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Literature Review

Self-Tapping Implants: Clinical Review

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ABSTRACT

It is a well-known fact that primary stability has an essential role and is a prerequisite for successful osseointegration. In oversized implant sites, lower bone-to-implant contact and lower primary implant stability, followed by delayed osseointegration have been documented. These are considered to be a serious risk especially in challenging regions such as the posterior maxilla. In order to enhance primary stability it is preferable to choose a tapered implant, which creates lateral bone compression at the moment of implant insertion. After using the pilot drill, the bone layer adjacent to the implant site is progressively compacted with a series of bone condensers of increasing diameter, which results in better bone-to-implant contact and denser bone. Self-tapping implants have mainly been used in regions with soft bone quality such as the maxilla. These are usually designed to avoid the use of tapping procedures for implant site preparation, which are replaced by the action of cutting edges incorporated into the lower, apical portion of the implant. This design reduces the need for a tapping procedure during placement surgery, and can improve both primary stability and implant survival rate.

Keywords: Implant, Primary stability, Macrodesign, Tapered, Self-tapping, Soft bone

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Introduction

Dental implants are widely used treatment modality to treat missing teeth because of their functional and esthetic advantages.[1,2] Osseointegration refers to the development of a direct structural and functional connection between living bone and the surface of a load bearing implant without the interposition of soft tissue.[3]

In oversized implant sites, lower bone-to-implant contact and lower primary implant stability, followed by delayed osseointegration have been documented.[4-6] In order to enhance primary stability it is preferable to choose a tapered implant, which creates lateral bone compression at the moment of implant insertion.[7] After using the pilot drill, the bone layer adjacent to the implant site is progressively compacted with a series of bone condensers of increasing diameter, which results in better bone-to-implant contact and denser bone.[8]

Self-tapping implants have been available since 1983 and have mainly been used in regions with soft bone quality such as the maxilla. These are designed to avoid the use of tapping procedures for implant site preparation, which are replaced by the cutting edges incorporated into the lower, apical portion of the implant(Fig 1).[9] It reduces the need for a tapping procedure during placement surgery, and can improve both primary stability and implant survival rate.[10]

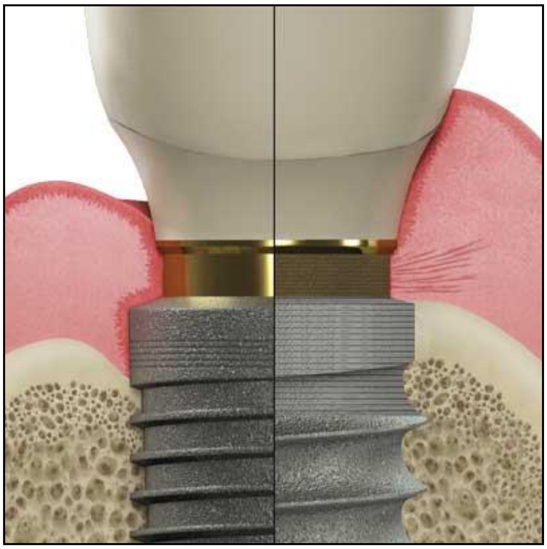

Figure 1

Bio mechanics

A self-tapping dental implant comprises a generally cylindrical body with a threaded outer surface for securing the implant to the wails of a preformed hole in a jawbone. The cylindrical body has a plurality of longitudinal recesses formed in the threaded surface at one end and extends longitudinally through a plurality of turns of the thread to form a self-tapping cutting edge at each interruption of the thread by one of the recesses. Each thread segment extends between a pair of adjacent recesses and diminishes in radius between the leading and trailing ends of the thread segment.[10]

A self-tapping dental implant is one that can be threaded into a pre-drilled hole in a jaw bone without pre-tapping the hole. The apical end portion of the implant itself taps the hole as the implant is simultaneously pressed into the hole and rotated.[9] (Fig 2). The cutting blades reduce the thread surface area and thus may minimize implant-bone contact in the apical third. The self-tapping implant also has an increased cutting characteristic. This design would help eliminate pretapping procedures in immediate implant placement resulting in improved initial implant stability.[11]

