

# Temporary Orthodontic Anchorage Devices

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## ABSTRACT

Efficient anchorage control is one of the important requisites for successful orthodontic treatment. The conventional means of anchorage control have been the use of transpalatal/lingual arch and palatal button but disadvantage is they do not provide absolute anchorage. Though the use of headgear provide efficient anchorage control, the patients are not compliant in using a headgear. Orthodontic implants have provided us with noncompliant and efficient means of anchorage control. This article traces the journey of development of implants as temporary anchorage devices.

**Keywords:** Anchorage, Implants, Onplant, Mini-implant, Microscrew, Skeletal and Spider screw.

Anchorage control can be one of the nightmares for an orthodontist. Efficient attainment and control of anchorage is fundamental to successful orthodontic and dentofacial orthopedic treatment. Adequate anchorage to correct dental or skeletal malocclusions is often a critical consideration in treatment planning. Because of anchorage limitations, we may have to settle for a compromised treatment alternative, or more complicated treatment alternatives like extraoral traction devices (which heavily depend on patient's compliance) or orthognathic surgery.<sup>1</sup> Implants are an excellent alternative to traditional orthodontic anchorage methodologies, and they are a necessity when dental elements lack quantity or quality when extraoral devices are impractical or when noncompliance during treatment is likely.

## A BRIEF INTRODUCTION TO IMPLANTS<sup>2</sup>

The earliest dental implants, as cited in archeological records of China and Egypt, were of stone and ivory. In the 16th and 17th centuries, dental implants made of precious metals like gold, ivory and iridium were in vogue till the introduction of stainless steel. The implants made of cobalt-chromium and titanium were introduced in 1940s and 1950s. Nonmetal biomaterial implants made of vitreous carbon and bioglass were introduced in 1970s.

Shortly thereafter, in 1982, Branemark presented his 15-year-old pioneering study of osseointegrated implants in the treatment of edentulous jaw. With osseointegration a clinical reality, the root form implant once again became implantology's most dominant design.

Implants can be classified under the following categories:<sup>3</sup>

1. According to their location, implants are classified as:
  - i. *Subperiosteal implants*: In this design, the implant body lies over the bony ridge. This type of design currently in use for orthodontic purposes is the 'Onplant'.

- ii. *Transosseous implants*: In this type, the implant body penetrates the mandible completely. This design is not widely used either in restorative dentistry or in orthodontics.
  - iii. *Endosseous implants*: These implants are partially submerged and anchored within the bone. These have been the most popular and widely used ones.
2. According to their configuration, implants are classified as:
    - i. *Root form implants*: These are the screw type endosseous implants and the name has been derived due to their cylindrical structure.
    - ii. *Blade/Plate form of implants*: These are flatter and can be used in resorbed and knife edge ridges.
  3. According to the composition:
 

Stainless steel, cobalt-chromium-molybdenum (Co-Cr-Mo), titanium, ceramic implants, miscellaneous such as vitreous carbon and composites.
  4. According to the surface structure:
    - i. *Threaded or nonthreaded*: The root form implants are generally threaded as this provides for a greater surface area and stability of the implant.
    - ii. *Porous or nonporous*: The screw type implants are usually nonporous whereas the plate or blade implants(non-threaded) have vents in the implant body to aid in ingrowth of bone and, thus a better interlocking between the metal structure and surrounding bone.

## USE OF IMPLANTS IN ORTHODONTIC PRACTICE

The implants provide absolute means of anchorage as they are rigidly embedded in the bone. They have been used for purpose of both orthopedic and orthodontic anchorage.

## Studies related to Implants used for Orthodontic Anchorage

As early as 1945, Gainesforth and Higley<sup>4</sup> mentioned the use of implant supported anchorage. They used vitallium screws in six dogs. These implants were inserted in the ramal area; immediately loaded and used to bring about retraction of upper canines. However, all screws were lost within a period of 16 to 31 days.

Linkow (1970)<sup>5</sup> about 25 years later, used an implant as a replacement for a missing molar. This was then used as an anchor tooth to which class II elastics were used to retract the upper anteriors. The upper arch was consolidated using a fixed appliance while in the lower arch, only the premolar and molar were banded and interconnected using a 0.040" rigid wire.

Creekmore and Eklund (1983)<sup>6</sup> published a case report of usage of a vitallium implant for anchorage while intruding the upper anterior teeth. The vitallium screw was inserted just below the anterior nasal spine. After a healing period of 10 days, an elastic thread was tied from the head of the screw to the archwire. Within one year, 6 mm intrusion was demonstrated along with 25° lingual torque.

