Review Article

DENTAL IMPLANT MACRODESIGN FEATURES IN THE PAST 10 YEARS: A SYSTEMATIC REVIEW

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ABSTRACT

Dental implant is a material used in replacing missing teeth. The osseointegration process of dental implants will be affected by the macrodesign of the fixtures. This study aimed to review the dental implant macrodesign in the past 10 years. This study was conducted in a systematic review method using two electronic databases (PUBMED and Science Direct). Only randomized controlled trials (RCTs) published in the last 10 years were used for this review. All the search results were filtered using Preferred Reporting Items for Systematic Reviews and Meta-Analyses and should fulfill some predefined inclusion criteria. The last step was to assess the methodological quality of the studies using the JBI Checklist for RCT. The search identified 357 studies with only 23 that going through full-text analysis, resulting in 14 articles included in the review. In total, 19 different implant brands were used in 12 different countries. Dental implant macrodesigns were divided into collar design, implant shape, thread geometry, and platform design. The macrodesign features of the implant were mostly developed in the variation of thread geometry and collar design.

Key words: Fixture, Implant geometry, Macrodesign, Missing teeth

Introduction

A dental implant is an endosseous material placed into the jaw to support a dental prosthesis. Due to its high success rate, dental implant is considered as the treatment of choice for missing teeth [1–3]. A systematic review showed that the 5-year survival rate of dental implants in the maxilla was 97.9% and 98.9% in the mandible [4, 5]. A prospective study stated that within 5 and a ½ years, the survival rate of dental implants was 95.73% [6-9]. Various factors affect the success of implant treatment, such as patient age, jawbone quality, and also osseointegration process which determine the secondary stability of the implant [10-12].

The osseointegration process is affected by several aspects including initial stability. One of the determinants of initial stability is implant design consisting of macro- and microdesigns. Implant geometry (shape, length, diameter) and thread geometry (pitch, shape, depth) are parts of the macrodesign of endosseous implants [10, 11, 13, 14]. Macrodesign features play an important role in the long-term success of implant treatment. Implant design is continuously developed to escalate the implant success rate. Improvement of diagnostic tools, implant designs, materials, implant placement techniques, and treatment planning makes a successful implant treatment easier to accomplish [11, 15–20].

Further research and improvement of macrodesign will require a thorough reference. Although a lot of implant studies have been done, the overview of implant macrodesign in the past decade is still lacking. Therefore, this present systematic review aimed to examine the dental implant macrodesign features in the past 10 years, as a guide for developing implant macrodesign in the future.

Materials and Methods

This systematic review was carried out using the preferred reporting items for systematic reviews and meta-analyses method with predetermined inclusion and exclusion criteria. The inclusion criteria included research articles in the form of randomized controlled trials (RCTs) published in 2011–2021 and written in English. Studies not meeting all inclusion criteria, unavailable in full-text, and animal studies were excluded.

An extensive search for RCT was conducted through PubMed and Science Direct with search terms as listed in **Table 1**. The search used Boolean Operators which combine the search terms with “OR” and “AND.” Two authors evaluated the articles’ methodological quality to check for any biases in the design, implementation, and analysis of the research using the JBI Critical Appraisal Checklist for RCTs.

Table 1. Keywords

Databases	Keywords	Results

PubMed	(((dental implant[Title/Abstract]) OR (implant body[Title/Abstract])) OR (fixture[Title/Abstract])) AND ((((((((((((((design[Title/Abstract]) OR (macro design[Title/Abstract])) OR (geometry[Title/Abstract])) OR (thread[Title/Abstract])) OR (microthread[Title/Abstract])) OR (shape[Title/Abstract])) OR (length[Title/Abstract])) OR (diameter[Title/Abstract])) OR (pitch[Title/Abstract])) OR (depth[Title/Abstract])) OR (crest module[Title/Abstract])) OR (cervical collar[Title/Abstract])) OR (platform switching[Title/Abstract])) OR (sloping shoulder[Title/Abstract])) OR (apex[Title/Abstract]))	135
ScienceDirect	(dental implant OR implant body) AND (design OR macro design OR geometry OR thread OR crest module OR platform switching OR apex)	222
Total		357

