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RESEARCH ARTICLE

MODERN PERSPECTIVES ON RAPID PALATAL EXPANSION

Kinnari Markana
BDS, Private Dental Practitioner, Gujarat.

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Abstract

Maxillary deficiency in the transverse dimension is a common problem in children. The conventional management of such malocclusion is with conventional rapid maxillary expansion. The beneficial effects of such an orthodontic therapy are explained in detail in the literature. But there are also negative effects of conventional rapid maxillary expansion. Thus, the improvements in the methods of expansion has led to discovery of miniscrew assisted rapid palatal expansion. The miniscrew assisted rapid palatal expansion are supported by mini implants and thus enable better skeletal expansion of maxilla. This article will discuss the favourable effects, negative effects, and clinical uses of conventional and miniscrew assisted rapid palatal expansion.

Introduction:-

Malocclusion in the transverse dimension is common in clinical practice. (Angell, 1860) Frequently, interceptive orthodontic treatment is required for such patients. The treatment is centered on the concept of forcing the two maxillary halves apart from each other. This is possible because of the inter-maxillary palatal suture present between the two maxillary halves.(Baydas et al., 2006) Maxillary expansion when introduced to orthodontic community was not accepted readily. It was only after 1960s when Hass et al. showed positive results in a series of cases with maxillary expansion, that it began to be accepted in the orthodontic community. (Bell 1982)

Conventional method of rapid maxillary expansion is undertaken in growing orthodontic population before the age of 12 years. In such patients, the expansion appliances are supported by the dentition (Either 2 or 4 teeth with bands) and there is a central activator which is opened 2 times a day or 0.5mm/day.(Bishara et al., 1987) Several studies have evaluated the effects of rapid maxillary expansion such as the skeletal effects, alveolar effects, and the periodontal effects. It is shown that although the rapid maxillary expansion is advantageous, it also has many disadvantages. These disadvantages has prompted further research-studies, and innovation in this field.

Mini-implants were introduced to orthodontic field more than 20 years ago. The introduction of mini-implants has enabled more sophisticated orthopedic and orthodontic approaches to manage complex malocclusions.(Darque et al., 2007) This is useful particularly in instances where the conventional approaches fail to provide adequate results. Therefore, mini-implants became the top choice for orthodontists for the management of malocclusions in the transverse plane to counter the disadvantageous effects of conventional rapid maxillary expansion and attain outcomes beyond the limit of conventional expansion. With the advances in the appliances, there are also advances in the bonding agents used to hold the appliance in place for expansion such as cyanoacrylate adhesives.(Mehta et al., 2016) As these bonding agents are not affected by the presence of moisture, there are less failures of expansion appliances. The objective of this article is to provide an overview of the value that mini-implants have brought to the

Corresponding Author:- Kinnari Markana
Address:- "Krushna Kutir", Arya Samaj Road, Madhav Baugh Society, Jamnagar- 361005.

orthodontic field and the importance of mini-implants in rapid maxillary expansion (mini-screw assisted rapid palatal expansion (MARPE).(Carlson et al., 2016)

Favorable effects of rapid maxillary expansion:-

Skeletal

The main desired effect of rapid maxillary expansion is the skeletal effect. The skeletal effects of maxillary expansion occur due to the two halves of maxilla separating at the inter-maxillary suture and median palatal suture in the shape of a triangle.(Mehta et al., 2021) The apex of the triangle is at the posterior region and superior region due to the increased resistance of the bone at the pterygo-maxillary suture.(Bishara et al., 1987) It has been shown by Lagravere et al. that a minimal amount of the expansion achieved with conventional rapid maxillary expansion is skeletal with only $1/4^{th}$ of expansion being skeletal and $3/4^{th}$ being dento-alveolar.(Lagravere et al., 2005) Thus, it is been a desire of the orthodontists to find methods to increase the skeletal effects of expansion. Miniscrew assisted rapid palatal expansion has thus been shown to lead to increased skeletal expansion than conventional rapid palatal expansion after 6 months. In the long follow up of 2.5 years, Mehta et al. showed that miniscrew assisted rapid palatal expansion and conventional rapid palatal expansion both can increase skeletal maxillary width compared to controls.(Mehta et al., 2021)

Dental

A significant increase is observed with rapid maxillary expansion as highlighted in the systematic review and meta-analysis in 2006 by Lagravère et al.(Lagravere et al., 2006) There is increase in the transverse distance between the maxillary first molars with rapid maxillary expansion. The increase in the distance is higher at the crown level as compared to the root level. Miniimplants have been used for long in orthodontic population for intrusion of teeth, extrusion of teeth and distalization of teeth.(Chang et al., 2019; Proffit et al., 2013) miniimplants are now also used for maxillary expansion. Rapid maxillary expansion when performed with miniscrews or mini implants can lead to increased maxillary expansion than controls.(Abu Arqub et al., 2021; Chane-Fane et al., 2015) Transverse movement of the teeth can be achieved on only one side with unilateral miniscrew assisted rapid palatal expansion.(Dzingle et al., 2020) It has been reported that the expansion achieved with arch-wires is mainly dental and the expansion achieved with aligners is similar to that by arch-wires.(Zhou et al., 2020; Mehta et al., 2014) Meaning that to achieve more skeletal expansion, miniscrew assisted rapid palatal expansion may be required.

