

Configurations of implant threads: A Review

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Abstract

Review Article

The dental implants are used for replacement of missing teeth, and it's have been widely used for restore the function, esthetic, speech, and patient confidence. It forms the contact between the implant and the bone. The implant threads are altered to improve the initial contact, primary stability, increase the surface area, and facilitate dissipation of loads at the implant and bone surface. Implant thread design is one of the key factors it determines the primary stability and stress distribution during osseointegration, the threaded implants are reduced both stress on bone and sliding distance between the implant and bone. The primary stability is play a important role in less bone quality, double and triple threaded implant increases the primary stability than single threaded implant, the implant threads distribute mechanical stress equally at bone implant interface, lead to stability of dental implants and less bone resorption and also higher thread profile improve the primary stability, the success or failure of implants depend on the thread designs and quality of bone.

Keywords: Implant thread design, Osseointegration, Threaded implants.

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INTRODUCTION

Dental implants are one of the most important devices, currently used for replacement of missing teeth Chetan Sugandhi *et al.*, 2020 [1]. They play a role in oral rehabilitation for managing partially and fully edentulous patients. Threaded dentistry implants are currently widely used due to their elevated achievement levels, threads are built into the model to convert shear stresses into more durable strength for optimization biomechanics of implants, The threads are alters the initial contact, and increasing the primary stability, enhance the osseointegration and shortens the healing period of implants Ohyama *et al.*, 2017 Ueda *et al.*, 2017) [2], it is mainly depended on the implant design, surface of implant, bone quality of the recipient site and the surgical procedure of implant placement, threads are used to achieve maximum primary contact, enhance the initial stability of the implant, and stress dissipation at the bone implant interface Yenumula J B Manikyamba *et al.*, 2018 [3]. The implant threads are design with more thread depth at the apical area and coronally it is decreases, this thread shape provide long-term successful under masticatory load, the square implant

thread design has a beneficial shape for occlusal loading compared with other thread designs ,dental thread design play important role in clinical success.

History

There are more implant thread designs are available, cylindrical, press fit implants had a friction fit insertion this implant design was very popular in 1980s loading these implants had a more crestal bone loss and 50% of implant failure to overcome this disadvantage threaded implants were introduced, due to presence of threads it increases the surface area, improve the shear stress, increases the osseointegration when load are applied to the implant body it dissipate the stress between bone and implant contact surface.

Classification

According to their shape

- V-Shaped
- Square
- Buttress
- Reverse buttress

According to presence of threads

- Single threaded
- Double threaded
- Triple threaded

Implant Thread

Threads have been incorporated into the implants to increase the initial stability Ivanoff, C. J. *et al.*, 1997 [4] large implant surface area distribute stress equally, Kohn *et al.*, 1992 demonstrated the presence of bone bridge form depth of one thread to another, when implants are loaded laterally and concluded that strain is more concentrated in the area of bone contact the crest of the thread and strain decrease from crest to the root of the thread.

Thread Shape

Thread shape is play a role in determine the thickness of the thread and face angle of the threads, Abu Hussein, H *et al.*, 2019 [5] the shape of the implant thread has a major role in transform the masticatory load into compressive load at the implant and bone surface, presently there are four types of basic thread shapes are available V-shape, square shape, buttress, reverse buttress shape (Figure 1), V-shaped implants threads also known as fixture with 30 degree angulation and square shape thread design also known as power threads Misch *et al.*, [6] V-shape and square shape thread design generally generate significantly less stress in trabecular bone, and cortical bone did not showed any difference in this thread design. When non-loading condition the bone thickness is uniformly distributed at above and below the thread, when under the loading

condition bone thickness increased at below the thread and weaker only on the thread tip.

Misch *et al.*, suggested that V-Shape thread (30 degree) generate higher shear force than reverse butters thread (15 degree) both the type of threads generate force which may lead to defect formation [6]. Ruy *et al.*, 2014 concluded that V-shaped threads were manufactured to reduce the stress in case of weakened bone [7]. the axial load on buttress, square threads are dissipated through compressive force, V-shaped and reverse buttress threaded implants transmit axial load through a combination of shear, tensile and compressive force, Steigenga *et al.*, conducted an animal study found that square thread implants were found to have greater bone implant contact compared with V-shaped and reverse buttress implant [8].

