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## Recent Advancements in Orthodontic Anchorage Using Mini-Implants

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### Abstract

Orthodontic mini-implants are a relatively newer form of anchorage compared to the conventional intraoral and extraoral anchorage appliances. Mini-implants can be used for the correction of a wide range of orthodontic malocclusions. This article reviews the current evidence on mini-implants regarding the clinical uses, and comparing it with conventional anchorage appliances. This article reports the difference between orthodontic mini-implants and prosthetic dental implants. It also reviews the information on how orthodontic mini-implants can be used for obtaining anchorage in antero-posterior, transverse, and vertical dimension. The biomechanical considerations of orthodontic treatment with conventional anchorage and mini-implants is presented in this paper.

**Keywords:** Orthodontics, Mini-implants, Anchorage, Recent advancements, Anchorage loss.

### INTRODUCTION

When an orthodontic force applied, there is an equal and opposite reaction to the force as described in the Newton's third law of motion. This reaction to the force application is observed in the clinical scenarios as anchorage loss, which is the unwanted movement of the teeth [1]. A plethora of approaches have been developed over time in orthodontics to overcome the anchorage loss. These approaches are termed as anchorage reinforcement procedures. Anchorage loss could be both in horizontal dimension leading to mesial drifting of molars, in vertical dimension leading to unwanted extrusion, or in transverse dimension leading to relapse of posterior crossbite. Anchorage can be termed as conventional intraoral anchorage which usually leads to significant anchorage loss [2]. The conventional extraoral anchorage such as headgear suffer from the issue of compliance. Recently, a new source of anchorage – mini-implants have been identified for anchorage reinforcement [3].

Mini-implants also called as mini-screws or temporary anchorage devices (TADs) in orthodontics. Orthodontic mini-implants are smaller in dimensions compared to prosthetic dental implants [4]. The size of orthodontic mini-implants varies from 1.5mm to 2mm in diameter and from 6mm to 10mm in length. The surfaces of orthodontic mini-implants are polished and smoother compared to the prosthetic dental implants. The reason is that orthodontic mini-implants do not depend on osseointegration with bone but rather on the mechanical retention for the retention. They can be inserted in the dental chair under local anesthesia. Most of the current orthodontic mini-implants are self-drilling so that a pilot drill is not required for insertion [5]. Orthodontic mini-implants can be loaded immediately by applying the desired force. Once the purpose of orthodontic mini-implants is completed, they can be removed by holding the head of the mini-implant with a driver and unscrewing the mini-implant.

The initial purpose of mini-implants was to achieve maximum anchorage in Antero-posterior (AP) dimension that was not available through traditional means [6]. Moreover, orthodontic mini-implants provided a method to reinforce anchorage without requiring patient compliance. This was a welcome alternative to traditional extraoral approaches such as headgear which was totally dependent on patient compliance. Due to these reasons, orthodontic mini-implants started to gain popularity [6]. Now, orthodontic mini-implants are being used for various kinds of tooth movements in addition to obtaining AP anchorage. Some of these applications are the correction of openbite with intrusion of posterior teeth and eruption of teeth with orthodontic mini-implants in case of impactions. Furthermore, orthodontic mini-implants are also used for the expansion of the narrow maxilla with mini-implant based expanders (MARPE) [7].

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The objective of this review is to give the information regarding orthodontic mini-implants and the recent advancements with a summary of the applications of mini-implants, and the new evidence for the techniques using mini-implants in orthodontics.

### Clinical Uses of mini-implants

Orthodontic mini-implants are versatile and can be used to provide support and anchorage reinforcement in all three dimensions. As the mini-implants are used intra-orally, they have a high acceptance by patients.

**Anteroposterior dimension:** Orthodontic anchorage in the AP dimension is traditionally stabilized by using Headgear appliance or the Nance appliance [8]. However, due to the compliance issues with headgear and ineffectiveness of Nance appliance, orthodontic mini-implants are more effective in AP dimension for anchorage reinforcement [9, 10]. It can be used to obtain direct anchorage in which the force is applied from the orthodontic mini-implant (typically inserted between the second premolar and first molar) to the anterior teeth for retraction. The retraction force can be applied to either a power arm on the anterior teeth or directly to the brackets. Enmass space closure is usually performed with mini-implants. Such type of space closure may be faster than the two step canine closure approach. Thus, it can be used as a method for accelerating tooth movement. Most methods of accelerating tooth movement include surgical insults near the tooth [11, 12]. In the direct type of anchorage, there is no force on the maxillary molar and thus, molars do not lose anchorage during the space closure. The indirect method of obtaining orthodontic anchorage with mini-implants holds the molar in position with a ligature wire from the mini-implant to the molars. The orthodontic retraction force is then applied from the molar to the anterior teeth. As the molars are held in place with mini-implants, the molars do resist moving forward and resist anchorage loss during the retraction process.

