location of the condyles during correction of Angle Class II, division 1, malocclusions with extraction only of maxillary premolars. However, the prevalence of patients with definitely posterior displacement of the condyles or joint sounds shortly after therapy was similar to the control group. They also noted an association between joint sounds and posterior displacement of the condyles.

Luecke and Johnston[12] studied the effects of maxillary first premolar extraction and incisor retraction on mandibular position. Their study group consisted of 42 Class II, division 1, patients whose treatment included the extraction of the two maxillary first premolars. They used regional and anterior cranial-based cephalometric superimpositions to quantify the individual components of the molar and overjet corrections, to measure both at the chin and condyles the mandibular displacement seen during treatment, and to examine the extent to which this displacement was related to the correction of maxillary incisor protrusion. Although the patients underwent marked maxillary incisor retraction (on average, 5 mm), lip retraction was much less pronounced. Also, 70% of the sample showed a net forward displacement of mandibular basal bone. Significantly, changes in condylar position were not correlated with incisor retraction but rather with the changes in the buccal occlusion and the growth of the maxilla. Thus, the 30% of the patients who showed evidence of distal displacement were generally nongrowing patients who underwent more than average anchorage loss in the mandible and less than average loss in the maxilla. Regardless of the direction of basal displacement, however, condylar remodeling apparently served to stabilize the spatial position of surface landmarks (e.g., condylion). Finally, although the orthodontic treatment produced marked incisor retraction, the soft tissue profile appeared to have been influenced more profoundly by the growth of the nose and the chin. The authors concluded that the available data failed to support the claim that maxillary premolar extraction and incisor retraction must, of necessity, lead to unsightly profiles and distal mandibular displacement.

Discussion

The following review of the supposed progression from premolar extraction to temporomandibular disorders reveals that these claims are either incorrect in their basic premise, or, if such effects do indeed occur, they are the re-

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sult of diagnostic errors or errors in mechanics. The literature review shows no scientific basis for the claim that premolar extraction results in a higher incidence of TMJ disorders.

Collapse of the vertical dimension

It has been proposed that when premolars are extracted, the forward movement of molars brings about a collapse of the vertical dimension. No studies were carried out and only one reference was cited to support this position. The reference was a 1954 article by Sleichter, who made the following brief statement based on a 1947 thesis by Cole: "...overbites reduced by treatment, especially extraction treatment, tended to return."[13]

A number of articles on vertical dimension were written prior to 1980.[20-27] Some were clinical in nature, presenting opinions based on treatment experience, while others compared treated and untreated cases. A consistent finding was that untreated patients showed an average decrease in the mandibular plane to SN plane angle. These articles also made reference to a number of general treatment concepts concerning vertical dimension:

1. In the treatment of low angle, deepbite cases:
   a. Nonextraction treatment is preferred, in that it helps in the bite opening process.
   b. When headgear is indicated, cervical headgear is preferred.
   c. Class II and Class III elastics are helpful in bite opening.
   d. Leveling of the arches helps in bite opening.
2. In the treatment of high angle, openbite cases:
   a. Premolar extraction treatment aids in bite closure.
   b. When headgear is indicated, high pull headgear is preferred.
   c. Class II and Class III elastics should be used minimally because of their extrusive effect.
   d. Complete leveling of the arches is contraindicated because it leads to bite opening.

Most authors did not document the exact method by which the above processes occurred, but they generally observed that the mandibular plane angle opened slightly in treated cases and closed slightly in untreated cases. They attributed the difference to the general extrusive nature of orthodontic tooth movement, despite application of the above principles. Of the clinical studies reviewed, only Pearson[27] reported the ability to close the mandibular plane angle with premolar extraction treatment. He treated high angle openbite cases by removing premolars and using vertical chin cups both prior to and during orthodontic treatment, with the specific intention of reducing the mandibular plane angle. He showed a mean decrease in the mandibular plane angle of 3.9°. There were no follow-up studies to indicate whether or not there was a rebound effect and an increase in the mandibular plane angle to its original size. As stated above, no other studies documented a significant decrease in the SN-to-mandibular plane angle with premolar extraction treatment. Dougherty,[23] for example, analyzed 96 patients, dividing them into four groups of different age ranges (9 to 11, 11 to 13, 13 to 15, and 15 to 18). Forty-four of these patients were males and 52 were females. Forty-two patients were treated on a nonextraction basis and 54 were treated with premolar extractions. In all of these age groups and in all of the nonextraction and extraction cases, there was a slight increase in the mandibular plane angle. In the nonextraction group the SN-to-mandibular plane angle increased from 33.381° ± 5.650° to 34.631° ± 5.732°, and in the premolar extraction group the SN-to-mandibular plane angle increased from 37.241° ± 4.761° to 38.926° ± 4.841°. This study supported the general opinion that increase in the mandibular plane angle occurs in orthodontically treated cases.

