International Journal of Multidisciplinary Research and Development
www.allsubjectjournal.com
Online ISSN: 2349-4182, Print ISSN: 2349-5979
Received: 26-09-2021, Accepted: 11-10-2021, Published: 27-10-2021
Volume 8, Issue 10, 2021, Page No. 58-60

Effects of maxillary expansion on mandible

Jayminkunar Suthar[1], Neelkumar Alkeshkumar Shah[2]
[1] Dental Surgeon, J.Z.M. & N. General Hospital, Nadiad, Gujarat, India
[2] Consultant Orthodontist, Faculty of dental Science, Dharmsinh Desai University, Gujarat, India

Abstract
The aim of this review is to analyze the effects of maxillary expansion on mandible and evaluate whether it leads to changes in the maxilla-mandibular relationship. The review summarizes information from various sources across the literature on how maxillary expansion affects the mandible in sagittal dimension. In addition, the effects of recently introduced techniques such as mini implants supported maxillary expansion are also reviewed. This review covers the information on how bonded maxillary expanders can help in preventing the extrusion of molars and afford better vertical control.

Keywords: maxillary expansion, mandible, class ii malocclusion, mini implant supported maxillary expansion, temporomandibular joint, bonded maxillary expanders

Introduction
A common presentation of orthodontic patients is the Angle's Class II malocclusion [1]. There are different patterns of class II malocclusions that need to be considered while planning treatment. In such cases, it is particularly important to consider the transverse deficiency of the maxilla [2].
Tollaro *et al*. described in their study that the discrepancy in the transverse dimension of patients with class II malocclusions tends to be in the range of 3mm to 5mm. This transverse discrepancy can be observed chair-side by asking the patients to move the mandible forward into class I malocclusion. It has been hypothesized that maxilla being deficient in the transverse dimension holds the mandible posteriorly [3, 4]. Increasing the width of maxilla by maxillary expansion may result in spontaneous forward movement of the mandible arch [5-8]. The reason cited for such an effect is that the expansion of maxilla decreases the interferences at the occlusal interface. Thus, the mandible postures forward and this improves the sagittal relationship between maxilla and mandible [9, 10]. This has been referred to as the "foot" in the "shoe" principle. As the shoe (maxilla) is widened, mandible (foot) moves forward. Supporting this principle is the study that patients with a smaller anteroposterior-length of mandible may show higher correction of the class II occlusion [2].

Materials and Methods
Extensive literature search was performed on the different types of expansion procedures and their effects on maxilla and mandible.

Effects of Bonded and Banded Maxillary Expansion
The effects of maxillary expansion as sated by Baratieri *et al*. and Wendling *et al*. show that there is a spontaneous correction of class II malocclusion after expansion and correction of transverse maxillary deficiency [9, 11]. This happens due to the decrease in the ANB angle suggesting an improvement in the maxillomandibular relationship towards Class I. The increase in SNB angle indicates that maxillary expansion leads to forward movement of the mandible [9, 11, 12]. However, it has been studied that after expansion, the anterior displacement of mandible is observed due to the overexpansion of maxilla. It is observed that the correction of class II malocclusion in patients with maxillary deficiency occurs during the retention period which is about 12 months following expansion rather than immediately after expansion. In contrast the previous studies, Chung *et al*. showed that the maxillary expansion did not correct the Class II relationship between maxilla and mandible [5].

Effects of Mini implant Supported Maxillary Expansion (MARPE)
The literature on the effects of MARPE is not as comprehensive as conventional maxillary expansion. MARPE is a new technique for maxillary expansion which enables higher orthopedic expansion of maxilla and increase suture opening [13]. MARPE increases the nasopharyngeal airway to a greater degree than the conventional maxillary expansion [14]. Mandible is connected to the glenoid fossa of the temporal bone at the Temporomandibular Joint (TMJ) [15]. Therefore, to identify the effect of MARPE on mandible, it is important to note the effect of MARPE on TMJ. Most research has shown that conventional maxillary expansion does not lead to negative effects of TMJ, although there are a few instances that show that maxillary expansion may lead to asymmetric movement of the condyles. This may be beneficial if the condyles are asymmetrically before treatment but may not be beneficial if the condyles are symmetric before treatment and this could result in asymmetric position of condyles after maxillary expansion [16]. Mehta *et al*. studied the samples from a randomized controlled clinical trial and showed that MARPE does not lead to negative effects on the TMJ and does not result in asymmetric movement of the condyles after expansion [17]. In this study, the effects of MARPE were observed immediately after expansion and at a longitudinal interval after expansion. In both the intervals, it was observed that MARPE had no side effects on the TMJ [17]. In patients with unilateral crossbite, it is hypothesized

that the condyles may be positioned asymmetrically [18]. In such patients, expanding the maxilla on the crossbite side may be beneficial. One such appliance has been designed by Dzingle *et al*. known as U-MARPE for the correction of unilateral crossbite [19]. Future studies should identify whether this appliance has any effects on the condyle position, TMJ, and mandible.

Vertical effects of Maxillary Expansion

The vertical effects of maxillary expansion can be seen by measuring the maxillary molar extrusion, gonial angle, and overbite. These measurements can be performed on the radiographs before treatment and after treatment, which will enable the identification of the effects occurring due to maxillary expansion. Maxillary expansion leads to the extrusion of maxillary molars [20]. Buccal tipping of maxillary teeth invariably occurs with maxillary expansion. This causes hanging palatal cusps of maxillary molars to contact with mandibular teeth and open the mandibular plane angle. Acrylic coverage can be performed on the occlusal surface of maxillary molars to prevent molar extrusion. The acrylic coverage acts as a bite block on the posterior teeth. This results in intrusion of posterior teeth. This type of maxillary expansion appliance design is known as bonded maxillary expanders. Bonded maxillary expanders are useful in patients with increased mandibular plane angle in which controlling the vertical effects of maxillary expansion are important [21].

Percentage of patients with Class II improvement with maxillary expansion

Guest *et al*. have reported that there in an correction of Class II molar relationship of greater than 1mm in about 92% of the patients who underwent RME [7]. Another study by McNamara *et al*. reported that in 50% of the patients, correction of greater than 2mm can be observed after RME [6]. These results were observed without the use of Class II elastics. There was a deficiency in this study in that no control group was present in the study and the results of these studies were compared with a historical control group. This can cause difficulties in generalization of the results of the study. In a randomized controlled clinical trial, it was observed that maxillary expansion did not lead to a significant change in the class II relationship as compared to untreated controls. These findings are significant in that the findings were compared with a matched randomized control group as compared to previous studies [22].

Measurement Error in the studies

The measurements for previous studies were performed on two dimensional radiographs such as lateral cephalograms. 2D radiographs have limitations such as magnification, and superimposition of structures [23]. This makes it difficult to accurately identify the landmarks on the radiograph. Because of this, it should be noted that there is a high human error in identification of landmarks and measurements performed on the radiographs [24]. When such measurements have a high probability of error, it can lead to inaccurate results. To reduce this error, an automated measurement of the radiographs should be performed [25]. Such automated measurements will help to reduce the human error and also increase the speed of the measurements.

Conclusions

Class II patients who undergo maxillary expansion may not show significant improvement consistently in the Class II relationship by advancement of mandible. The vertical effects of maxillary expansion that should be taken into consideration while implementing the procedure as it affects the sagittal relation between maxilla and mandible. Mini implant supported maxillary expansion does not appear to negatively affect the temporomandibular joint. Bonded maxillary expanders may be useful in patients where vertical control of maxillary teeth is important.

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