Extensive research relating to the usage of retromolar implants (Fig. 1) for orthodontic anchorage has been done by Eugene Roberts (1990, 1994).<sup>7,8</sup> The first clinical trial was on an adult in whom an atrophic extraction site had to be closed.

A special implant was developed that was 3.8 mm wide and 6.9 mm long, which was placed in the retromolar area. A 0.021" × 0.025" SS wire was used for anchorage from the screw around the premolar bracket.

Southard et al (1995)<sup>9</sup> compared the intrusion potential of implants with that of teeth (dental anchors). Titanium implants were placed in extracted 4th premolar area in dogs followed by a healing period of three months. Then an intrusive force of 50 to 60 gm via 'V' bend was applied. This was compared with the intrusive potential of teeth on the other side using the same mechanics. No movement of implant was seen at the end of the experiment whereas, on the other side, the tooth acting as the anchor units tipped severely. Therefore, they concluded that implants were definitely superior to the teeth acting as anchor units.

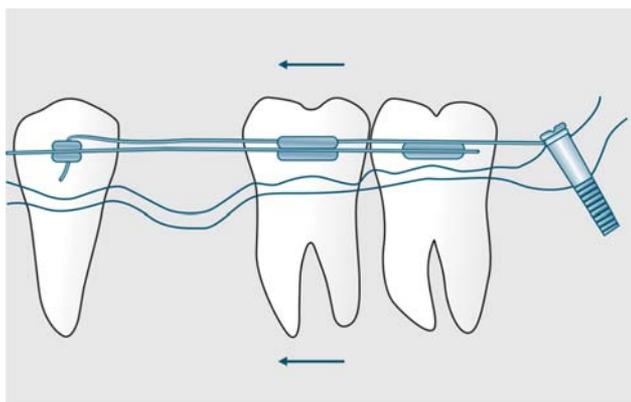


Fig. 1: Retromolar implant



Fig. 2: Onplant

But these osseointegrated implants used for anchorage had their inherent disadvantages, such as:<sup>10</sup>

1. Inability to place these implants in interdental areas owing to their bulkiness.
2. Placement involved a two stage procedure and, therefore a long waiting time before loading the implant.
3. Anatomic limitations, such as erupting teeth, possible nerve damage or altered sensation.
4. The high cost, especially of the root form implant used for prosthetic replacement.
5. Limitations in the direction of force application.
6. Difficulty in hygiene care.

These factors made it imperative that newer implants, which did not completely osseointegrate, adapted specifically for orthodontic usage be developed. Ten such systems from 1995 onwards have been introduced.

The first of the systems introduced in orthodontics was the Onplant (Fig. 2), which is a classic example of a subperiosteal implant. Developed by Block and Hoffman (1995),<sup>11</sup> it consists of a circular disc 8 to 10 mm in diameter with a provision for abutments in the center of superficial surface. These abutments would enable the orthodontist to carry out tooth movement against the Onplant. The undersurface of this titanium disc is textured and coated with hydroxyapatite. The hydroxyapatite, being bioactive, helps in stabilization of the implant by improving integration with bone. The average thickness (height) of the implant is 3 mm.

Four new systems, which could be grouped under the category of osseous implants were introduced. Osseous implants are those placed in dense bone, such as the zygoma, the body and ramus area or the midpalatal areas.

The Orthosystem implant developed by Wehrbein (1996)<sup>12</sup> is a titanium screw implant with a diameter of 3.3 mm inserted into the median palate or the retromolar regions of the mandible or the maxilla. The implants are surface treated with sandblasting and acid etching for making the surface rough in order to improve integration. They are available in two sizes of 4 mm



Fig. 3: Skeletal anchorage system

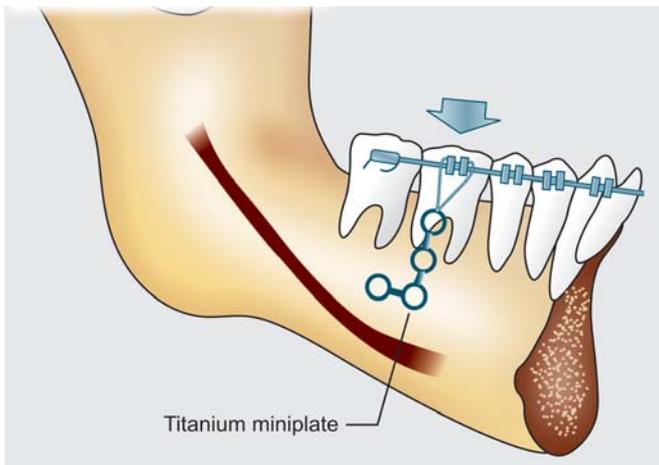


Fig. 4: Skeletal anchorage system

and 6 mm. An 8 week waiting period has been suggested before applying forces onto this implant.