Dalia Samir *et al.*, 2021 conducted a study on implant thread cross sectional design on the micromotion of implant in different bone qualities, they found that micromotion decreases as the bone quality increases in D1 and D2 bone the best thread to be used it is V-shaped design, in D3 and D4 bone shaped thread [9]. According to Manikyamba *et al.*, in 2017 Implant thread design is important factor it as increasing the implant surface area between implant to bone contact region, dissipating the stress, increasing the initial stability which enhances the implant osteointegration and success. Agrippana *et al.*, did a study to investigate the effect of implant thread design on biological stability, they come to an end implant thread design on bone level and bone level tapered implant did not affect the biological stability [10].

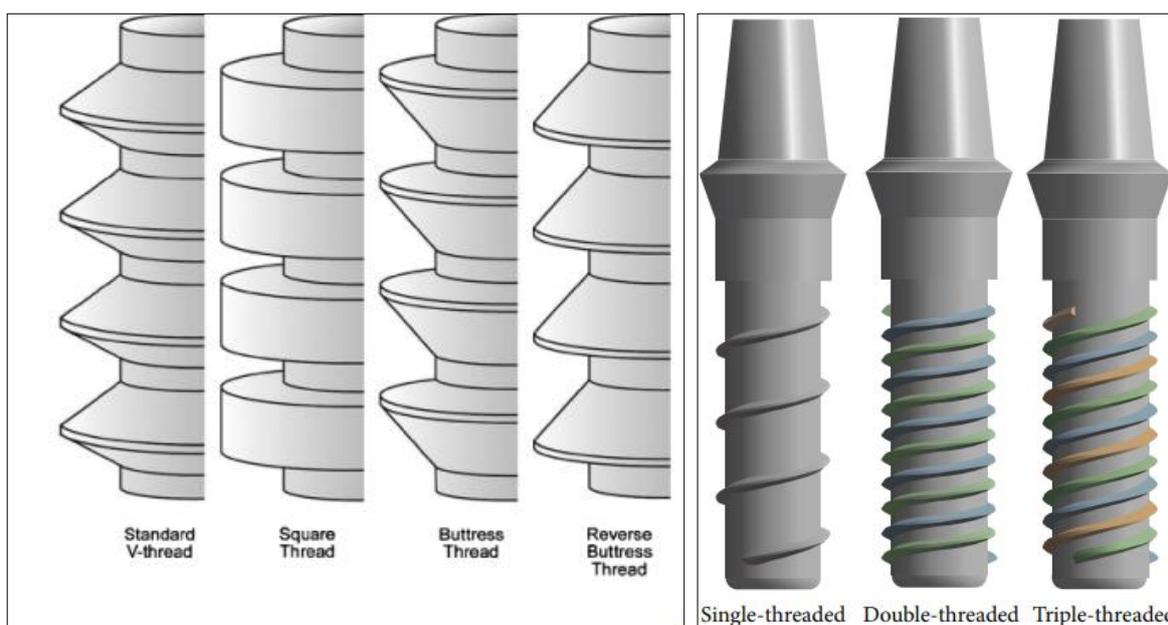


Fig 1: Available implant thread pattern types

The concept of double threaded and triple threaded implants has been introduced recently. These

threads provide a faster thread penetration and generate less heat during implant placement and increases

primary stability, the threaded implant requires more torque for implant placement and improve high contact with the bone, the survival rate was depended upon the stress on the bone and implant. According to Ma *et al.*, 2014, the single thread implants show best primary stability than the double and triple threaded implant, when lead angle increased in these implants with load applied in both horizontal and vertical direction. Yoko Yamaguchi *et al.*, 2020 carried a study to investigate the primary stability of single and double threaded implants they found that faster insertion of double threaded implant with high lead angle diminishes the primary stability because they cause damage to the bone during faster insertion [11]. Ayman Soror *et al.*, 2020 carried out study to investigate the insertion torque and primary stability of single versus double and triple threaded implants they concluded that greater primary stability and insertion torque provided by the double and triple threaded implant than the single threaded implant [12].

