



ISSN Print: 2394-7489  
ISSN Online: 2394-7497  
IJADS 2021; 7(2): 558-560  
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[www.oraljournal.com](http://www.oraljournal.com)  
Received: 04-02-2021  
Accepted: 06-03-2021

**Lalit Kharadi**  
Salman Dental Center, Building  
90c Road 902, Block 109, Hidd-  
Al Muharraq, Kingdom of  
Bahrain, Bahrain

## Applications of mini-implants in orthodontics

**Lalit Kharadi**

DOI: <https://doi.org/10.22271/oral.2021.v7.i2i.1262>

### Abstract

(Salman Dental Center, Hidd) Mini-implants obtain anchorage form bone and thus provide increased control of orthodontic tooth movement and help in reducing the side effects during the management of complex malocclusion. Since the introduction of mini-implants in orthodontics, it has undergone several modifications in design, composition, size and shape. In this article, a wide-ranging review of the current application of mini-implants, the success rates of mini-implants, factors affecting the success rates of mini-implants, complications with mini-implants has been described. The utility of mini-implants has increased in the recent years. With the high success rates found with palatal mini-implants, mini-screw assisted rapid palatal expansion is popular method in contemporary orthodontics. Additionally, mini-implants with aligners can also be used to provide an esthetic option to the patients for the correction of complex malocclusion.

**Keywords:** mini-implants, orthodontics; temporary anchorage devices (TADs)

### 1. Introduction

Anchorage in orthodontics has been a problem since the inception of modern orthodontics by Dr. Edward Angle. Anchorage refers to the prevention of unwanted tooth movement. One of the concerns regarding anchorage is that it is difficult to obtain adequate anchorage from the posterior teeth while moving the anterior teeth to the maximum capacity. In cases where maximum retraction of anterior teeth is required, absolute anchorage with mini-implants can be beneficial. When mini-implants were introduced to the orthodontic world, the protocol regarding implants were not established and this led to a higher level of failure. However, in the recent times, the success rates have been found to be pretty high. This is due to the developments in the design, size, and shape of mini-implants. There is a good amount of heterogeneity in the mini-implant design with diameter from 1mm to 2.4mm and length from 4mm to 21.5mm<sup>[1, 2]</sup>.

The applications of mini-implants are not only limited to retraction of anterior teeth in cases requiring maximum anchorage. Mini-implants are also useful for protraction of molars, expansion of maxillary arch, management of impacted canines, intrusion of posterior maxillary and mandibular dentition, and correction of inclined occlusal planes<sup>[1-5]</sup>.

### 2. Materials and Methods

#### 2.1 Application of Mini-implants in orthodontics

Mini-implants are used widely in orthodontics for various purposes. One of the major advantages of mini-implants is that it allows for maintenance of good oral hygiene, and has a reduced incidence of periodontal problems as compared to conventional anchorage devices such as Nance appliance<sup>[6]</sup>. The utility of mini-implants to orthodontists because of easily insertion and the widespread acceptance of the mini-implants by the patients has led to increased popularity of mini-implants. There have been considerable developments in the field of orthodontic mini-implants mainly in the advances in design, advances in placement techniques, and a better understanding of the risk factors. In comparison with previous anchorage systems such as mini-plates, mini-implants are less bulky and thus can be inserted in areas between the roots of teeth, or in alveolar bone. Mini-implants have found to be successful in the range of 80 to 100 percentage. The buccal mini-implants have shown lower success rates than palatal mini-implants.

**Corresponding Author:**  
**Lalit Kharadi**  
Salman Dental Center, Building  
90c Road 902, Block 109, Hidd-  
Al Muharraq, Kingdom of  
Bahrain, Bahrain

Thus, the use of palatal mini-implants have increased in past few years [3]. The failure rates of mini-implants are in the low range of 10 to 30 percentage [1, 7, 8]. The factors that are associated with the failure of mini-implants are the diameter of the screw, the age of the patient, thickness of cortical bone, density of bone, type and depth of soft-tissue, inflammation, oral hygiene, preparation of the insertion area and primary stability [8]. The thickness of cortical bone is important for the success of mini-implants, but the thickness of cancellous bone is not critical [9, 10]. Another critical factor for the success of mini-implants is the type of forces applied on mini-implants and the adhesives used for the appliance cementation. If heavy forces are used in rotational movement, then it may increase the chances of failure of mini-implants. On the other hand, the advances in the adhesives in dentistry has led to increase in the bond strength and decrease in the failure rate of the orthodontic appliances on the teeth [11-13]. Such advances are critical for the success of mini-implants.