Next, came the Skeletal Anchorage System (Figs 3 and 4) developed by Umemori and Sugawara (1999).<sup>13</sup> It essentially consists of titanium miniplates, which are stabilized in the maxilla or the mandible using screws. The recent versions of these miniplates have been modified for attaching orthodontic elastomeric threads or coil springs. Different designs of miniplates are available, and this fact offers some versatility in placing the implants in different sites. The 'L' shaped miniplates have been the most commonly used ones, while the 'T' shaped ones have been proposed for usage while intruding anterior teeth. The screws used for fixing the miniplate are usually 2 to 2.5 mm in diameter.

Graz implant supported system introduced by Karcher and Byloff (2000)<sup>14</sup> consists of a modified titanium miniplate with provision for four miniscrews, and two oval shaped cylinders. This was used mainly as a support for the Nance button of a pendulum appliance in the palate.

Hugo De Clerck and Geerinckx (2002)<sup>15</sup> of Belgium, introduced the Zygoma anchor system. It is a curved titanium

miniplate with provision for three screws of 2.3 mm diameter to offer the necessary stability.

These osseous implants were effective in achieving complex tooth movements like molar intrusion. But, they had their own limitations. They need a fairly complex surgery and, therefore have to be placed by a surgeon. Secondly, the chances of infection are greater than the screw implants. Their removal is as difficult as their placement.

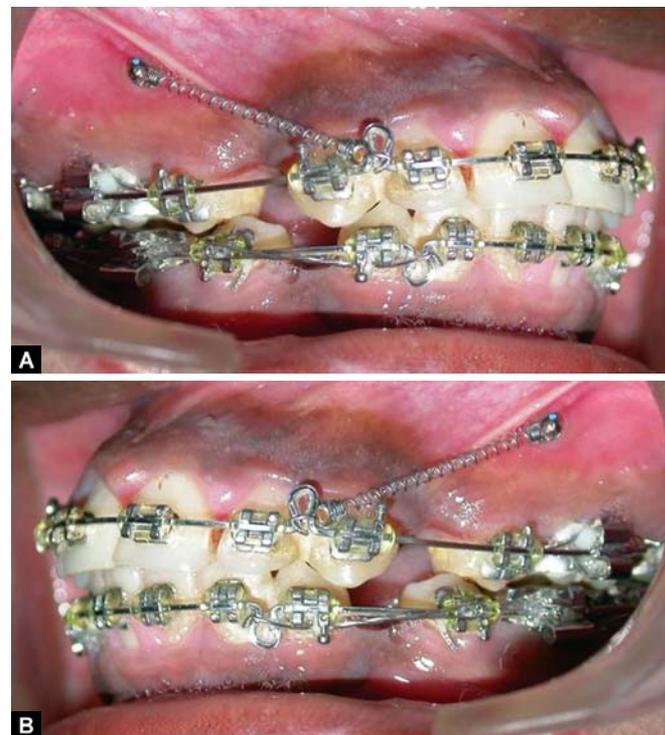
Interdental implants were developed in the late 1990s. They are endosseous implants, but of smaller diameter, which allows placement in interdental areas. These rely more on mechanical retention than complete osseointegration.

The interdental implants are favored over the retromolar implants due to the following reasons:<sup>16</sup>

1. Placement is very simple and can be done under local anesthesia.
2. They seem to be equally effective in resisting forces as the larger root form implants.
3. They can be used for bringing about all types of tooth movement.
4. Removal is an uneventful procedure.

Among these interdental implants, the earlier variant was the impacted titanium post introduced by Bousquet et al (1996).<sup>17</sup> He published a case report demonstrating the use of an impacted titanium post for orthodontic anchorage. The post, 0.7 mm in diameter and 6 mm long, was made of titanium alloy (Ti<sub>6</sub>Al<sub>4</sub>V).

Ryuzo Kanomi (1997)<sup>18</sup> introduced the mini-implant. This is a modified surgical miniscrew of 1.2 mm diameter and 6 to 7 mm length, which can be placed interdentially.