Thread Geometry

Threads on the implant body were designed to increase the surface area, implant stability and dissipate the load at the bone implant interface, functional surface area of implant thread design depends on many variables such as thread pitch, thread depth, thread width.

Thread pitch: It is the distance between adjacent threads and it direct the number of threads per unit length, smaller the pitch more threads and also increases the surface area, Sagrika shaukla *et al.*, 2014, when decrease in thread pitch is more beneficial for occlusal force distribution, implant thread pitch usually increases the initial stability in lower bone density, Ryu HS *et al.*, 2014. Elitsa Sabeva *et al.*, 2020 did a study to compare the implant thread pitch, thread profile, surface morphology on the primary stability of implant and they found that higher the thread profile and wider thread pitch affect the primary stability more than the rougher surface of the implant [13].

Thread lead: It is the distance that a screw would advance in the axial direction per one complete revaluation, its advice the how far implant thread can reach after a single turn, it basically determines the speed of insertion of dental implant, in a single threaded design lead is equal to pitch and double threaded design lead is double the pitch and in triple threaded design lead is triple the pitch. When one thread lead implant rotates once, a double thread implant at 1rpm inserts 2 threads into the bone, triple threaded implants 3 times faster than the single thread Abuhussein, Misch, C. E *et al.*, 2008, (Figure 2). Ormianer *et al.*, 2016 conducted a study on implants with thread pitches they investigated that implant with greater pitch decreases the bone loss [14].

Thread depth: It is the distance between the major and minor diameter of thread or the distance between the outer most and inner most aspect of the thread, when increasing depth it means greater surface contact of bone Miyamoto I *et al.*, 2005, crestal type of implants allow a uniform thread depth at the length of the implant, in tapered implants the outer surface diameter decrease due to taper in shape so that the depth decrease towards the apical region, Yenumula J B Manikyamba 2018, there is less ability to anchorage the bone at the apical region for primary stability by placing a tapered threaded implant [3] increase the thread depth greater the implant surface area, advantage of increasing the thread depth in area of cancellous bone as it increases the interfacial density of bone and significantly create a dense bone at the implant surface area, the shallow implant thread depth it is easier to insert the implant in dense bone Misch, C. E *et al.*, (2008), and increased insertion torque of implants with greater thread depth may require the use of a bone tap to fully seat the implant. Increasing the implant thread depth also increases the functional surface area.

Thread width: It is the distance between the coronal most and apical most part at the tip of a single thread design in the same axial line. Implant increases the surface area by 15-25% for every 1mm increase in diameter, when implant as become wider the depth of the implant thread become deeper without decreasing the body wall thickness between the inner diameter and abutment screw space with in the implant, the wider the implant it more similarly describes the natural tooth emergency profile Steigenga JT *et al.*, 2003.

Crest Module

The neck of the implant is called as crest module, the implant thread at crestal region contact with the cortical bone is also called as crest module (Figure 3), it is extended from implant body and incorporates antirotation components of the implant abutment connections Yadav P *et al.*, 2016, crest module with more than 20 degree showed beneficial pressure component on the adjacent bone, it reduces the chance of bone loss. Aparna IN *et al.*, 2012, According to Bozkaya *et al.*, compared the different thread profile and crest module, average masticatory load did not affect on the cortical bone, when excess masticatory load applied, overloading occurs at near the apical region of the cortical bone hence there is a crestal module minimizes bone stress [15]. Mahanagy Mohamed *et al.*, 2020 compare the implant stability and periimplant bone loss around two implant thread design that is conventional micro thread implant and crestal micro thread design implant, they found that crestal micro thread design showed better stability and less periimplant marginal bone loss than conventional micro-thread design implants [16].

