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A deep and multi-helix flute threaded implant: a review and clinical analysis

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Abstract (J Korean Assoc Oral Maxillofac Surg 2025;51:131-140)

Objectives: Implant success depends on osseointegration that is influenced by macrogeometry, including thread design. Thread macrogeometry has a crucial role in achieving primary stability, particularly in low-density bone. Our study reviews the thread design's impact on implant stability, focusing on Straumann BLX (Straumann Co.) implants for practical insights.

Materials and Methods: We searched the PubMed/MEDLINE and Embase for studies released until August 2023 using the following keywords: "implant", "macrogeometry", "thread", "thread depth", "thread pitch", "thread geometry", "macrodesign", "flute", "osseointegration", and "stability". In addition, 58 Straumann BLX implants with dynamic threads, which feature a deep thread design and incorporate a multi-helix flute structure to enhance primary stability across different bone densities, were reviewed retrospectively at our institute.

Results: The literature demonstrated that thread pitch, depth, and flute design significantly affect stress distribution and initial stability, especially in low-density bone. Implants with deep threads and spiral flutes showed improved primary stability and insertion efficiency. Clinically, retrospective data from 58 cases supported favorable outcomes in challenging bone conditions such as posterior maxilla and implant replacement sites.

Conclusion: We need to determine appropriate designs for implants with the consideration of bone quality and implantation bed condition.

Key words: Macrogeometry, Thread depth, Stability, Osseointegration, Dental implants

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I. Introduction

Long-term success of dental implants relies on stable integration with surrounding bone, a process known as osseointegration. Among the crucial factors influencing osseointegration, implant macrogeometry assumes a significant role[1]. This macrogeometry includes thread pitch, thread shape, as well as thread width and depth features.

The screw implant design enhances initial stability, minimizes micromotion of the implant, and increases mechanical retention, which is the primary prerequisite for immediate loading success. The use of screw-threaded implants gained widespread recognition and adoption, particularly after the 1980s, prompting a continuous effort for innovation and refinement in screw thread designs. Although the changes in thread design may have been subtle, there has been still an attempt in a revolutionary shift of design in thread factors. Thread designs appear to have a significant influence in achieving implant osteointegration by increasing initial stability, maximizing bone-implant contact (BIC), and favoring stress distribution at the bone-implant interface. When dealing with type 4 bone, the thread design has a greater impact on stability compared to other types of bone[2].

The aim of this work is to assess the relationship between thread design and stability of implants. To achieve this, we will conduct a comprehensive review of the current literature, drawing on the collective knowledge and insights from the field. Furthermore, we will leverage our clinical expertise and practical experiences, focusing on Straumann BLX (Straumann Co.) implants, which feature a deep thread design and incorporate a multi-helix flute structure. These features are specifically engineered to enhance insertion efficiency and primary stability in anatomically challenging sites such as

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the posterior maxilla, sites of implant failure, and areas with compromised bone density. This approach allows us to combine theoretical and empirical perspectives to gain a deeper understanding of the impact of macrogeometry on implant performance and stability.

II. Materials and Methods

The PubMed/MEDLINE and Embase databases were queried for research articles published to August 2023 using the specified keywords: "implant", "macrogeometry", "thread", "thread depth", "thread pitch", "thread geometry", "macrodesign", "flute", "osseointegration", and "stability". The search strategy by population, intervention, comparison, outcome, and study design (PICOS) is shown in Table 1.

Inclusion criteria: The papers must have evaluated implant thread designs with those of other implant types. Furthermore, one of the following methods has to be adopted in the study: finite element analysis, prospective cohort studies, retrospective cohort studies, case control studies, randomized controlled trials, or another clinical trial design.

Exclusion criteria: Case reports, case series, and systematic reviews are excluded criteria. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) were employed in this integrative study.

In addition, 58 implants with dynamic threads (BLX) that were installed at the Department of Oral and Maxillofacial Surgery at Seoul National University Dental Hospital from April 2022 until the present day were examined. Patients included in this study were adults requiring implant placement in sites with compromised bone conditions, such as severe alveolar bone loss, previous implant failure, or low-density posterior maxillary bone. All surgical procedures were performed under local anesthesia. A full-thickness mucoperiosteal flap was elevated following a crestal incision in the edentulous area. Implant osteotomies were prepared according to the manufacturer's protocol, and implants were inserted following the recommended drilling sequence and depth specifications.

Table 1. PICOS strategy for the systematic review

PICOS	Strategy
Population (participants)	Dental implant
Intervention	Modification of thread design
Comparison	Comparative group/intervention group
Outcome	Osseointegration response, stability

(PICOS: population, intervention, comparison, outcome, and study design)

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III. Results

1. Literature review

A total of 298 items were found, of which 38 were duplicates. Following a review of the abstracts and titles, 25 papers met the inclusion and exclusion criteria and were chosen for further analysis. 10 articles were excluded because they dealt with other factors in their results, and 15 articles were then subsequently selected.(Fig. 1)

Thread factors involved thread shape, pitch, depth, width, and cutting flute. Thread designs can be classified based on their characteristics.

2. Thread pitch

Thread pitch refers to the spacing between threads, measured along the same side of the axis, and indicates the number of threads per unit length. Therefore, when implants are of identical length, a finer pitch results in more threads, thereby increasing the surface area[3].

Lead is another geometric parameter in screw design, distinct from pitch, which measures the distance between thread centers after one full rotation. Lead is the axial distance a screw advances in one rotation. In single-threaded screws, lead equals pitch, but in double-threaded screws, it is twice the pitch, and in triple-threaded screws, three times. This impacts the implant insertion speed: a double-threaded implant inserts twice as fast as a single-threaded one, while a triple-threaded needs only a third of the time. Thus, both lead and pitch are vital for optimizing the efficiency of implant placement in bone, influencing insertion speed and surface area contact.