## 2.2 Mini-implants and anterior open-bite

Mini-implants can be used in anterior open bite patients for the correction of vertical discrepancies. In such cases, mini-implants can be used in the posterior arch between the maxillary molars and intrusive force can be applied on the posterior dentition through the mini-implants [6]. This leads to intrusion of posterior teeth and thus, closure of mandible by autorotation thus closing the anterior open bite [14]. Mini-implants can also be inserted in the mandibular arch between the mandibular molars. Mandibular mini-implants are helpful in establishing an intrusive force on the mandibular molars to prevent mandibular molar extrusion while the maxillary molars are intruded [15].

## 2.3 Mini-implants and maxillary expansion

Mini-implants are often placed in the palatal bone for expansion of maxillary arch to correct the posterior crossbite. [16,17] Rapid palatal expansion appliances using mini-implants for anchorage are known as mini-screw assisted rapid palatal expansion (MARPE) or bone-anchored maxillary expansion appliances. MARPE appliance are used so that more skeletal expansion is achieved and dental expansion is minimal. Expansion with MARPE increased the maxillary arch width and thus, leads to resolution of posterior crossbite. It has also shown to cause increase in airway volume after expansion [16, 17]. The changes achieved with MARPE are found to be stable over time. In a recent study, Mehta *et al.* showed that MARPE appliances led to an increased nasopharyngeal volume after 2.5 years following expansion [3]. However, there were no differences in the total airway volume between MARPE and controls. With conventional maxillary expansion, bilateral expansion of maxillary arch occurs even in unilateral crossbite patients. With the help of mini-implants, new designs such as Unilateral MARPE U-MARPE have been developed for the correction of unilateral crossbite [18].

## 2.4 Mini-implants and distalization of molars

In Class III malocclusion, mandibular dentition is placed anteriorly in relation to the maxillary arch [19]. In such cases, mini-implants can be placed in the buccal shelf area used to distalization of mandibular arch. Such mini-implants are known as buccal shelf mini-implants. In addition, mini-implants can also be placed on the mandibular ramus for the uprighting of mandibular second molars. Chang *et al.* showed that ramus shelf-mini-implants can be used efficiently for

achieving uprighting of mandibular molars [20].

## 2.5 Mini-implants and Aligner therapy

Clear aligner therapy has an important role in contemporary orthodontics [21, 22]. As more and more adult patients are undertaking orthodontic treatment, the emphasis for esthetic treatment modalities has increased. In addition to being esthetically pleasing, clear aligners have the advantage of applying low forces on the teeth, and thus can potentially lead to decreased root resorption as compared to fixed orthodontic appliances [23]. Over the years, the type of malocclusions that can be treated with clear aligners has increased because of the use of mini-implants with aligners. Mini-implants can be inserted between the maxillary anterior teeth to intrude the maxillary anteriors in conjunction with aligner therapy. [24] In addition, many patients with Class III malocclusion can be treated with mini-implants and aligner therapy to distalize the mandibular arch with mini-implants.

## 3. Results & Discussion

The insertion angle of mini-implants has an impact on the type of force and the direction of force applied on mini-implants. This has an effect on the success of mini-implants. When mini-implants are inserted between the roots of teeth, care has to be taken not to cause injury to the adjacent teeth. This can be evaluated with radiographs before inserting the mini-implants. It has been shown that 2-dimensional (2D) radiographs are not as effective in evaluating anatomy or head and neck surfaces as 3-dimensional (3D) radiographs such as Cone-beam computed tomography (CBCT) [25]. Furthermore, it has been shown that rotations errors in the position of head while recording the radiographs can lead to errors in measurements made on the 2D radiographs [26]. It has been shown that mini-implants that are angled while inserting have a higher contact area with the bone and thus, have increased success rates [27]. However, it should be noted that very high angle may create slippage while inserting the mini-implant. [27]

### 3.1 Complications of mini-implants

A very common complication of mini-implants is mobility. Mobility can be considered failure if it is too high to warrant removal of mini-implant. Sometimes mini-implants also undergo fracture. In such cases, the mini-implant should be retrieved safely with orthodontic instruments taking care that the patient does not swallow the mini-implants [7, 27]. When there is a failure of mini-implants, a second mini-implant can be inserted in the same area after 3 months or in a difference area. Studies have reported that mini-implants with reduced diameter or length have a higher chance of failure. In addition, patients who are chronic smokers have a higher chance of peri-implantitis leading to mobility of mini-implants and failure of mini-implants [28].

## 4. Conclusions

Mini-implants have a wide range of applications for orthodontic treatment. The most important advantage of mini-implants is that it provides absolute anchorage. The improvements in the design of mini-implants and advancements in the understanding of the risk factors have led to high success rates of mini-implants. Mini-implants can be used successfully for intrusion, expansion, and distalization, with fixed orthodontic appliances and in conjunction with clear aligner therapy.

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