Soft tissues

A high number of studies have been published with regards to the effects of rapid maxillary expansion but very few have studied the effect of rapid maxillary expansion on soft tissues. Johnson et al. showed in 2010 that rapid maxillary expansion causes a higher width of inter-alar distance in growing orthodontic population.(Johnson et al., 2010) This finding is correlated to the higher sizes of the nasal fossa.(Johnson et al., 2010) These studies were not performed on Cone-Beam Computed Tomography (CBCT). Mehta et al. have shown that CBCT can enable the accurate measurement of the maxillary and mandibular teeth and bone.(Mehta et al., 2020) In addition to the skeletal changes, CBCT has been repoted to be accurate for the measurements of dental structures as well.(Barreto et al., 2020; Gandhi et al., 2021) It was reported by Kim et al. using CBCT that there is 1.8 mm increase in the interalar distance and interorbital and infraorbital distance with expansion.(Kim et al., 2012) It is worthy to note that the nose moves anteriorly with expansion and the subnasale also advances. It can be interpreted that these effects of rapid maxillary expansion leads in growing orthodontic population can help in positive changes in maxillary volume.

Mandible

It has been shown by Ugolini et al. that rapid maxillary expansion produces effects not only on the maxilla but also on the mandible.(Ugolini et al., 2016) In this study, the patients were in the age range of around 8.5 years. The experimental group (with rapid maxillary expansion) was compared with a control group. A higher intermolar distance and angle was reported in the experimental group as opposed to the control group. A few other studies have shown similar results with rapid maxillary expansion causing positive effects on the arch-width of mandible.

Clinical uses of rapid maxillary expansion:-

Airway

Nasal cavity plays an important role to humidify and prepare the air traveling to the lungs. As the two halves of maxilla participate in the structural construction of nasal cavity, it has been hypothesized since long that expansion of maxilla would affect the nasal cavity.(Oliveira et al., 2008) It has been shown by De Felippe et al., that rapid maxillary expansion cause an increase in the volume of nasal cavity.(Oliveira et al., 2008) Howevere De Felippe et

al. did not measure the effects of miniscrew assisted rapid palatal expansion. Mehta et al. in 2021 showed that miniscrew assisted rapid palatal expansion leads to an increased volume of the nasal cavity.(Mehta et al., 2021) In this study, the patients from a randomized controlled trial were evaluated. The patients were randomly divided into three groups: miniscrew assisted rapid palatal expansion, conventional rapid palatal expansion, and controls. This study was the only study to report the long term findings of miniscrew assisted rapid palatal expansion on airway. It was shown that miniscrew assisted rapid palatal expansion cause a higher nasopharyngeal airway volume compared to conventional rapid palatal expansion and controls.

A high percentage of children are suffering from obstructive sleep apnea. About 4-11% of children in the United States have OSA.(Marcus et al., 2012) In many cases, a tonsillectomy, and continuous airway positive pressure have been implemented as a treatment for OSA in children. But frequently the disease would not be completely managed by this therapy only. Several research studies have explored that rapid maxillary expansion would be beneficial to patients with OSA. Specifically with miniscrew assisted rapid maxillary expansion, a higher nasopharyngeal airway volume has been shown as compared to controls.(Mehta et al., 2021) A systematic review with meta-analysis showed that there was a reduction in the apnea/hypopnea index in patients with OSA after maxillary expansion.(Machado-Júnior et al., 2016)

Negative effects of rapid maxillary expansion:-

Periodontal effects

The decreased height of alveolar bone following rapid maxillary expansion is a major concern for rapid maxillary expansion. It has been hypothesized that rapid maxillary expansion can lead to dehiscence because it is pushing the teeth transversely. Garib et al. has showed that there is a higher incidence of dehiscence with conventional rapid maxillary expansion.(Garib et al., 2006) As miniscrew assisted rapid maxillary expansion does not apply forces directly on teeth, it would have less unfavourable effects on alveolar bone than conventional rapid maxillary expansion.

Conclusion:-

Rapid maxillary expansion is an established treatment modality for management of maxillary deficiency. But rapid maxillary expansion also has some disadvantages. To improve the rapid maxillary expansion technique and overcome such disadvantages, novel methods have been introduced to orthodontics. In this article, we discussed the benefits and undesirable effects of conventional rapid maxillary expansion, and the latest method of miniscrew assisted rapid palatal expansion.

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