Several articles and papers discussing the effect of premolar extraction on the vertical dimension have been published since 1987. Staggers[28] studied the treatment changes that occurred in 22 second molar extraction cases and compared them with the treatment results of 22 first premolar extraction cases. Her analysis of cephalometric data demonstrated only a few statistical differences between the two groups. The second molar extraction groups showed no change in the mandibular plane to the horizontal plane (SN plane plus 7°) angle and the first premolar extraction group showed a decrease of 0.5° in this same angle. Thus, there was very little difference between the two groups and a significant collapse of vertical dimension in the first premolar extraction group did not occur.

Garlington[29] studied vertical changes in high mandibular plane angle cases following enucleation of second premolars. These second premolars were enucleated with the specific purpose of reducing the vertical

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dimension in these cases. Garlington compared the changes in 23 cases with Isaacson et al.'s [24] pretreatment values for total facial height, upper facial height, and lower facial height in high angle cases. The patients in Garlington's study all showed GoGn-SN angles of greater than 38°. Garlington observed a value for lower facial height that was lower than Isaacson's value by a statistically significant amount (P<.01). But he also noted that the mandibular plane-to-SN plane angle in the second premolar extraction cases decreased only 0.8° over the period of his study.

Klapper[30] studied the influence of premolar extraction and nonextraction orthodontic treatment on brachyfacial and dolichofacial growth patterns. The sample consisted of 30 nonextraction cases, half with brachyfacial patterns and half dolichofacial, and 30 extraction cases, half brachyfacial and half dolichofacial. Although the Frankfort mandibular plane angle changes were evaluated in this study, this measurement was included within the facial index which included four other measurements (lower facial height, mandibular arc, facial axis, and facial depth). There were no significant differences recorded in any of these groups in the facial index. Facial axis did not exhibit any statistically significant changes in any of the groups.

In two recently completed masters' theses at the University of Southern California Department of Orthodontics, the effects of premolar extraction treatment on the mandibular plane angles were studied. Cusimano[31] examined the effects of four first premolar extractions on the GoGn-SN angle and on a second vertical angular measurement using Björk's mandibular measurements and the Horizontal Plane (7° plus SN). The sample consisted of 16 male and 21 female patients with GoGn-SN angles greater than 36° (i.e., one standard deviation above Reidel's[32] average of 31.71°). Changes in vertical dimensions were determined using eight linear and two angular measurements. The results were similar to previous studies concerning the effects of first premolar extraction on vertical angular measurements. The average GoGn-SN angle was 39.4° ± 3.3° before treatment and 39.8° ± 4.0° after treatment, an increase of only 0.4°. The average constructed plane angle was 56.9° ± 4.3° before treatment and 57.5° ± 4.9° after treatment, an increase of 0.6°. The mandibular first molars moved mesially 4.1 mm ± 1.9 mm and occlusally 2.2 mm ± 1.6 mm. The maxillary first molars moved forward an average of 5.0 mm ± 2.4 mm and occlusally 3.2 mm ± 1.4 mm. Cusimano concluded that while the molars came forward a substantial amount, the compensatory vertical eruption of these teeth nullified any potential bite closing effect (Figure 1).

