

Effect of Age and Skeletal Maturation on the Outcomes of Rapid Maxillary Expansion

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Abstract

Background: The effects of maxillary expansion depends on age and skeletal maturation of an individual. The review aims to identify the different parameters that can affect the amount of dental and skeletal effects achieved with expansion. **Objective:** Current literature regarding expansion techniques and the factors responsible for higher success rates were identified. The findings were evaluated and presented in a systematic manner. **Results:** There is a difference in the amount of skeletal effects of maxillary expansion in individuals with mineralized palatal suture. **Conclusion:** Bone-anchored maxillary expansion of mini implant supported palatal expansion (MARPE) can be useful in older individuals to achieve higher skeletal expansion and opening of mid palatal suture.

Keywords: Rapid maxillary expansion, mid palatal suture, Bone anchored maxillary expansion, min implant supported rapid palatal expansion (MARPE), Cone beam computed tomography.

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INTRODUCTION

Insufficiency of maxillary arch in transverse component is found with Angle's Class I, II, and III malocclusion [1, 2]. The basal bone of maxilla can be widened using different expansion devices such as bonded expansion, banded expansion, hybrid expansion, mini implant expansion [3-6]. The skeletal and dental effects of expansion devices can be affected by the age of the patient. This can alter the predictability of the effects of maxillary expansion. In the conventional literature, the effects of maxillary expansion are usually reported in terms of the biological response and its relation to age. The biological response of maxillary expansion is dependent on the sutures such as the mid palatal suture, skeletal and dental effects. However, in cadaveric studies, it has been seen that the mid palatal suture is patent in older individuals as well and thus, there has been an interesting evolution in the philosophy of whether age can be considered as a factor in the maturation of mid palatal suture.

MATERIALS AND METHODS

Studies investigating the effects of expansion with different devices were evaluated. Important information noted from the studies was that a critical consideration for an orthodontist is whether the effects

of maxillary expansion will be more dental or skeletal. This is necessary to determine the amount of skeletal and dental effects of expansion at the start of treatment, as that will affect the choice of the appliance for the management of the patient. Sometimes, even in young patients, increased maturation or decreased patency of the mid palatal suture can be present. This can cause side effects such as pain, recession, and lack of suture widening with expansion [7-9].

RESULTS

Earlier studies in 1980s have shown that maxillary expansion can give a better orthopedic response if it is done before puberty. Even though, there is literature showing differences in the maturation of midpalatal suture, it is still accepted that there will be decreased skeletal effects of expansion after puberty [10]. Thus, orthodontist determine the maturation status of the patients using different techniques such as cervical vertebrae maturation in the lateral cephalograms, or additional radiographs such as hand-wrist radiographs [11]. In pubertal patients, maxillary expansion can be used in combination with intermaxillary elastics from skeletal anchorage to correct Class III malocclusion [12]. Using Cone beam computed tomography (CBCT), the mineralization of

mid palatal suture can be evaluated to aid as an additional guide for the predictability of the expansion response.

DISCUSSION

Skeletal maturation affects the level of response achieved with expansion. A higher amount of dental effects are seen with higher levels of skeletal maturation. Patients who are at pre-pubertal stage have more skeletal effects of expansion leading to increased basal bone development [13, 14]. Whereas, patients who are post-pubertal have less skeletal effects and this increases the chances of side effects. Thus, the choice of expansion device plays a vital role in the treatment planning process by the orthodontists. The method of expansion can be either non-surgical or surgical. Surgical expansion can be undertaken after fusion of mid palatal suture to better achieve skeletal expansion. But due to the invasiveness of the surgery, patients often refuse this option [15].

Non-surgical methods of expansion can be done with banded or bonded expanders. When the patients are younger than 10 years of age, and are prepubertal, such methods of expansion show very promising results. But when patients are older, these methods do not work as predictably. In such situations, expansion devices known as bone anchored expansion can be used [16]. Bone anchored expansion devices are designed with the use of temporary anchorage devices (TADs) inserted into the palatal bone. When the bone anchored expansion devices also known as mini implant supported palatal expansion (MARPE) are used, they transfer the force to the bone in maxillary palate and not to the teeth in the maxillary arch [17]. Because the forces are transferred to the maxillary bone in the palate, it leads to increased expansion of the two halves of the maxilla and causing a widening of the mid palatal suture. With this method of expansion, the skeletal effects of expansion can be achieved in older individuals.