Orsini et al.[4] studied sheep with "narrow-pitch" (0.5 mm) and "wide-pitch" (1.7 mm) implants and discovered that lower thread pitch increases BIC, which enhances both initial anchoring and primary stability in cancellous bone. This shows that altering thread pitch has a considerable impact on implant success in less dense bone types.

Orlando et al.[5] performed an *in vitro* study on fine-pitch (0.762 mm) and wide-pitch (1.016 mm) implants. For dense cortical bone (D1 or D2), fine-pitch implants combined with a 2.5 mm diameter osteotomy site were recommended. In contrast, for softer bone types (D3 or D4), wide-pitch im-

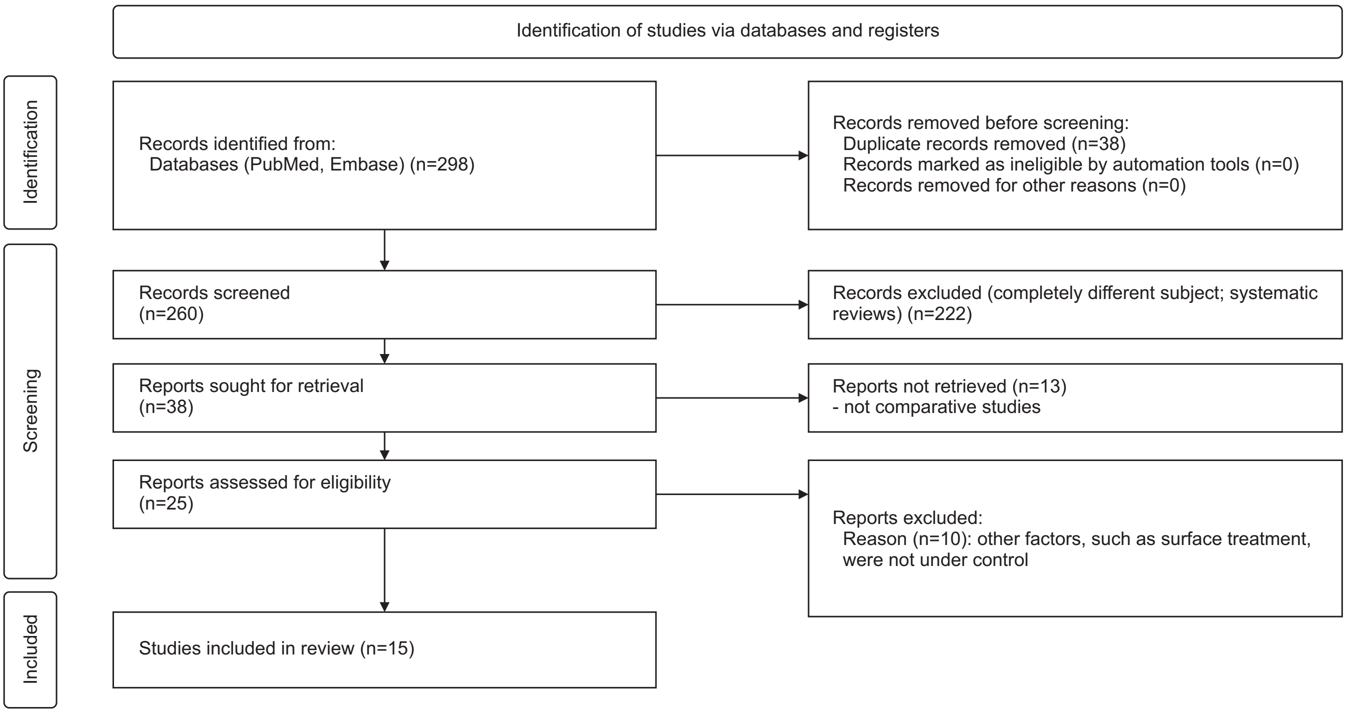

Fig. 1. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow diagram illustrating the selection process of studies for the systematic review.
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plants with a 1.5 mm diameter osteotomy site were shown to perform better.

Kong et al.[6] utilized finite element analysis to study implants with thread pitches ranging from 0.5 to 1.6 mm. The analysis demonstrated that stress on the implant reduced as the thread pitch decreased from 1.6 to 0.8 mm. However, thread pitches smaller than 0.8 mm led to increased stress, particularly in cancellous bone, highlighting the importance of pitch size in reducing stress.

Chun et al.[7] reported that as the screw pitch gradually decreased, the maximum effective stress also reduced; however, when the screw pitch was smaller than 0.9 mm, its impact on further reducing the maximum effective stress in the jawbone was minimal. The relevant literature on thread pitch is outlined in Table 2.

3. Thread depth and width

The distance between a thread's major and minor diameters is known as thread depth, according to Misch et al.[3]. Another method to define thread depth is the distance between the outermost tip of the thread and the body of the implant. The distance between the coronal and apical majority sections of a single thread's tip in the same axial plane is defined as the thread width.

Both geometric variables of thread depth and width significantly affect the implant insertion process and its surface area interaction with the bone. A shallower thread depth simplifies the implantation, particularly in dense bone structure, potentially eliminating the need for tapping. Deeper threads, on the other hand, increase primary stability in regions with lesser bone density or greater occlusal stresses by increasing the functional surface area at the BIC. Therefore, while shallow threads facilitate easier insertion into dense bone without the need for tapping, deeper threads provide the advantage of a broader surface area, beneficial in softer bone regions or under higher occlusal loads[3].