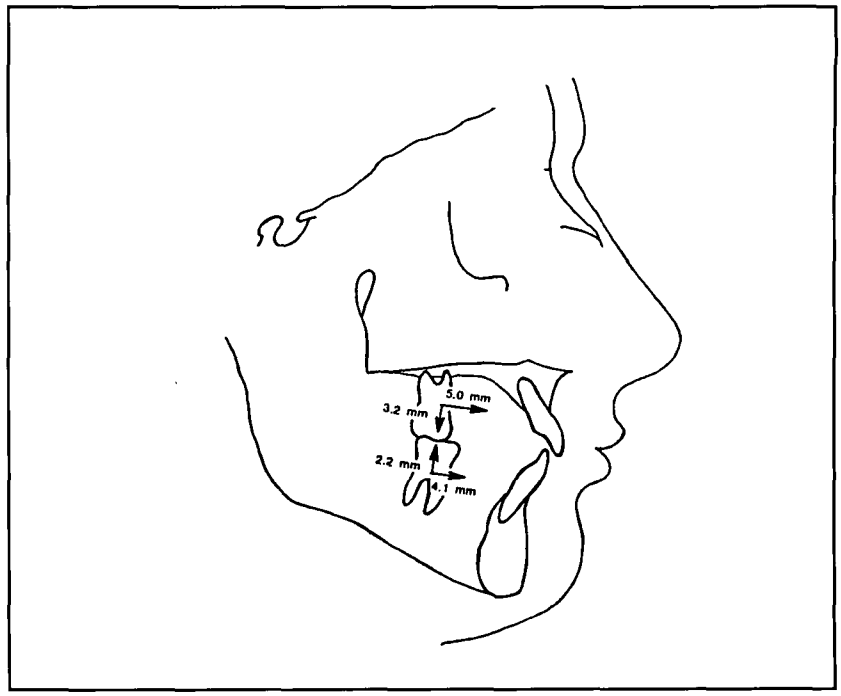

Figure 1

Figure 1
Cusimano[31] studied a group of 37 high angle patients who were treated after extraction of four first premolars and found that occlusal movement of the posterior teeth tended to maintain the mandibular plane angle so that and vertical dimension remained unchanged.

In 1992 Linn[33] presented a comparative study of first and second premolar extraction treatments on facial vertical development. Linn studied 16 first premolar extraction cases selected from the files of the USC orthodontic department and compared them with 16 second premolar extraction cases from the private practice of one orthodontist. All patients had mandibular plane angles of 38° or greater, Class I molar relationships, and an age range of 8 to 18 years at the start of treatment. All patients were treated with fixed edgewise appliances. Linn's studies showed no closure of the mandibular plane angle in either the first premolar or second premolar extraction cases. Although mesial movement of the maxillary and mandibular first molars was not measured, movement did occur. This study demonstrated the compensatory vertical eruption of the posterior segments that nullifies any bite closure effect from the mesial movement of the molars. Linn commented that the results of his study seemed to imply that the overriding factor in growth and development of the craniofacial complex is one of stability and maintenance of the genetically determined relationship of the component parts of the max-

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illa, mandible and dentoalveolar processes to each other and to the cranial base. This seems to occur regardless of the choice of first or second premolar extraction treatment.

Staggers[34] compared vertical changes occurring in 45 Class I nonextraction cases with those occurring in 38 first premolar extraction cases. She observed no significant difference between the vertical changes in both groups. Orthodontic treatment in both groups produced a slight increase in vertical dimension (mandibular plane to horizontal plane angle increase of 0.11° ± 2.53° in the extraction group and 0.14° ± 1.97° in the nonextraction group).

Flattening of the facial profile

Recent studies do not support the position that premolar extraction causes undesirable flattening of the facial profile. Drobocky[36] studied the changes in facial profile of 160 orthodontic patients treated with the extraction of four first premolars. Records of 10- to 30-year-old patients were selected from five sources: patients treated by Charles H. Tweed on file at the Tweed Foundation; patients treated with the Begg technique by the Kessling Rocke Group; patients from two different practices treated with pretorqued and preangulated edgewise brackets; and patients with premolars enucleated at an early age. The mean changes for the total sample included an increase of 5.2° in the nasaolabial angle and retraction of the upper and lower lips 3.4 mm and 3.6 mm to the E-line, respectively. Between 5% and 25% of the sample had more protrusive lips after treatment. The Tweed patients generally exhibited the greatest lower lip retraction. Comparing these treated cases with values representing ideal facial patterns, it was concluded that the extraction of four first premolars generally did not result in a "dished-in" profile. The authors observed that approximately 10% to 15% of the cases could be defined as demonstrating excessively flat facial profiles after treatment, while 80% to 90% of the patients demonstrated profiles that were improved or remained satisfactory after premolar extraction treatment.

In 1990 Staggers[28] compared 22 cases treated with second molar extractions with 22 first premolar extraction cases and concluded that the two groups had fewer differences than indicated by the advocates of second molar extraction. The lower lips in the premolar group were retracted a greater amount than in the second molar group. However, the resulting facial profiles after extraction of second molars appeared to be no different from those obtained after the extraction of first premolars.