The fusion of maxillary suture occurs by the age of 14-16 in both females and males. In females, the suture fusion has been reported to be earlier than males [18]. Thus, if higher skeletal response of maxillary expansion is desired, then the expansion should be performed at an earlier age.[19, 20] But in clinical practice, this is not always the scenario. Frequently, patients show up at the orthodontic practice for treatment at an older age. In older age, the expansion leads to more dental and less skeletal effects [21]. In older individuals, the mid palatal suture is more mineralized, and it does not widen as much with the traditional expansion devices. Traditional expansion devices apply the forces to the teeth. Thus, the teeth feel most of the brunt of the forces, and the palatal bone and mid palatal suture fail to widen with such devices in older individuals [22]. With the new bone anchored expansion devices or MARPE, the suture experience

increased forces due to the temporary anchorage devices inserted into the bone. In some cases, osteoperforations can be performed on mid palatal suture to increase the bone remodeling [23]. So, the palatal bone width increases and the mid palatal suture opens with MARPE devices [6].

Age is frequently used as a parameter for assessing the skeletal maturation of individuals. It has also been shown that mandibular bone shows differences in the ramus width and depth according to age [24]. So it can be understood that maxillary bone would show differences with age as well. However, the biological response depends more on the skeletal maturation levels assessed from mid palatal suture maturation, hand wrist radiograph, and cervical vertebra maturation index [25, 26]. Such indices can help to identify the pubertal stage of the patient. The highest growth velocity occurs between the cervical vertebrae maturation stage 2 and 3 [27]. Cervical vertebral maturation stage 3 indicates puberty whereas the stages after that are post pubertal stages. Cervical vertebrae maturation stage of 1, 2, and 3 correlate well with mid palatal suture maturation stage of A, B, and C. This provides a relatively better guide than just age as it has been reported that children in the same age range can show different levels of mid palatal suture maturation [28, 29].

The effects of maxillary expansion are not limited to only to maxillary teeth but also the basal bone, and adjacent structures. The circummaxillary sutures such as zygomaticotemporal suture, zygomaticomaxillary suture, and pterygopalatine sutures also experience a significant amount of force with the expansion devices.[30, 31] Mid palatal suture maturation can be evaluated with mid palatal suture density, the obliteration index of mid palatal suture, and morphology of mid palatal suture. All of these methods have been shown to reliably predict the expansion response compared to chronological age. However, such methods do have certain disadvantages such as the density of mid palatal suture is affected by the conditions in which CBCT was recorded. As the CBCT machines have difference settings for recording the CBCT, this can lead to different values of mid palatal suture density recorded by investigators. Artificial Intelligence has been used to interpret and evaluate the lateral cephalometric radiographs [32]. In the future, Artificial Intelligence can be used even for evaluating radiographs such as CBCT.

In such individuals where the mid palatal suture is maturation is high, MARPE appliances have a distinct character of applying forces to the bone. When expansion devices are used, the forces are applied in the transverse component. The point of application of force with MARPE devices is lower and closer to the center of resistance of maxilla than that of the traditional devices. The force thus is causes more parallel

transverse forces and leads to reduced buccal tipping of molar teeth. The main aim with maxillary expansion is to obtain more skeletal expansion and less dental effects, and thus more stable results.

CONCLUSIONS

The response of maxillary expansion can be predicted based on the mid palatal suture maturation, and other indicators such as attainment of puberty. Cervical vertebrae maturation, and hand wrist radiograph can aid in evaluation of skeletal maturation, although mid palatal suture maturation shows wide individual variation. Bone anchored maxillary expansion or mini implant supported palatal expansion (MARPE) can be used in individuals where mid palatal suture maturation is high to achieve higher skeletal effects and less dental effects.

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