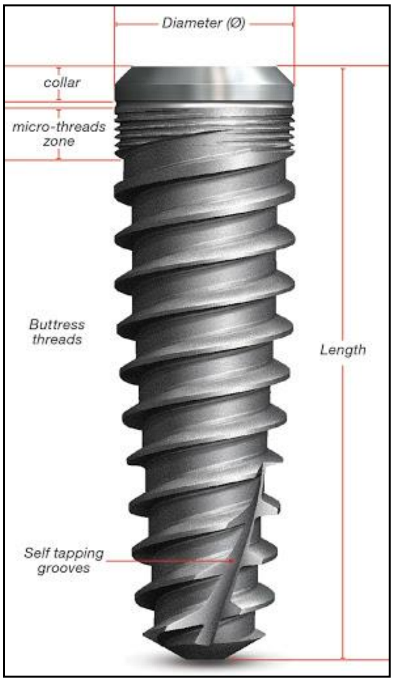

Figure 2. Self-tapping implants with vertical cutting blades in the apical third of the implant

Technique

- Stable In-and-out vertical movement of the drill is critical to allow irrigation and flushing away of debris while penetrating the bone.
- Drill to bone contact should not exceed a few seconds, while pushing the drill further into the bone up to the pre-determined length.
- Replace drills and proceed drilling as indicated for the desired implant diameter, paying attention to adjustments that may be required due to bone quality at the specific site.
- Drilling should be performed at low speeds (800rpm -2000rpm).
- Pre-tapping (threading of the bone) procedure should not be done and the tapping should be done by the implant itself.
- Implant placement procedures should be accomplished at very low speed (25-30rpm) or manually.

Indications

- Poor bone quality. (D4)
- Immediate implant placement
- Immediate loading of implant.
- Inadequate mesiodistal space.

Advantages

- The most widely used implant design nowadays is tapered/conical in analogy to the root form of teeth.
- Ideal for immediate implant placement.
- Well-designed for narrow gaps with root proximity of adjacent teeth.
- High primary stability due to screw-design.
- Soft bone and less risk of labial perforation due to the apical reduced diameter in all directions.
- The high insertion torque of tapered implants with a special screw design also favors them for immediate loading.
- Despite the indication of tapered implants for all types of bone quality it has a significant advantage in soft bone (D4) as it condenses bone locally resulting in more implant stability.
- This advantage is also taken off in simultaneous augmentation/implantation procedures when a transcrestal sinus lift is performed.

Disadvantages

- It is a very technique sensitive procedure.
- Difficult to get the orientation of the implant.

Implant stability at initial and second fixation

Implant stability has been recognized as one of the most important and useful factors when it comes to predicting implant anchorage. Primary implant stability is defined as the biomechanical stability upon implant insertion, being influenced by numerous factors, such as: bone quantity and quality, the geometric design of the implant, surgical technique, and insertion torque.[12]

Secondary stability is developed from regeneration and remodeling of the bone and tissue around the implant after insertion and affected by the primary stability, bone formation and remodeling. The time of functional loading is dependent upon the implant stability. The effect of different implant body forms on the initial and second stability with similar bone quality.[13] In a comparison of the taper-shaped implant and the hybrid-shaped implant with a self-tapping function, the tapered shaped implant showed superior initial stability at the time of implantation. However, both implants showed the same stability with the second fixation. Additionally, the shape of the implant as well as the shape of the turn was different in present study. It was also suggested that the difference in the shape of turn may affect the initial fixation.[6]

During the period from insertion to the end of osseointegration, the primary stability obtained by anchoring the implant in the bone declined, while secondary stability increased as a result of bone growth on the surface of the implant. The evidence for larger, smaller or similar ISQ values at the end of the process compared to initial stability is uncertain, however. Some researchers found that low primary ISQ values increased after osseointegration, whereas in implants with a high primary ISQ, the post-osseointegration values declined.[6] Studies have said that initially high stability (ISQ values of 70 or higher) tended not to increase further with time, despite decreases in initial mechanical stability and increased biological stability.[14-18]

These authors concluded that initially low stability normally tends to increase with time due to bone remodeling.[19-21] Polo et al stated that values converged visibly on a mean ISQ of around 75.[21] On these grounds, then, although very high primary stability is regarded as beneficial, particularly in situations when the implant is expected to bear loads during osseointegration, it does not necessarily entail greater secondary stability. The reason seems to be that after osseointegration, due to bone remodeling around the implant, the highest values neither increase nor decrease, whereas the lowest values tend to increase.[22]

Bicortical fixation, indirect sinus elevation, and unicortical fixation

Hsu et al evaluated self-tapping implants placed using stopper drills to bicortically engage both the alveolar crest and sinus floor (bicortical fixation) achieved primary and/or secondary stability comparable to that of short implants, engaging on the alveolar crest cortical bone (unicortical fixation) or implants engaging both the crest and sinus floor but via greenstick fracture and grafting (indirect sinus elevation).[23]
Primary and secondary implant stabilities of bicortical fixation did not differ significantly from those of unicortical fixation and indirect sinus elevation. However, the use of the bicortical fixation technique is indicated since it is simpler and more economical than indirect sinus elevation; plus, it allows for longer implants than the unicortical fixation while yielding similar secondary implant stability.[24]