In 1993 Young and Smith[37] compared facial profile changes in patients treated without extraction with profile changes in patients whose treatment included the extraction of four first premolars. Cephalometric radiographs were used to examine the soft tissue profiles of 198 orthodontic patients treated with fixed appliances on a nonextraction basis. These records were selected from five sources, which consisted of cases treated by a Tweed Foundation instructor using the Tweed technique; patients treated with the Begg appliance; patients from two different practices treated with pretorqued, preangulated edgewise appliances; and patients treated in two stages with functional appliances followed by full fixed edgewise appliances. These cases were compared with the selection of cases collected by Drobocky and Smith in which patients were treated with four first premolar extractions. Although the mean values of soft tissue changes were smaller in the nonextraction patients, the variability of these changes was generally as great as in the four premolar extraction cases. In addition, the percentages of undesirable facial changes were similar in the extraction and nonextraction samples. The authors concluded that it was simplistic and incorrect to blame undesirable facial aesthetics after orthodontic treatment on the extraction of first premolars.

Diagnosing and treatment planning for an orthodontic case is a complicated process. No matter which method of analysis is used, the evaluation of maxillary and mandibular incisor position and soft tissue profile is an integral part of this process. Clinical evaluation of the patient, cephalometric evaluation of hard and soft tissues, a careful look at study models and photographs, and, in some instances, computer imaging techniques help establish the most appropriate treatment goals, including the goals related to the facial profile. The decision to extract or not extract is based on such key factors as: the importance of a periodontally sound end result; the vertical and horizontal skeletal pattern of the patient; the protrusion or retrusion of incisors; the soft tissue thickness and the facial profile; and the amount of crowding or spacing. The decision to extract premolars is not made lightly. When extractions are included in the treatment plan, it is done with the express purpose of providing the most satisfactory facial profile for the

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patient.

It should be pointed that there are some clinical situations in which the facial profile may become slightly flattened, irrespective of whether extraction or nonextraction treatment is performed. For example, a patient with a dentition that is significantly retruded relative to the chin and the nose may exhibit some facial flattening, even when treated on a nonextraction basis, and when every attempt has been made to keep the profile as full as possible. Some Class II cases that are borderline surgical cases (in which a decision is made to treat without surgery) may show some facial flattening. In such cases, every attempt is made to keep mandibular incisors as far forward as is safely possible, given the restrictions of alveolar bone in the mandibular anterior segment, so that maxillary incisors are not over-retracted. However, despite these measures, the facial profile may become slightly flattened due to the existing skeletal pattern. And finally, some cases with excessively long lower facial heights that are treated without surgery may show some facial flattening because the incisors, as a form of dental compensation, must be left in a more upright position in order to allow for proper anterior tooth contact. These types of cases are frequently treated on an extraction basis. However, the extractions do not cause the facial profile to flatten.

In summary, there is no basis for the statement that premolar extraction treatment leads to undesirable flattening of the facial profile when proper diagnosis and treatment planning procedures are carried out.

Premature anterior contacts leading to posterior mandibular displacement

Does premolar extraction lead to excessive retraction and retroclination of incisors (particularly maxillary incisors), which in turn results in premature anterior contacts and posterior mandibular displacement? Leucke and Johnston[12] said no, and a review of the mechanical principles of premolar extraction treatment reveals that incisor retroclination, bite deepening, and incisor interferences are not inevitable results of premolar extraction treatment. They are preventable, just as they are with nonextraction treatment. There is an increased tendency in extraction cases toward incisor retroclination and bite deepening, due primarily to four factors, all of which are preventable with appropriate treatment mechanics. These factors are: initial canine angulation, canine retraction during leveling and aligning, torque control during space closure, and overbite control during overjet reduction.