Studies by Kong et al.[8] and Ao et al.[9] extensively explored the impact of thread height and width on implant stress distribution, employing three-dimensional finite element models to identify configurations that minimize stress peaks under various loading conditions. The optimal thread heights and widths were found by Kong et al.[8] to be between 0.34 and 0.50 mm and 0.18 and 0.30 mm, respectively. They also noted that the thread height was more sensitive to stress concentrations, particularly under non-axial loads that produced higher stresses than axial loads and that cancellous bone experienced significantly higher forces than cortical bone. Similarly, Ao

Table 2. Effects of thread pitch on implant stability

Study	Method	Implant (thread)	Parameter	Conclusion
Orsini et al.[4] (2012)	*In vivo*	Pitch: narrow pitch (0.5 mm), wide pitch (1.7 mm)	Bone-to-implant contact, removal torque	Implants designed with smaller thread pitch might be beneficial in situations where primary stability is a concern, particularly in cancellous bone.
Orlando et al.[5] (2010)	*In vitro*	Pitch: fine-pitch (0.762 mm), wide-pitch (1.016 mm)	Insertion torque	For dense cortical bone (types D1 or D2), a fine-pitch implant design combined with a 2.5 mm diameter osteotomy site is recommended. Conversely, for softer bone types (D3 or D4), it is advisable to use a wide-pitch implant design with a 1.5 mm diameter osteotomy site.
Kong et al.[6] (2006)	FEA	Pitch: 0.5 to 1.6 mm	Maximum equivalent stresses	Stress reduced with decreasing pitch, from 1.6 to 0.8 mm. Thread pitches of less than 0.8 mm exhibited higher stress. Thread pitch affects stress more sensitive in cancellous bone.
Chun et al.[7] (2002)	FEA	Pitch: 0.7, 0.9, 1.0 mm	Maximum effective stress	The maximum effective stress decreased as the screw pitch gradually reduced; however, screw pitch had a minimal impact on reducing the maximum effective stress in the jaw bone when it was smaller than a certain value (0.9 mm).

(FEA: finite element analysis)
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et al.[9]'s research confirmed these findings, demonstrating that thread depths greater than 0.44 mm and widths between 0.19 to 0.23 mm yield the most favorable biomechanical behavior in immediately loaded implants, reinforcing the notion that thread depth plays a more crucial role in stress distribution compared to thread width.

For areas with softer bone density, selecting implants with specific thread designs – shorter pitch and deeper depth – can improve primary stability, a key factor for dental implants to be successful[10]. With a statistically significant difference between the groups, deeper threads showed a propensity to have a larger density of osteocytes, indicating higher levels of new bone formation inside the thread areas[11]. Deeper threads in the implant neck area do not result in harmful effects regarding peri-implant hard and soft tissue dimensions[12]. Table 3[8-13] provides a summary of the literature on thread depth that is currently accessible.

4. Cutting flutes

The cutting flutes of dental implants are design features present on the apical (bottom) part of the implant that resemble grooves or flutes similar to those on drill bits. This feature is specifically engineered to assist in the self-tapping process during implant placement. The cutting flutes help in cutting through the bone, facilitating the insertion of the implant by removing bone material as the implant is screwed into place.

When contrasted with non-self-tapping implants, self-tapping implants demonstrated a significantly higher level of primary stability. This may be explained by the tight contact between the implant and the bone that results from the compressive threads, as well as the small lateral displacement that the implant causes on the bone tissue when it is inserted, pushing loose bone trabecula closer together[14].

In order to minimize resistance during the first insertion, flute designs are also essential. Because the bowl shape flute creates the smallest area possible to hold the crushed bone fragments, it increases the insertion torque and bending strength[15]. The existing literature on cutting flutes is presented in Table 4[14-18].

There are some characteristic features of implant geometry: Microthreads of the neck, progressive threads, expanding threads, deep threads, knife threads, and dynamic threads.

1) Microthreads of the neck

Retentive features at the neck of the implants increases bone-to-implant contact and convert shear forces to compressive forces.(Fig. 2. A) Therefore, microthreads promote bone formation[19]. According to Wolff's law, retentive components at the implant neck aid in the distribution of certain stresses, hence supporting the maintenance of the height of the crestal

Table 3. Effects of thread depth and width on implant stability

Study	Method	Implant (thread)	Parameter	Conclusion
Reinaldo et al.[10] (2021)	*In vitro*	Thread depth: 0.5, 0.35 mm	ISQ value	Deeper thread depth (0.5 mm) had higher ISQ values.
Gehrke et al.[11] (2019)	*In vivo*	Conventional thread, deep thread	Removal torque, bone-to-implant contact, BAFO, osteocyte count	Deeper thread presented higher amount of BAFO% and osteocyte.
Sun et al.[12] (2016)	*In vivo*	Thread depth: 0.45, 1.15 mm	Bone-to-implant contact, bone loss, ISQ, soft tissue height	Thread depth and pitch in the implant neck area do not influence peri-implant hard and soft tissue dimensions.
Lee et al.[13] (2015)	*In vitro*	Thread depth: 0.35, 0.85, 0.60, 1.10 mm	Insertion torque	Greater insertion torque can be achieved with deeper threads without the accompanying decrease in mechanical strength.
Ao et al.[9] (2010)	FEA	Cylinder implants with depth of 0.2-0.6 mm and width of 0.1-0.4 mm	Maximum von Mises stress, maximum displacement	The stress distribution was more impacted by thread depth than by thread width. The best results were obtained with threads that were 0.19-0.23 mm wide and had a depth of more than 0.44 mm.
Kong et al.[8] (2008)	FEA	Threaded implants with height of 0.2-0.6 mm and width of 0.1-0.4 mm	Maximum von Mises stress	The optimal thread depth and width were, respectively, 0.34-0.5 mm and 0.18-0.3 mm. Another more sensitive element to lower the peak stress concentration inside the bone was thread depth.