Self-tapping implants in bone density type i-ii

Studies have shown that implant loosening can be caused by formation of collagen-rich connective tissue capsule around the implant due to higher pressure while drilling.[25-28] The same may occur when self-tapping implants are placed in high density bone that is mainly comprised of cortical bone as this type of bone is more resistant to deformation due to having higher modulus of elasticity and low blood supply.[29] These characteristics decrease the ability of load distribution and increase the susceptibility to bone necrosis of the dense cortical bone compared to trabecular bone as the result of application of excessive torque at the time of implant placement.[30]
Unintentionally high or excessive torque applied when inserting the implant can result in excessive compression of the cortical bone causing microdamage, which is a permanent deformation of the microstructure of loaded cortical bone in the form of fatigue and creep. There is a general consensus to avoid self-tapping implants use in High density bone.[31-33] Golami et al stated that all 90 self-tapping implants that have been placed in type I and type II bone were successful 3 years after placement, with minimal crestal bone level changes. Self-tapping implants can be successfully placed in high density bone. However, clinicians must be aware of using a bone quality adapted drilling protocol.[11]

Torque values in different regions of mouth

It is clear that primary stability plays an essential role in successful osseointegration. Primary stability is a function of local bone quantity and quality, and it differs in different regions of mouth.[12] Kahraman et al concluded that a statistically significant difference in insertion torque value was found between mandible and maxilla; mandible had higher insertion torque values. Also, there were significant differences in ISQ values between mandible and maxilla at surgery and prosthesis delivery. When anterior and posterior regions were considered, the insertion torque and ISQ values, both at the surgery and prosthesis delivery, did not differ significantly.[33]

Implant design on the biomechanical stability of self-tapping implants

Implant design refers to three-dimensional implant structure, comprising all elements and features of the implant. As bone quality cannot be changed, selection of the appropriate implant design is imperative to improve the magnitude of stress that is transmitted to the bone-implant interface in the posterior maxilla in order to preserve the bone.[34] Hsieh et al stated evaluated two types of self-tapping implants, straight flute (STF) and spiral flute (SPF) designs were studied.[10] Two synthetic bone blocks with varying densities(0.32

g/cm3 and 0.16 g/cm3) were chosen to simulate the bone quality of the anterior maxilla. Bone Level Tapered Implants displayed superior resistance to push-in force in soft-density bone, and NobelActive implants displayed superior resistance to lateral force in hard-density bone. Implant stability can be influenced by the apical fixture design of self-tapping implants in immediate implantation.[35]

Immediate vs. Early loading

Implant Placement protocols given by ITI consensus stated that immediate implant placement is done in the socket on the same day as tooth extraction, early implant placement is done with soft tissue healing(4–8 weeks) or with partial bone healing(12–16 weeks) after tooth extraction, whereas in late implant placement they are done after complete bone healing, more than 6 months after tooth extraction.[36]

Kokovic et al compared clinical results of immediate and early loading (EL) self-tapping implants placed in posterior mandibles.[7] Seventy-two self-tapping implants with SLA surface (Ø 4, 1/4, 8 mm; length 8 and 10 mm) were analyzed. They have not shown any difference in RFA values and in crestal bone level changes between the immediately and the early loaded groups. Over the observation time, the implant stability increased significantly in both groups. Whereas at placement the longer implants exhibited higher RFA values than the shorter implants, this difference was no longer present at later time points. They concluded that self-tapping implants provides a high value of primary implant stability and that it is acceptable for IL protocol in the posterior region of the lower jaw.[37]

Short implants

The European Consensus Conference on short, angulated, and diameter-reduced implants defined short implants as those with ≤8 mm in length and ≥3.75 mm in diameter, standard implants as those >8 mm in length and ≥3.75 mm in diameter, and ultrashort implants as those <6 mm in length.[38] Also they stated that short implants are used primarily to avoid bone augmentation procedures and they are applicable if vertical bone volume is limited by other anatomical structures such as maxillary sinus or the mandibular canal, but there is sufficient alveolar ridge width to use ≥3.75 mm diameter implants.[39]

Thread number, geometry, and configuration have an essential role in dental implant stability, since it can influence implant insertion through bone(e.g., self-tapping implants), and stress distribution. It is hard to analyze the particular influence of each factor, such as thread form(v, square, buttress, or reverse buttress shaped), depth, number, angle, lead, and pitch. Implant companies limit the information that gives to professionals since their products are protected by intellectual property.[40]

