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Review Article

EFFECTS OF EXTRACTION ON FACIAL VERTICAL DIMENSION- A CRITICAL ANALYSIS

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ABSTRACT

Extraction has been a controversial subject in the speciality of orthodontics for a long time. Some authors believe that the extraction of premolars leads to temporomandibular disorders because of collapse in vertical dimension. Over-retraction and retroclination of incisors cause the facial profile to flatten, bring about premature anterior contacts and displace the mandible and condyle distally. But numerous correlation studies in the literature do not support this contention. 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. Moreover, there is no evidence that premolar extraction causes higher incidence of temporomandibular disorders or undesirable flattening of the facial profile.

INTRODUCTION

The extraction of premolars as a practical form of orthodontic therapy has been accepted for many years; but there is a controversy concerning the effect of premolar extraction on the vertical dimension. First premolar extraction is considered by many to be an etiologic factor in temporomandibular joint (TMJ) disorders. It has been suggested that orthodontic forward movement of the posterior teeth after mandibular and maxillary premolar extraction leads to a reduction in vertical dimension (Tulley, 1959; Wyatt, 1987; Bowbeer, 1987). The mandible is then allowed to overclose; as a result, it was thought that TMJ problems are likely to occur. There are no published results to support this theory. Another theory that has been proposed is that first premolar extractions lead to over-retraction of the anterior teeth, particularly the maxillary anteriors (Witzig, 1987; Farrar, 1983). This over-retraction of anterior teeth is thought to displace the mandible and the condyles posteriorly. Posterior condylar displacement has long been associated with TMJ disorders. As with the previous hypothesis, this theory has not been substantiated by research.

Garlington, 1987 attempted to reduce the vertical dimension through early removal of the remaining deciduous teeth and enucleation of the second premolars; although there was a statistically significant decrease in lower facial height, the MPA decreased by only 0.8°.

Pearson, 1973 showed a mean decrease in MPA of 3.9° after premolar extraction, with vertical chincups used before and during orthodontic therapy. There was, however, no follow-up study to determine whether the mandibular plane angle reopened to its original position after treatment. Cusimano *et al*, 1993 analyzed the premolar extraction cases and found no over collapse of the vertical dimension; on the contrary, the vertical dimension was either maintained or slightly opened.

Stability following orthodontic treatment continues to be a challenge to all orthodontists (Little, 1990). The ability to maintain long-term alignment following orthodontic treatment involving the extraction of premolars has also been unpredictable. Therefore, the extraction and non-extraction decision continues to be a controversy in orthodontics and numerous studies have compared the fluctuating patterns of positive and negative perceptions of the effects of extraction and non-extraction orthodontic treatments in recent years (Hayasaki *et al*, 2005; Kahl-Nieke *et al*, 1996; Rossouw *et al*, 1999). Premolars are the most commonly extracted teeth for orthodontic purposes (Hans *et al,* 2006). The two primary reasons for removal of the permanent teeth are to correct a discrepancy between tooth size and arch length, and to reduce bimaxillary protrusion. Premolars are suitably located between the anterior and posterior segments and since there are two premolars per quadrant, premolar extractions would seem to be most appropriate to allow straight forward relief of crowding or

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the correction of an improper interincisor relationship (Gottlieb *et al*, 1996).

The effect of premolar extraction on the facial vertical dimension and temporomandibular disorders (TMD) has remained a controversy since long time (Wyatt, 1987). According to some authors (Bowbeer, 1987; Witzig, 1987; Wilson, 1971), extraction causes the posterior teeth to move forward which leads to overclosure of the mandible and loss of vertical dimension. According to another proposal, lingual tipping of the anterior teeth occurs during space closure which creates incisal interferences and displaces the condyles posteriorly thus contributing to TMD (Witzig, 1987; Bishara *et al*, 1997; Farrar and McCarty, 1983). Though widely investigated, the effect of extractions on facial height remains unclear. However, there are many reports and data to disprove this hypothesis (Gianelly *et al*, 1991; Luecke and Johnston 1992; Al-Nimri 2006; Kremenak *et al*, 1992).