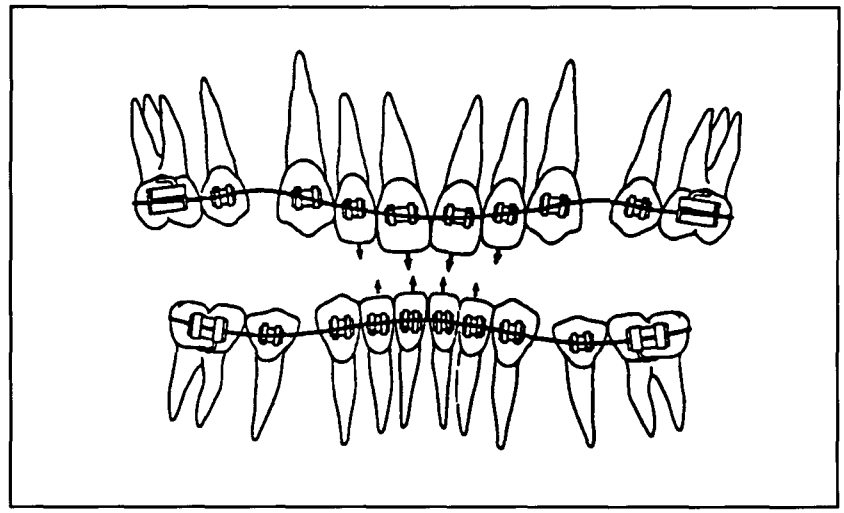

Figure 2

Figure 2
When premolar extraction cases show upright or distally inclined canine crowns and preadjusted brackets are placed on the canines, these brackets show extreme angulations. When archwires are placed in these brackets as well as the incisor brackets, the result is incisor extrusion and bite deepening.

1. *Initial canine angulation.* Many orthodontists use preangulated brackets that have distal root tip or mesial crown tip built into the canine brackets. When these brackets are placed on canines in which the crown is upright or distally inclined, they create a deflection in the anterior segment of the initial archwire which leads to extrusion of the incisors (Figure 2). This condition can be prevented in any of three ways. First, the brackets can be left off the incisors until the roots of the canines have been distalized and the crowns assume a more normal position. This will bring the archwire to a more acceptable position relative to the incisor brackets. Second, the archwire can be temporarily left out of the incisor bracket slots until the canines have assumed a more appropriate position. The archwires can then be placed more passively in the incisor slots. And third, compensatory bends can be placed in the archwire mesial to the canine brackets, which will also allow the archwire to sit more passively in the incisor brackets until the canines can be brought to a more acceptable angulation.

2. *Canine retraction during leveling and aligning.* The purpose of premolar extraction is normally to provide room for canine retraction so that anterior crowding and/or anterior protrusion can be corrected. When canines are tipped distally during the retraction process, the angulation in the canine brackets produce the same extrusive effect on the incisors as described above. When elastic forces are applied from posterior segments to canines in the early stages of treatment with light archwires, the

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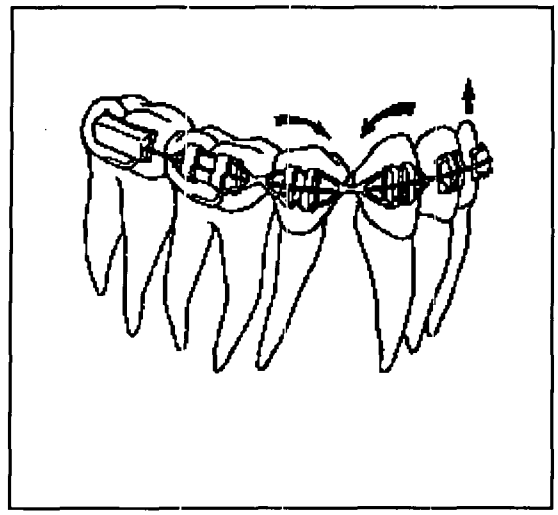

Figure 3
Tipping effect of elastic forces on canines in the early stages of leveling and aligning.

effect is generally distal tipping of canines (Figure 3). This is because the elastic force is greater than the uprighting effect of the light initial archwires. Connecting posterior segments to canines with figure eight ligature wires will produce a light and limited retractive force on the canines (Figure 4) which minimizes the tipping effect on the canines and the subsequent extrusion of incisors.[38]

3. Torque control during space closure. When extraction spaces are closed using either sliding mechanics or closing loop mechanics, there is a tendency toward retroclination of the incisors. This is usually desirable in the mandibular arch, but not in the maxillary arch. This anterior torque consideration can be managed in any of three ways. First, preadjusted incisor brackets can be selected with varying amounts of anterior torque, depending on the needs of the case. Most orthodontists prefer additional torque (palatal root torque) in maxillary incisor brackets and more uprighting torque (labial root torque) in mandibular incisor brackets in the management of premolar extraction cases. Second, since there is no single set of bracket angulations that solves all torque problems, torque can be placed in the incisor area of rectangular archwires to control incisor position. And third, whether using closing loops or sliding mechanics for space closure, forces should be such that torque control is not lost.