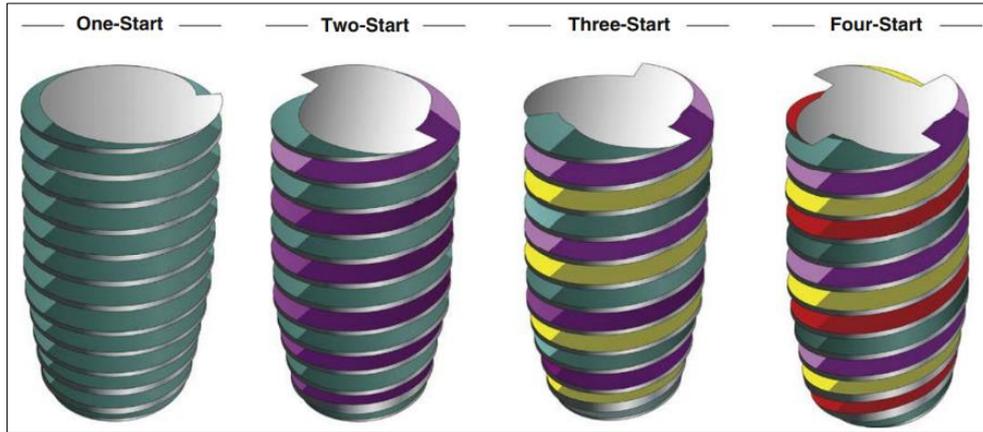


Fig 2: Types of thread pitches

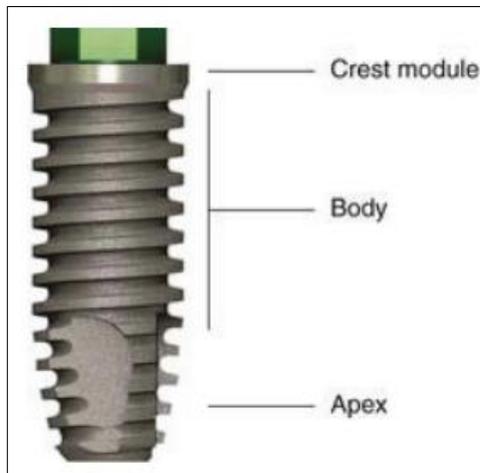


Fig 3: Crest module

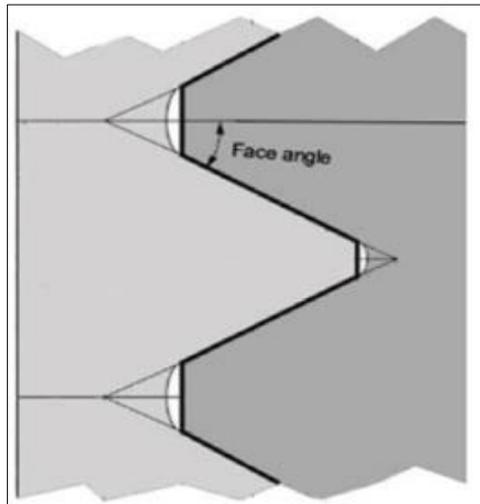


Fig 4: Facial line angle

Facial Angle:

It is the angle formed between the face of thread and perpendicular to the long axis of the implant (Figure 4), the facial angle of the implant thread design changes the direction of the masticatory load applied on the prosthesis, and distribute the load at bone and implant interface V-shaped implant thread design has a

30 degree of facial angle and square shaped implant thread design has a 90-degree facial angle at the long axis of the implant. Chun, H *et al.*, 2002.

Apical Region:

The Apical region of the implant thread design usually tapered to permit the proper seating of implant

into the prepared osteotomy site, the anti-rotational characteristic features was added to the apical region in the form of holes and vents, the bone can be grown with in these holes and vents thus increasing the bone implant contact Tushar *et al.*, 2022 [17].

CONCLUSION

Implant thread design was a major important factor in the biomechanical properties of the dental implants, implant threads usually enhance the initial contact, primary stability, insertion torque, and increases the surface area of implant, and stress distribution on the bone and implant contact area. the threaded implant design mainly improves the osteointegration and long-term success rate of implant by reducing the masticatory load on implant and bone interface, when primary stability is main concern in low bone density double and triple threaded implants increases the primary stability than the single threaded implant.

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