REVIEW OF LITERATURE

Ilken Kocadereli, 1999 did a study to evaluate changes in vertical dimension occurring in class I patients treated orthodontically with first premolar extraction and to compare these changes with those occurring in class I patients treated orthodontically without extraction. Records of 40 non-extraction patients and 40 maxillary and mandibular first premolar extraction patients was taken. Cephalometric measurements (linear and angular) surveyed and compared for changes in cephalometric variables resulting from orthodontic treatment. Statistical analysis of data revealed no significant differences between extraction and non-extraction groups except upper first molar position to PtV which showed mesial molar movement in extraction group. Results showed that vertical changes occurring after first premolar extraction were not different than those occurring in non-extraction cases. On average, most of changes in linear cephalometric measurements from before treatment to after treatment reflected an increase in vertical dimension. Results of this study did not support the hypothesis that premolar extraction results in loss of vertical dimension of occlusion.

Meena Kumari, 2010 did a study to compare the vertical facial and dental arch dimensional changes occurring with extraction and non-extraction orthodontic treatment. The sample consisted of 81 subjects with 41 patients treated with non-extraction and 40 patients treated with first premolar extractions. Pre-treatment and post-treatment cephalometric values were compared in the two groups. Changes seen in vertical parameters after treatment were not significantly different from each other in the two groups. The study showed that the changes in vertical proportions were similar with both treatments producing an increase in vertical dimension in cephalometric variables measured. Increase in vertical dimension may also be attributed to residual growth and mechanotherapy used which tends to favour extrusion of teeth. There is also compensatory eruption of posterior segments that nullifies any bite closing effect from the mesial movement of molars.

Kim *et al*, 2005 did a study to investigate the effect of first and second premolar extraction on facial vertical dimension. The sample consisted of two groups, with one group (G 1) having maxillary and mandibular first premolar extractions and the second group (G 2) having upper and lower second premolar extractions. G 2 showed more mesial movement of first molars and less retraction of anteriors. Both groups showed increased anterior facial height. G 2 had more cases with increased lower facial height. Molars can be extruded when extraction space is closed. Extrusion appears to maintain or even increase the facial vertical dimension. Greater mesial movements can possibly allow for more molar extrusion. Therefore the wedge effect concept that bite is closed by extraction of second premolar and forward movement of molars seems invalid.

Pearson, 1978 used extraction and vertical-pull chin cup for vertical control in treatment of patients having backward rotational growth tendencies. Mandibular plane angle measured to Sella-Nasion (GoGn-SN) decreased by an average of 3.9 $^{\circ}$ following four first premolar extractions and vertical pull chin cup therapy.

Aynur Aras, 2002 did a study to analyse vertical changes following orthodontic extraction treatment in skeletal open bite subjects. The study concluded that no significant mandibular rotational change was observed following orthodontic treatment with first premolar extractions in subjects with skeletal open bite consisting of anterior teeth involvement only. The extraction of second premolars or first molars led to a closing rotation of the mandible in skeletal anterior open bite extending to the posterior teeth.

Farzin Heravi and co-authors, 2012 conducted a study to compare dentoskeletal changes following orthodontic treatment with first premolar extraction in long face and normal patients. Treatment changes revealed a significant increase in the vertical distance from the upper molar to palatal plane, the lower molar to mandibular plane and Menton to palatal plane in all groups. There was significantly more increase in most post-treatment linear measurements in males than in females, with the same direction in both genders. There were no significant differences between normal and long face in any measurement. The study concluded that all of the orthodontic patients had some dental extrusion after the extraction of four first premolars during fixed orthodontic treatment. The difference between normal and long face patients was not significant.

GC Ramesh and co-authors, 2012 did a study to evaluate overbite and vertical changes following first premolar extraction in high angle cases. The study concluded that there was no decrease in the vertical facial dimension, overbite and mandibular plane angle following first premolar extraction in high angle cases.