(FEA: finite element analysis, BAFO: bone fraction occupancy, ISQ: implant stability quotient)

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Table 4. Effects of cutting flutes on implant stability

Study	Method	Implant (thread)	Parameter or load	Conclusion
Hsieh et al.[16] (2021)	*In vitro*	Non cutting flute, spiral cutting flute, straight cutting flute	Insertion torque, maximum force, resistance to lateral loads	The peak insertion torque increased when the flute's design was changed from straight to spiral. Compared to self-tapping implants, non-self-tapping implants showed better initial stability and more resilience to lateral loading.
Jimbo et al.[17] (2014)	*In vivo*	Blossom (spiral cutting flute); straight self-tapping	Insertion torque, bone-to-implant contact, bone area fraction occupied	Organization of peri-implant bone around implants with the Blossom flute was improved.
Marković et al.[14] (2013)	*In vivo*	Self-tapping, non-self-tapping	ISQ value	Self-tapping implants did produce considerably greater primary stability compared to non-self-tapping implants when using the bone-drilling technique.
Wu et al.[15] (2012)	*In vitro*	Non flute, edge flute, bowl flute, spiral flute	Insertion torque, holding power, bending strength	Flute form also helps to reduce resistance to first insertion. Both insertion torque and bending strength in bowl cutting flute are significantly higher.
Toyoshima et al.[18] (2011)	*Ex vivo*	Cutting flute, non-cutting flute	Insertion torque, Periotest, RFA, and push-out test	Hybrid self-tapping implants could achieve high primary stability, making them suitable for usage in low-density bone.

(ISQ: implant stability quotient, RFA: resonance frequency analysis)

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bone. Certain drawbacks exist, such as higher plaque retention, if threads are exposed[20].

2) Progressive threads: Greater depth in the apical portion than in the coronal portion

This design may shift more load to the cancellous bone, which is more flexible than the crestal cortical bone.(Fig. 2. B)[21] This

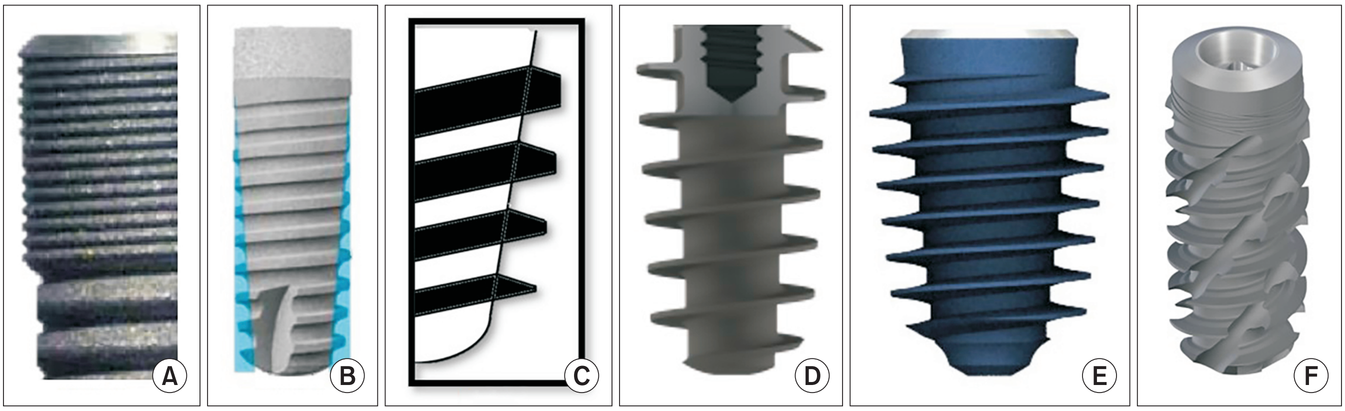

Fig. 2. Various implant thread designs: A. Microthread design. B. Progressive thread design with increasing depth. C. Variable threads. D. Deep threads. E. Knife threads. F. Multiple helix and variable thread design.
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is claimed to help reduce cortical bone resorption. Proper occlusal stress may improve blood circulation in cancellous bone, enhancing bone metabolism and, as a result, bone remodeling[22].

3) Variable threads: Gradually increased width from the apical to the coronal part

The variable thread design promotes primary stability under suboptimal conditions by compressing premature bone. (Fig. 2. C)[23] This cutting characteristic allows the implant to cut through brittle bone and be forced into place with a narrower initial osteotomy. Although it still occurs with other tapered implant types, alveolar fracture is less common with this design[24].

4) Deep threads

Deep threads increase the implant's surface area, thereby improving bone-to-implant contact.(Fig. 2. D) These features convert shear forces to compressive forces. In addition, the large inter-thread area promotes angiogenesis and sustains blood supply[25,26]. The large distance between threads promotes bone regeneration area and increases the bone-to-implant contact area[27].

5) Knife threads

Knife threads have a deeper thread depth and a smaller thread width.(Fig. 2. E) Knife thread implants reduce microfractures in the surrounding bone and apply compressive force, resulting in higher implant stability quotient values compared to V-thread implants. This suggests that during the early stages of the healing process following surgery, implant stability is significantly influenced by the macro-thread design.

6) Deep threads and multi-helix flutes: Spiral long flutes with deep and variable threads

Spiral long flutes distribute bone chips along the full length of the threads, enhancing primary and secondary stability. (Fig. 2. F) Variable threads condense bone along the threads, thereby achieving primary stability.

IV. Discussion

1. Macrogeometry of Straumann BLX design with four distinguishing features

1) Deep threads

An efficient way to improve osseointegration at accelerated healing times is to use deeper and bigger thread diameters to provide increased implant stability in soft bone. Deep threads provide more bone-to-implant interference and more space for new bone formation. Therefore, it can improve both primary and secondary stability.

2) Spiral long cutting flute

Cutting flutes have two main characteristics: the cutting edge that creates the osteotomy and the flutes that provide space around the implant. Triple cutting flutes allow for easy installation of the implant into the small osteotomy, enhancing initial stability. Long flutes distribute autologous bone chips while relieving tension from the deep threads.