4. Overbite control during overjet reduction. Premolar extraction cases require varying amounts of overjet correction for completion of treatment. If this overjet reduction is commenced without proper overbite control, premature anterior contacts result (Figure 5). This can also be prevented with proper arch leveling and by using force levels that do not overpower space closure archwires, resulting in bite deepening.

Posterior condylar displacement

There is no evidence in the literature to date indicating that premolar extraction treatment causes distal mandibular displacement and subsequent posterior condylar displacement. Instead, the literature supports the view that condyles are in a more concentric position at the end of orthodontic treatment. This "centric relation" position should be the goal of orthodontic treatment, irrespective of whether treatment is carried out on an extraction or nonextraction basis. Today, centric relation is considered to be a position in which the condyles are positioned in an upward and anterior position (with the condyle at the posterior superior aspect of the articular eminence) or in an uppermost and midmost position in which the condyles are seated and concentric. The difference between these positions is minimal—within a one-millimeter range of one another—which is tolerable for diagnostic as well as finishing purposes. Most orthodontists generally do not believe that condyles should be placed on the articular eminence as Gelb[39] suggested (in a "4-7" position). Even if the articular discs are anteriorly displaced, most orthodontists today are not attempting to "build" the occlusion on the discs in this forward position. Attempts at doing this have resulted in the condyles seating back into the fossa, once again behind the articular disc.[40] Most orthodontists and oral surgeons attempt to avoid medial or lateral torquing or distal movement of the condyles during orthognathic surgery. These condyle changes have been shown to lead to condylar remodeling and, at times, TMD symptoms.[41] And finally, most orthodontists attempt to avoid finishing cases with condyles in a posterior position. The general goal of most orthodontic treatment is centric relation.

It must also be noted that untreated patients with healthy, asymptomatic temporomandibular joints show variations in their condylar positions. This has been demonstrated by Blaschke[42] and Pullinger.[43] Their work shows that in groups of healthy, asymptomatic patients, the distribution of condylar positions generally fits a bell-shaped curve, with some condyles being anteriorly positioned and some being posteriorly positioned. Thus, there are radiographic variations from the normal in the

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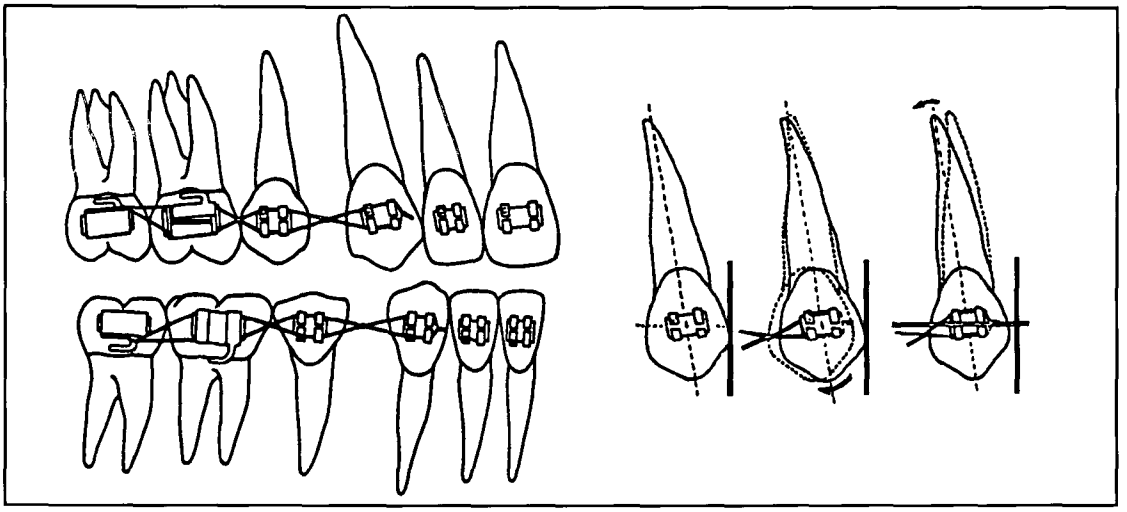

Figure 4A-B

population of patients presenting for orthodontic treatment. However, this should not alter the goal of orthodontic treatment to centric relation position.