HR Sukhia, 2013 evaluated lower facial height treatment changes in bi-maxillary protrusion orthodontic cases. The aim of the study was to investigate the change in lower anterior facial height (LAFH) following 1st premolar extraction and incisor retraction in bimaxillary proclination orthodontic cases. The study concluded that Lower facial height can be altered following 1st premolar extractions and incisor retraction in bimaxillary proclination patients. The soft tissues associated with the lower facial height also showed changes which contributed to the improvement in the patients facial profile post-treatment. Thereby the main complaints of increased facial height and especially lip protrusion can be addressed following extraction treatment.

McLaughlin and Bennett, 1995 endorse the fact that premolar extraction does not cause collapse of the vertical dimension, flattening of facial profile or temporomandibular disorders (TMDs). Analysis of premolar extraction cases reveals that there is no collapse of the vertical diomension, on the contrary the vertical dimension is either maintained or slightly opened.

Yating Wang and co-authors, 2013 evaluated vertical changes in Class I malocclusion between two different extraction patterns. Records of 47 patients with extraction of maxillary first premolars and mandibular second premolars (4/5, Group A) and 46 patients with extraction of four first premolars (4/4, Group B) were obtained. Pre-treatment and post-treatment cephalograms were digitized, 8 skeletal and 10 dental cephalometric measurements were selected to evaluate vertical changes. After treatment, both groups showed significant vertical changes after orthodontic treatment without remarkable differences between the groups. It was concluded from the study that no significant vertical changes occurred after orthodontic treatment with two different extraction patterns. The hypothesized wedge effects due to mesial movement of posterior teeth might be balanced by the extrusion of posterior teeth as well as the residual growth potentials.

DISCUSSION

Retrospective sample studies (Luecke and Johnston 1992; Sadowsky and Bebole, 1980; Sadowsky and Polson, 1980; Dibbets and van der Weele, 1987; Egermark and Thilander, 1992; Rendell *et al*, 1992) and longitudinal sample studies (Kremenak *et al*, 1992; [2] Hirata *et al*, 1992; Artun *et al*, 1992) have consistently failed to demonstrate a causative link between orthodontic treatment (including premolar extraction) and temporomandibular joint disorders. In Angle Class I malocclusions, the extraction of premolars was to relieve tooth-arch length discrepancy. In most cases the extraction space is used to relieve crowding, and the remainder is used to retract the anterior teeth. When the anterior teeth are being retracted, the objective of anchorage is to maintain the position of posterior teeth. If anchorage is maintained, then the supposed loss of vertical dimension cannot happen (Staggers, 1994). The effect of growth on the vertical dimension of the face is an important factor. As the mandible develops, it is displaced downward and forward because of primary and secondary displacement (Enlow, 1990). Facial height increases as a result of facial growth. Facial growth direction may be altered by the use of orthopedic appliances, but alteration of growth with extraction has not been documented.

Vertical pattern is one of the factors affecting extraction decision during treatment planning. More important criteria include soft tissue profile, crowding, overjet, tooth size and status of teeth. The study done by Meena Kumari and Mubassar Fida, 2010 showed that the changes in vertical proportions were similar with both treatments (extraction and non-extraction) producing an increase in the vertical dimension in cephalometric variables measured. Thus, their study does not support the theory as suggested by several authors (Wyatt, 1987; Bowbeer, 1987; Wilson, 1971) that the extraction of the first premolars produces a loss in the vertical dimension of occlusion. In a study by Staggers, 1994 on 45 non-extraction and 38 extraction patients, they showed that the extraction of all first premolars did not result in loss of vertical facial dimensions when compared to non-extraction treatment, corroborating the findings of Kim *et al,* 2005. The results of Kocadereli's research (1999) on 40 patients in each extraction and non-extraction groups showed that premolar extraction did not cause loss of vertical dimension.

Sivakumar and Valiathan, 2008 showed that linear vertical dimensions increased in both the extraction and the non-extraction groups and the changes were comparatively greater in the extraction group. The increase in vertical dimensions as seen in this study may be attributed to growth because the patients included were in their growing period which generally results in the increase in facial height and also to the orthodontic force application that tends to favour extrusion of teeth. There is also compensatory eruption of posterior segments that nullifies any bite closing effect from the mesial movement of molars.