3) Variable threads

The implant's cutting nature allows it to cut through the

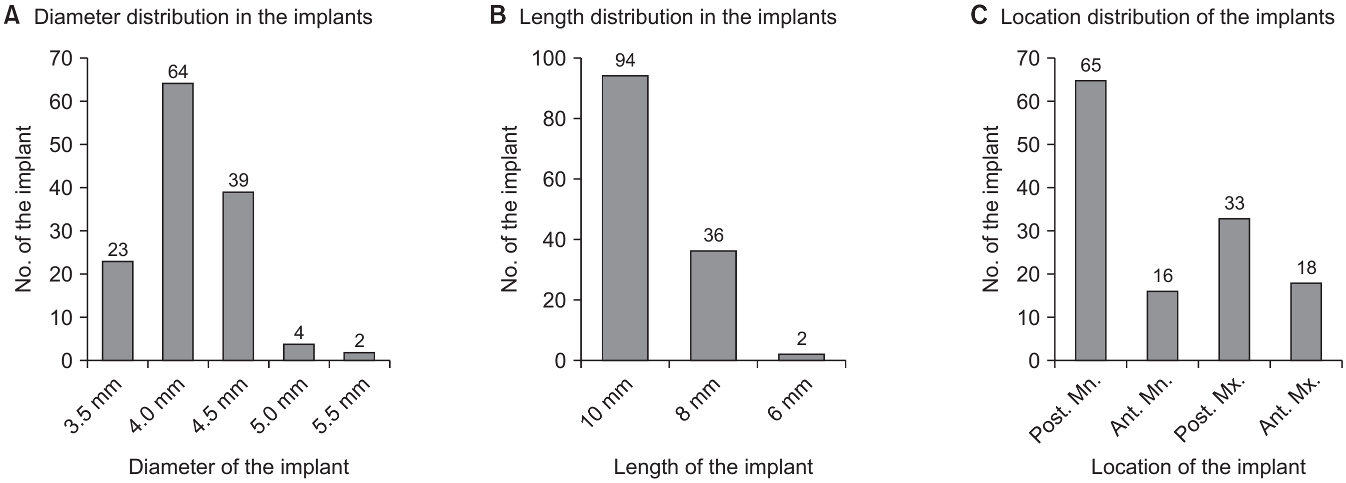

Fig. 3. Distribution of implants based on diameter, length, and location. A. Diameter distribution of implants. B. Length distribution of implants. C. Location distribution of implants. (Post. Mn.: posterior mandible, Ant. Mn.: anterior mandible, Post. Mx.: posterior maxilla, Ant. Mx.: anterior maxilla)
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brittle bone and drive itself into place with a smaller initial osteotomy. Alveolar fracture, which can occur with other tapered implant designs, is reduced as a result.

4) Progressive threads

Crestal bone is better preserved when stress is distributed apically rather than coronally around the implant fixture. Thin cortical crestal bone areas like the posterior maxilla can an indication for this design.

2. Clinical installation data of the implants

A total of 132 implants were placed in 66 patients, with two implants subsequently removed due to failure to achieve primary stability. The patient demographic included 26 males and 40 females, with an average age of 61.9 years, ranging from 21 to 92 years. In terms of implant diameter, 4.0-mm implants were most commonly used, being placed 64 times and accounting for 48% of all implants. Additionally, 4.5-mm implants were placed 39 times, 3.5-mm implants were placed 23 times, and a smaller number of 5.0 and 5.5-mm implants were used.(Fig. 3. A) The majority of implants, specifically 94, were 10 mm in length, followed by 36 implants of 8 mm in length, and two implants of 6 mm in length.(Fig. 3. B) Implant placements were most frequent in the mandibular molar region with 65 implants, making it the predominant site, followed by the maxillary molar, maxillary anterior, and mandibular anterior regions.(Fig. 3. C) The leading cause for implantation was identified as failure at the site of an existing implant, with severe periodontitis and osteomyelitis also being significant factors.(Fig. 4)

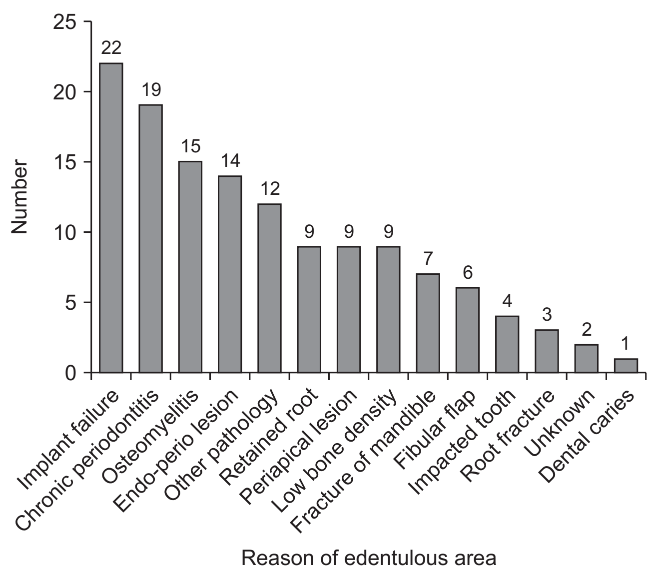

Fig. 4. Distribution of reasons for edentulous areas, categorized by factors such as implant failure, chronic periodontitis, osteomyelitis, and other pathologies.
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1) Case 1: Straumann BLX in a substantial bone resorption site

A 33-year-old female patient presented with a periapical lesion on #37. The preoperative radiogram revealed substantial alveolar bone resorption around tooth #37.(Fig. 5. A) The tooth was extracted with the mass excision of the lesion with