For patients with Class II malocclusion, mini-implants can also be used to perform distalization of molars [13]. The insertion of mini implants in palatal area can be used for efficient distalization of molars and posterior teeth. When the distalization is attempted with conventional appliances, the equal and opposite force acts on the anterior teeth leading to proclination of anterior teeth. With mini-implants, the anchorage is not obtained from anterior teeth but rather than the mini-implants which are inserted in the bone, which reduces the side effects such as proclination of anterior teeth [14].

For patients with Class III malocclusion, it is important to identify the skeletal maturation of the patients. The skeletal maturation is usually identified with cervical vertebral maturation assessment (CVMI) [15]. If patients have growth remaining then mini-implants can be used for attachment of intermaxillary class III elastics to correct the negative overjet [16]. In such cases, mini-implants are inserted in the posterior region of maxillary buccal mucosa between the first and second molars. In the mandible, the mini-implants or mini-plates are inserted in the parasymphiseal region [17]. This design allows for the use of intermaxillary class III elastics from the mini-implants which results in reduced side effects as with conventional class III elastics. With this design, forward movement of the maxilla and maxillary arch has been reported to achieve correction of anterior crossbite [16].

**Transverse Dimension:** Orthodontic patients with premature exfoliation of teeth or with congenital absence of some teeth, present with a mid-line shift. This can be corrected with mini-implants by applying the force to center the orthodontic midline [18, 19]. Sometimes, the underlying cause of asymmetry is not entirely dental but rather a combination of dental and skeletal. When the maxilla is narrow skeletally, expansion of maxilla can be performed with rapid palatal expanders [20, 21]. The conventional approach utilizes teeth as anchorage for the expansion movement resulting in higher dental side-effects such as molar tipping,

root resorption, etc. [22] Expanders can be used with mini-implants (known as MARPE – mini-implants supported rapid palatal expansion) to reinforce anchorage and reduce the dental side-effects [7]. A higher amount of orthopedic expansion has been reported with mini-implants supported expansion compared to conventional expansion. Moreover, long term data has suggested that mini-implant supported expansion does not lead to side effects on the Temporomandibular joint [23]. When transverse force is applied with conventional expanders, the maxillary arch expands bilaterally. In unilateral crossbite patients, mini-implant supported expansion can be used to expand the maxilla unilaterally [24].

**Vertical Dimension:** In patients with anterior open bite, the conventional orthodontic treatment utilizes extractions of premolar or molar teeth [25]. The retraction of teeth with extraction and relative extrusion leads to closure of open bite. For orthodontic correction, a Transpalatal arch is typically used in patients with hyperdivergent tendency to prevent the molar extrusion during the orthodontic treatment [26]. In the mandibular arch, a lingual arch can be placed for preventing the extrusive effects of orthodontic treatment on molars. Another approach is surgery in which the maxilla is moved upward with Le Fort – I maxillary impaction surgery [27]. This leads to the correction of anterior open bite. With mini-implants non-surgical alternatives are available for the management of the anterior open bite. Orthodontic mini-implants can be inserted in the buccal mucosa to apply the intrusive force on the posterior teeth. Moreover, mini-implants can also be used in the palate to apply the orthodontic forces for the intrusion of posterior teeth and correction of anterior open bite [28, 29].

Future studies on the long-term effects of mini-implants in orthodontic would be essential to develop our knowledge on the effectiveness of this techniques and the amount of relapse. The important aspect for successful use of mini-implants is the proper diagnosis and treatment planning. Using artificial intelligence, the diagnosis and treatment planning can be automated and the inconsistencies can be reduced to improve the success rates for mini implants [30].

### CONCLUSION

Mini-implants are safe and minimally invasive anchorage reinforcement appliances that can be used to augment orthodontic anchorage. Mini-implants are do not require compliance as with the conventional extraoral anchorage. Mini-implants are more effective than the conventional intraoral anchorage designs as they are inserted in the bone. Mini-implants can be used in different sites in the maxilla and mandible to provide correction of orthodontic malocclusion in anteroposterior, vertical, and transverse dimensions.

### Conflict of interest

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