Figs 5A and B: Mini-implant

These implants have been used successfully for anterior intrusion and retraction (Figs 5A and B) molar distalization (Fig. 6) and molar intrusion (Fig. 7).

Costa et al (1998)<sup>19</sup> published a preliminary report on their newly developed mini-implant called as Aarhus Anchorage System.

Micro-implant anchorage is a customized implant system (Fig. 8) developed by a team of Korean orthodontists (Park et al 2001).<sup>20</sup> These are small diameter implants, which can be placed interdental either in the buccal sulcus or palatal interdental areas. The screws are available in different lengths and diameters. The maxillary implants are longer than the mandibular ones owing to the difference in the thickness of cortical bone. The micro-implants are made of titanium. The pilot drill is usually 0.2 to 0.3 mm smaller than the desired implant size and is drilled at a slow speed. The implants are driven at an angle of approximately 30 to 40° to the long axis of the maxillary teeth and 10 to 20° to the mandibular teeth to ensure optimum retention by augmenting the area of contact between the implant and adjacent bone.

Case reports on micro-implant usage have shown their efficacy in anterior retraction with/without intrusion and molar uprighting.<sup>21,22</sup>

Newer interdental systems like OMAS (Orthodontic mini anchor system) introduced by Lin et al (2003)<sup>23</sup> are identical to the micro-implants. They vary in their form and their head design.

The Spider Screw (Fig. 9) introduced by Maino et al (2003)<sup>24,25</sup> and this implant has bracket shaped head with 0.022" rectangular slot and a two perpendicularly placed round slots of size 0.027" placed beneath the bracket head.

The principles however remain the same. The trend presently seen is towards immediate loading of these screws.

Chen Y<sup>26</sup> et al evaluated the factors influencing the success of orthodontic implants and suggested that implant diameters of less than 1.3 mm or greater than 2 mm, as well as lengths of less than 8 mm, are more susceptible to failure.

Jeffrey D Hyde<sup>27</sup> et al conducted a survey of network orthodontists' attitudes toward miniscrew usage and their experiences with failures and related complications. The results of the survey showed that the most common indication for miniscrew placement in previous studies has been maxillary anterior retraction followed by molar protraction and posterior intrusion with other types of treatment in a clear minority. Two

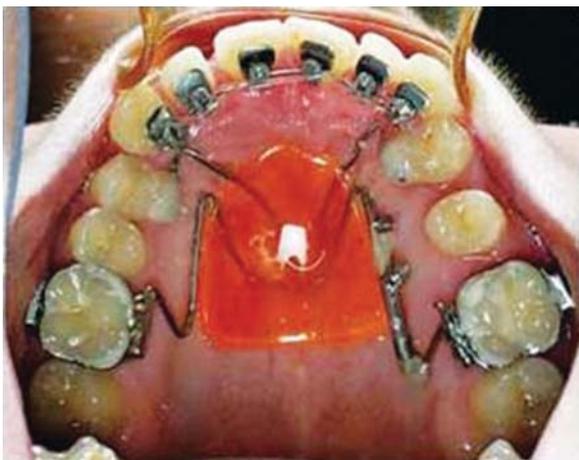


Fig. 6: Mini-implant used for molar distalization



Fig. 8: Micro-implant



Fig. 7: Mini-implant used for molar intrusion

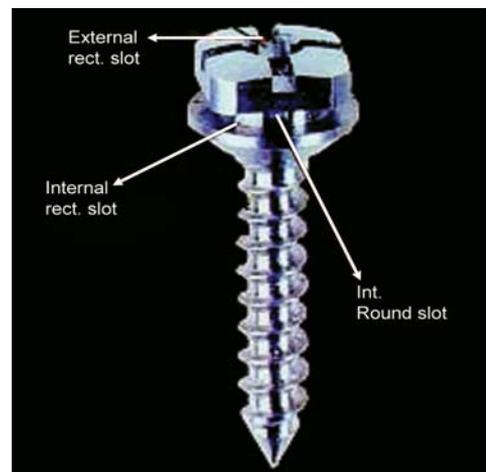


Fig. 9: Spider screw

complications reported most often were soft-tissue overgrowth/irritation and irritation from a spring or attachment.

Adriano G Crismani<sup>28</sup> analyzed the published clinical trial on orthodontic implants and concluded that the implants placed in the maxilla have a higher success rates than the mandibular implants.

## CONCLUSION

Mini implants are one of the most significant developments in the history of orthodontics till today. They have helped in widening the scope of orthodontic treatment that could never be thought of before.

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