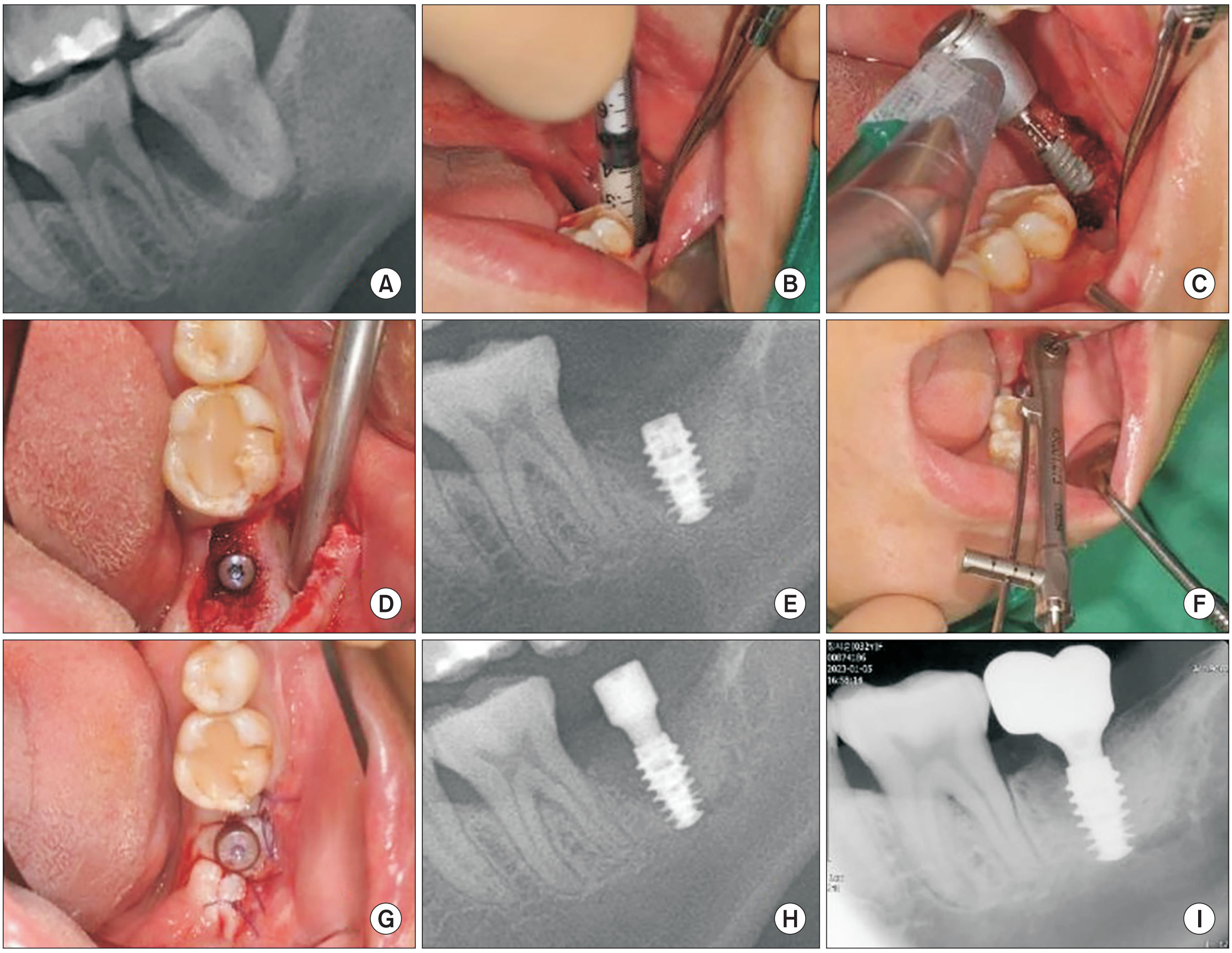

Fig. 5. Straumann BLX (Straumann Co.) installation at the extraction site of an endo-periodontal lesion. A preoperative panoramic view showed a periapical lesion at site #37 (A). A bone graft was performed at site #37 (B). The fixture was installed with a covers crew (C-E). Re-entry at site #37i was done 5 months after the implant installation (G, H). The final prosthesis was delivered (I).
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a subsequent bone graft.(Fig. 5. B) International Team for Implantology (ITI) Straumann BLX 4.5×8.0 mm implant placement and bone graft on #37i were performed at the 4-month follow-up.(Fig. 5. C-5. E) The re-entry procedure with an ITI Straumann BLX healing abutment 5.0 mm (gingival height 2.5 mm, abutment height 4.0 mm) was carried out 5 months following implant placement.(Fig. 5. F-5. H) The final prosthesis was delivered.(Fig. 5. I)

2) Case 2: Immediate reimplantation in the implant failure site

A 51-year-old female patient had ITI Straumann BL (4.1×10 mm) dental implants placed at the sites of #25 and #27. During the regular follow-up when adjusting the prosthesis at #25i after 3 years and 6 months, the implant fixture came out. (Fig. 6. A, 6. B) There was no clinical or radiological evidence of implant failure. Peri-implantitis granulation tissue was observed in the implant bed upon endoscopic examination.(Fig. 6. C) The previously grafted maxillary sinus site appeared healthy.(Fig. 6. D) The implant site was prepared for an ITI Straumann BLX WB 5.0×10.0 mm with an regulat base 4.0-mm cover screw.(Fig. 6. E, 6. F)

V. Conclusion

Deep, multiple helix flutes, and variable thread implants are particularly suitable for challenging clinical scenarios. Their design is beneficial in regions where enhanced primary stability is required, such as the posterior maxilla, areas with severe bone defects, osteoporotic bone, or in sites of previous