Sowden and Schmitz reported greater bone damage when placing self-drilling mini-implants when compared with self-tapping mini-implant using scanning electron microscopy.[41]

The self-drilling and self-tapping systems showed a similar result in maximum insertion torque in both controls and diabetic group. This result did not match with the expectation that the self-drilling system, which has no predrilling procedure, will have higher maximum insertion torque than the self-tapping system. In both controls and diabetic group, total insertion energy was higher in self-drilling system than self-tapping system.[41]

Nevertheless, under the circumstance of root contact, self-drilling miniscrews displayed a significantly lower stability and higher failure rate than self-tapping miniscrews,[42,43] which could be caused by the higher risks of damage to root and adjacent alveolar bone, and the following inflammation surrounding the implants owing to the higher cutting capacity of self-drilling miniscrews.[44] This suggested more attention should be paid to the determination of the placement location when self-drilling miniscrews are used at the sites with narrow root proximity. Interestingly, distal root contact rate was higher than mesial roots for self-drilling screws, especially at the right maxillary alveolar bone.[45-47] This might be due to the fact that most clinicians are

right-handed and the observation positions at chairside are different for each quadrant.
that success rates of the two types of screw anchorage are similar, at least in the maxillary molar area.[48,49] The results should be interpreted with caution at other sites. Moreover, compared to self-tapping system, self-drilling miniscrews seem more susceptible to high mobility and failure when contacting to roots, thus we recommend the utilization of more accurate placement guide for self-drilling miniscrews at position with narrow root proximity.[50,51]

COMMERCIALLY AVAILABLE SYSTEMS

Figure 3. Self-tapping Camlog®

Figure 4. BlueSkyBredent® (Bredent GmbH&Co.Kg®, Senden, Germany)

Figure 5. Self-tapping blades (Biohorizons, Birmingham, Alabama, USA)

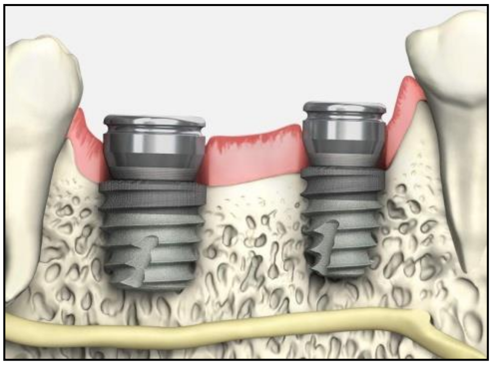

Figure 6. Biohorizons® Tapered Short (Biohorizons®, Birmingham, Alabama, USA)

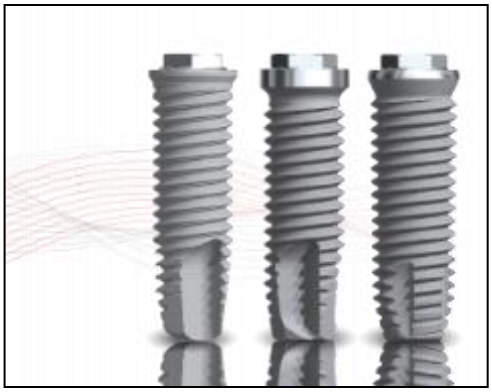

Figure 7. Mark II self-tapping implant and Mark IV self-tapping tapered implant (Nobel Biocare AB, Goteburg, Sweden)

Figure 8. Osseotite (Biomet 3I)

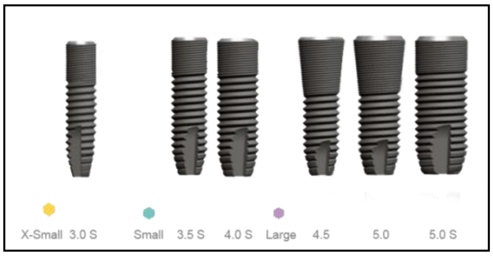

Figure 9. Tioblast implant (AstraTech AB, Molndahl, Sweden))

Figure 10. Intralock® Intrahex (Intra-lock International, Boca-Raton, Florida, USA)

Figure 11. Straumann® Tissue Level Standard Plus (Straumann AG, Basel, Switzerland)

Figure 12. Tixos® Short (Leader Novaxa, Milan, Italy)

Authors' contribution

Vidya S Bhat: Manuscript editing, Literature search, data collection

Sanath Kumar Shetty: Data Analysis, manuscript drafting

Syed khizer Ishquddin: Manuscript editing, Literature Search, Data Analysis

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Conflict of interest

The authors have nothing to disclose or any conflicts of interest.

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