Orthodontic treatment is generally completed in adolescents before growth is fully expressed, therefore, any growth changes must be anticipated. It is also crucial to judge what is going to change after the orthodontic treatment.

Vertical and arch dimensional changes are affected by the anchorage requirements, and also by the amount of space utilized for decrowding. It is evident that there is much individual variation in response to growth and treatment created by differences in choice of treatment mechanics and different facial and occlusal objectives, depending on pre-treatment characteristics as well as the extraction sequence itself.

Extractions of specific teeth are required in the various presentations of malocclusion as part of a comprehensive treatment to achieve goals and stability. It is important that all aspects, like soft tissue profile, degree of crowding, overjet, molar relation, status of teeth, growth etc., are taken into account when making a detailed treatment plan.

Neither non-extraction nor extraction treatment should be goals of treatment in themselves, but merely different paths taken to best meet the diagnosed needs of individual patients at the time of presentation. With good case selection, clear objectives and careful management throughout the treatment, any un-toward effects can be avoided.

Studies on the relationship between orthodontic treatment with extraction and facial vertical dimension (FVD) have shown that the extractions for orthodontic purposes does not significantly change the FVD. Staggers, 1994 showed that there was no significant difference in the vertical dimension changes between 1st premolar extraction and non-extraction groups, and orthodontic treatment produced increases in the cephalometric vertical dimensions in both groups. A study was done by Chua *et al*, 1993 to examine the effect of extraction and non-extraction on lower anterior facial height (LAFH, ANS-Me) with a standardized score to account for effects due to growth and it concluded that non-extraction treatment was associated with a significant increase in LAFH, but extraction treatment was not associated with any significant changes in LAFH. Another study done by Cusimano *et al*, 1993 found that there were no differences in facial height of hyperdivergent patients with first premolar extraction treatment when pre- and post-treatment results were compared.

Taner-Sarisoy and Darendeliler, 1999 reported in their studies that treatment with fixed appliances and premolar extractions did not significantly alter the growth pattern but orthodontic treatment can significantly influence LAFH. The net increase of lower facial height ratio (LFHR) is due to extrusion of molars by treatment mechanics and residual vertical growth of the patients. It is possible that mesial molar movement may help accommodate these effects and work to maintain LFHR. Extrusion appears to maintain or even increase the FVD. Therefore, greater mesial movements can cause more molar extrusion due to the chosen mechanics of space closure. If extrusion of the posterior teeth keeps pace with the increase in anterior facial height, SN-MP will be maintained and the bite-closing effect of mesial molar movement will be nullified (Cusimano *et al*, 1993). Residual growth has to be considered because it can influence LAFH.

Garlington and Logan, 1990 in their study on the mandibular second premolar enucleation cases observed a significant decrease in LAFH due to forward rotation of the mandible and they found no significant differences in total facial height and the maxillomandibular plane angle (MMA). This suggests that there were compensatory changes in the maxillary vertical growth.

CONCLUSION

The vertical changes occurring after the extraction of first premolars were not different than those occurring in the nonextraction cases when treatment results of extraction and nonextraction cases were evaluated.

An increase in vertical facial dimensions after treatment was seen in both extraction and non-extraction groups. There was no significant difference in vertical dimensional changes between extraction and nonextraction groups.

Mandibular plane angle is maintained by the occlusal movement of posterior teeth and thereby keeps pace with the increase in anterior face height and nullifies the bite closing effect of posterior protraction. The facial complex does increase in size with growth, but Mandibular plane (GoGn-SN plane) while moving inferiorly, remains essentially parallel to its pre-treatment position, due to treatment mechanics.

Therefore the Wedge effect concept that the bite is closed by extraction of second premolar and forward movement of molars seems invalid and thus premolar extraction decisions for hyperdivergent patients should not be based on a desire to change the facial vertical dimension but should be based on other criteria such as incisor retraction, area of crowding, tooth sizes and condition of teeth.

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