Summary and conclusions

It has been stated that the extraction of premolars leads to a reduction in vertical dimension, over-retraction of the premaxilla, retroinclination of incisors, deepening of the bite, and anterior incisal interferences. This, in turn, is said to lead to distalization of the mandible, posterior displacement of the condyles, and TMD. A review of the orthodontic literature revealed that there is no higher incidence of temporomandibular joint sounds or generalized temporomandibular disorders in patients treated with the extraction of premolars than in untreated patients or those treated on a nonextraction basis. There is also no evidence of increased incidence of posterior mandibular displacement or posterior condylar displacement when comparing first premolar extraction cases with nonextraction and untreated patients.

A discussion of the sequence described in the supposed progression from premolar extraction to temporomandibular disorders can be summarized as follows:

1. Collapse of the vertical dimension. There is no evidence that premolar extraction leads to collapse of the vertical dimension. In fact, the orthodontic literature indicates that the vertical dimension is usually increased slightly with orthodontic treatment. It has been suggested in the literature that the extraction of premolars is often helpful in the treatment of high angle openbite cases, in that this treatment aids in closure of the bite. This bite clo-

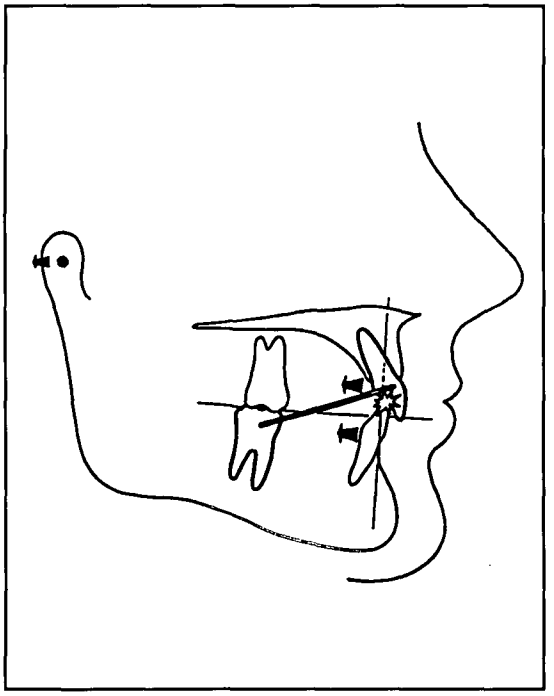

Figure 5

Figure 4A-B
The tipping effect of elastic forces on canines during leveling and aligning can be minimized by utilizing figure-eight ligature ties for canine retraction.

Figure 5
Effect of failure to control the overbite before or during overjet correction is initiated with Class II mechanics.

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sure, however, is due primarily to anterior dental changes rather than skeletal changes involving closure of the mandibular plane angle and collapse of the vertical dimension. Finally, it has been suggested that nonextraction treatment be carried out in low angle deep bite cases. However, if crowding and/or protrusion is excessive, then premolar extraction treatment may be necessary and, with proper treatment mechanics, can be accomplished without collapse of the vertical dimension.

2. Flattening of the facial profile. There is no evidence that premolar extraction leads to undesirable flattening of the facial profile. If this does occur, it is primarily the result of diagnostic errors and/or errors in treatment mechanics, rather than the result of the extraction of premolars per se.

3. Excessive anterior interferences. The premise that all anterior interferences lead to TMD has not been proven, but the avoidance of such interference is important for a number of reasons (i.e., periodontal trauma, avoidance of tooth wear and root resorption, and possible TMD considerations, etc.) The development of anterior interferences during premolar extraction treatment is related to treatment mechanics, rather than to the extractions per se. Such interferences can be avoided by properly managing canines during leveling and aligning, by controlling anterior torque, by using appropriate force levels during space closure, by stripping the mandibular incisors and/or opening spaces to build up the maxillary lateral incisors in cases with anterior tooth size discrepancies, and by ensuring that the overbite is controlled during overjet reduction.

4. Posterior condylar displacement. There is no evidence that premolar extraction treatment leads to posterior condylar displacement. Orthodontists make every attempt to treat cases, both extraction and nonextraction, to a centric relation position, and have the mechanical ability to accomplish this in most cases.

Objective evaluation reveals little support for the claim that premolar extraction treatment leads to temporomandibular disorders. The specialty continues to be receptive to recommendations for improving treatment results, but such recommendations must be based on sound clinical and/or research principles and not on undocumented opinions.

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