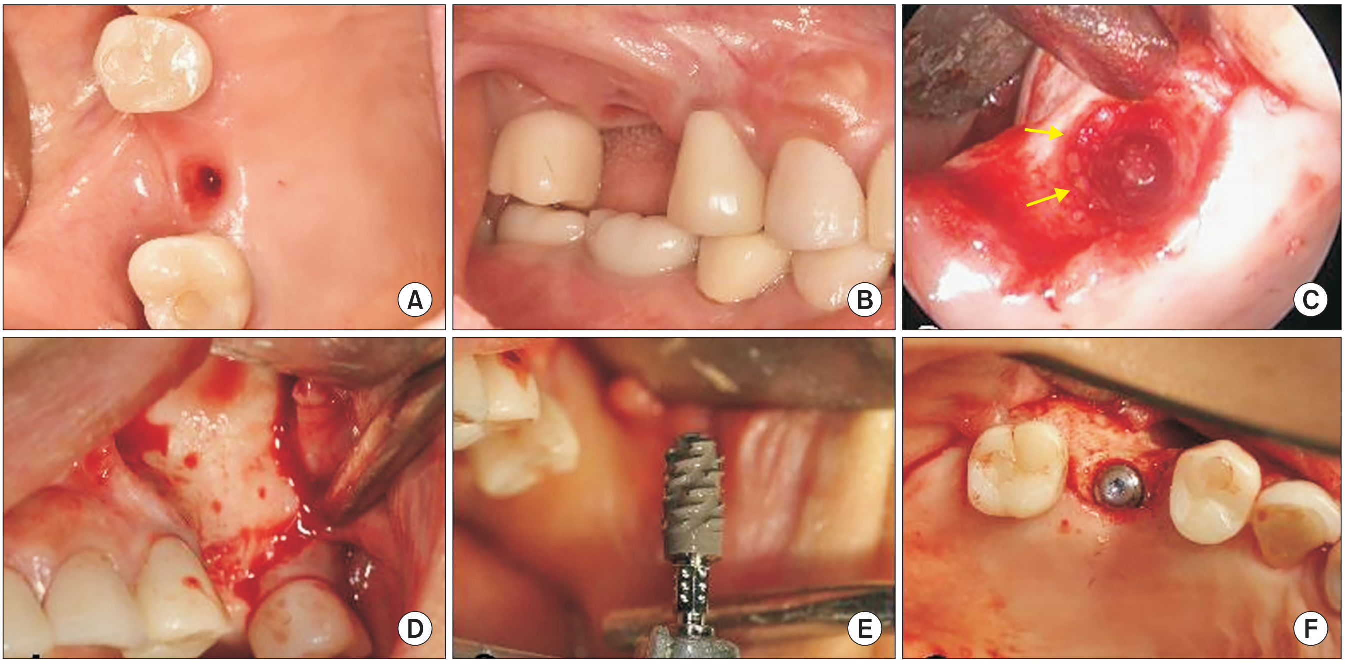

Fig. 6. Straumann BLX (Straumann Co.) installation at the site of an implant failure. The implant fixture at site #25 was lost (A, B). Endoscopic examination revealed granulation tissue associated with peri-implantitis (C). The previously grafted maxillary sinus site appeared to be healthy (D). A new implant was placed at the failed implant site, #25 (E, F).
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implant failure. The aggressive thread design and multiple helix flutes allow for better engagement in compromised bone quality, providing higher initial stability which is crucial in such conditions.

However, these implants are contraindicated in areas with thick cortical bone, high bone density, or insufficient bucco-lingual width due to the potential risk of over-stressing the bone, leading to complications like pressure necrosis or fracture. Therefore, careful consideration of the patient's bone anatomy and quality is essential to selecting an implant design that ensures optimal outcomes.

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Authors' Contributions

K.J.L. wrote the manuscript, K.R.M. and M.Y.E. collected the data and images, M.H.S. revised and corrected the manuscript, S.M.K. designed and wrote the manuscript.

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Ethics Approval and Consent to Participate

This study was approved by the Institutional Review Board (IRB) of Seoul National University School of Dentistry (IRB No. S-D20200007). The written informed consent was waived by the IRB due to the retrospective nature of the study.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

References

1. Kreve S, Ferreira I, da Costa Valente ML, Dos Reis AC. Relationship between dental implant macro-design and osseointegration: a systematic review. Oral Maxillofac Surg 2024;28:1-14. https://doi.org/10.1007/s10006-022-01116-4
2. Arnhart C, Kielbassa AM, Martinez-de Fuentes R, Goldstein M, Jackowski J, Lorenzoni M, et al. Comparison of variable-thread tapered implant designs to a standard tapered implant design after immediate loading. A 3-year multicentre randomised controlled trial. Eur J Oral Implantol 2012;5:123-36.
3. Misch CE, Strong JT, Bidez MW. Scientific rationale for dental implant design. In: Misch CE, ed. Contemporary implant dentistry. 3rd ed. Mosby; 2008:200-29.
4. Orsini E, Giavaresi G, Trirè A, Ottani V, Salgarello S. Dental implant thread pitch and its influence on the osseointegration process: an in vivo comparison study. Int J Oral Maxillofac Implants 2012;27:383-92.
5. Orlando B, Barone A, Giorno TM, Giacomelli L, Tonelli P, Covani U. Insertion torque in different bone models with different screw pitch: an in vitro study. Int J Oral Maxillofac Implants 2010;25:883-7.
6. Kong L, Liu BL, Hu KJ, Li DH, Song YL, Ma P, et al. [Optimized thread pitch design and stress analysis of the cylinder screwed dental implant]. Hua Xi Kou Qiang Yi Xue Za Zhi 2006;24:509-12, 515. Chinese.
7. Chun HJ, Cheong SY, Han JH, Heo SJ, Chung JP, Rhyu IC, et al. Evaluation of design parameters of osseointegrated dental implants using finite element analysis. J Oral Rehabil 2002;29:565-74. https://doi.org/10.1046/j.1365-2842.2002.00891.x
8. Kong L, Hu K, Li D, Song Y, Yang J, Wu Z, et al. Evaluation of the cylinder implant thread height and width: a 3-dimensional finite element analysis. Int J Oral Maxillofac Implants 2008;23:65-74.
9. Ao J, Li T, Liu Y, Ding Y, Wu G, Hu K, et al. Optimal design of thread height and width on an immediately loaded cylinder implant: a finite element analysis. Comput Biol Med 2010;40:681-6. https://doi.org/10.1016/j.compbiomed.2009.10.007
10. Reinaldo E, Bonifacius S, Adenan A. Influence of short implant thread pitch and depth to primary stability on D4 bone density: a laboratory study. J Int Oral Health 2021;13:456-61. https://doi.org/10.4103/JIOH.JIOH_82_21
11. Gehrke SA, Eliers Treichel TL, Pérez-Díaz L, Calvo-Guirado JL, Aramburú Júnior J, Mazón P, et al. Impact of different titanium implant thread designs on bone healing: a biomechanical and histometric study with an animal model. J Clin Med 2019;8:777. https://doi.org/10.3390/jcm8060777
12. Sun SP, Lee DW, Yun JH, Park KH, Park KB, Moon IS. Effects of thread depth in the neck area on peri-implant hard and soft tissues: an animal study. J Periodontol 2016;87:1360-8. https://doi.org/10.1902/jop.2016.150738
13. Lee SY, Kim SJ, An HW, Kim HS, Ha DG, Ryo KH, et al. The effect of the thread depth on the mechanical properties of the dental implant. J Adv Prosthodont 2015;7:115-21. https://doi.org/10.4047/jap.2015.7.2.115
14. Marković A, Calvo-Guirado JL, Lazić Z, Gómez-Moreno G, Ćalasan D, Guardia J, et al. Evaluation of primary stability of self-tapping and non-self-tapping dental implants. A 12-week clinical study. Clin Implant Dent Relat Res 2013;15:341-9. https://doi.org/10.1111/j.1708-8208.2011.00415.x
15. Wu SW, Lee CC, Fu PY, Lin SC. The effects of flute shape and thread profile on the insertion torque and primary stability of dental implants. Med Eng Phys 2012;34:797-805. https://doi.org/10.1016/j.medengphy.2011.09.021
16. Hsieh MC, Huang CH, Hsu ML. Influences of screw design features on initial stability in immediate implant placement and restoration. Clin Biomech (Bristol) 2021;89:105453. https://doi.org/10.1016/j.clinbiomech.2021.105453
17. Jimbo R, Tovar N, Anchieta RB, Machado LS, Marin C, Teixeira HS, et al. The combined effects of undersized drilling and implant macrogeometry on bone healing around dental implants: an experimental study. Int J Oral Maxillofac Surg 2014;43:1269-75. https://doi.org/10.1016/j.ijom.2014.03.017
18. Toyoshima T, Wagner W, Klein MO, Stender E, Wieland M, Al-Nawas B. Primary stability of a hybrid self-tapping implant compared to a cylindrical non-self-tapping implant with respect to drilling protocols in an ex vivo model. Clin Implant Dent Relat Res 2011;13:71-8. https://doi.org/10.1111/j.1708-8208.2009.00185.x
19. Chowdhary R, Halldin A, Jimbo R, Wennerberg A. Influence of micro threads alteration on osseointegration and primary stability of implants: an FEA and in vivo analysis in rabbits. Clin Implant Dent Relat Res 2015;17:562-9. https://doi.org/10.1111/cid.12143
20. Kang YI, Lee DW, Park KH, Moon IS. Effect of thread size on the implant neck area: preliminary results at 1 year of function. Clin Oral Implants Res 2012;23:1147-51. https://doi.org/10.1111/j.1600-0501.2011.02298.x
21. Krebs M, Schmenger K, Neumann K, Weigl P, Moser W, Nentwig GH. Long-term evaluation of ANKYLOS® dental implants, part I: 20-year life table analysis of a longitudinal study of more than 12,500 implants. Clin Implant Dent Relat Res 2015;17 Suppl 1:e275-86. https://doi.org/10.1111/cid.12154
22. Menini M, Bagnasco F, Calimodio I, Di Tullio N, Delucchi F, Baldi D, et al. Influence of implant thread morphology on primary stability: a prospective clinical study. Biomed Res Int 2020;2020:6974050. https://doi.org/10.1155/2020/6974050
23. Younes F, Eghbali A, De Troyer S, De Bruyckere T, Cleymaet R, Cosyn J. Marginal and apical bone stability after staged sinus floor augmentation using bone condensing implants with variable-thread design: a two-dimensional analysis. Int J Oral Maxillofac Surg 2016;45:1135-41. https://doi.org/10.1016/j.ijom.2016.04.012
24. Benalcázar-Jalkh EB, Nayak VV, Gory C, Marquez-Guzman A, Bergamo ET, Tovar N, et al. Impact of implant thread design on insertion torque and osseointegration: a preclinical model. Med Oral Patol Oral Cir Bucal 2023;28:e48-55. https://doi.org/10.4317/medoral.25576
25. Makary C, Menhall A, Zammarie C, Lombardi T, Lee SY, Stacchi C, et al. Primary stability optimization by using fixtures with different thread depth according to bone density: a clinical prospective study on early loaded implants. Materials (Basel) 2019;12:2398. https://doi.org/10.3390/ma12152398
26. McCullough JJ, Klokkevold PR. The effect of implant macro-thread design on implant stability in the early post-operative period: a randomized, controlled pilot study. Clin Oral Implants Res 2017;28:1218-26. https://doi.org/10.1111/clr.12945
27. Trisi P, Berardini M, Falco A, Podaliri Vulpiani M. Effect of implant thread geometry on secondary stability, bone density, and bone-to-implant contact: a biomechanical and histological analysis. Implant Dent 2015;24:384-91. https://doi.org/10.1097/id.0000000000000269

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