The initial search produced 135 titles from PubMed and 222 from Science Direct. Using Mendeley, all articles were checked for duplication until 354 were obtained. After the first evaluation (title and abstract screening), 331 articles were excluded. Of the 23 remaining articles that went through full-text reading, 9 articles were excluded for the reasons presented in **Figure 1**. Thus, 14 articles were checked for the risk of bias and included in the final analysis.

Results and Discussion

Fourteen articles are included in the inclusion criteria as shown in **Table 2**. The results of data extraction for the macrodesign and the parameters for assessing the effect of implant design on the treatment success factors in the selected articles are presented in **Table 3**. Bias assessment using the JBI Checklist for RCT indicated that the 14 articles met the criteria for a good RCT. The test contained 13 methodological questions with four answer choices: Yes, No, Unclear, and Not Applicable. Samieirad *et al*. (2019) have the best methodological quality with 12/13 "Yes" answers while the study by Randall *et al*. (2019) got the lowest "Yes" answer score of 8/13.

Table 2. Article's title

Author	Article's title
Randall *et al*. (2019)	The effect of dental implant collar design on crestal bone loss at 1 year after implant placement
Thoma *et al*. (2018)	Randomized controlled multicentre study comparing short dental implants (6 mm) versus longer dental implants (11-15 mm) in combination with sinus floor elevation procedures: 5 years data
Carmo Filho *et al*. (2019)	Effect of implant macrogeometry on peri-implant healing outcomes: a randomized clinical trial
den Hartog *et al*. (2017)	Anterior single implants with different neck designs: 5 years results of a randomized clinical trial
Pohl *et al*. (2017)	Short dental implants (6 mm) versus long dental implants (11-15 mm) in combination with sinus floor elevation procedures: 3 years results from a multicentre, randomized, controlled clinical trial
Khorsand *et al*. (2016)	Effect of microthread design on marginal bone level around dental implants placed in fresh extraction sockets
Schincaglia *et al*. (2015)	Randomized controlled multicenter study comparing short dental implants (6 mm) versus longer dental implants (11-15 mm) in combination with sinus floor elevation procedures. Part 2: Clinical and radiographic outcomes at 1 year of loading
Gehrke *et al*. (2015)	Does implant design affect implant primary stability? A resonance frequency analysis-based randomized split-mouth clinical trial
Weerapong *et al*. (2019)	Comparative study of immediate loading on short dental implants and conventional dental implants in the posterior mandible: a randomized controlled trial
Enkling *et al*. (2013)	Influence of platform switching on bone-level alterations: A 3 years randomized clinical trial
Telleman *et al*. (2017)	Impact of platform switching on interproximal bone levels around 8.5 mm implants in the posterior region; 5 years results from a randomized clinical trial
Telleman *et al*. (2013)	Short implants with a nanometer-sized CaP surface provided with either a platform-switched or platform-matched abutment connection in the posterior region: a randomized clinical trial
Camarda *et al*. (2021)	Prospective randomised clinical trial evaluating the effects of two different implant collar designs on peri-implant healing and functional osseointegration after 25 years
Samieirad *et al*. (2019)	Tapered versus cylindrical implant: which shape inflicts less pain after dental implant surgery? A clinical trial

Table 3. Records data extraction

Records number	Author	Research Country	Macro design type	Conclusion
1	Randall *et al*. (2019) [21]	USA	Implant collar design Brand: Zimmer Biomet Dental (Palm Beach, FL, USA) Tapered screw-vent implant with 1.8 mm triple lead thread and 0.36 mm thread depth Control: 1.0 mm machined collar above a 1.5 mm nonthreaded microtextured Test: 0.5 mm nonthreaded microtexture above a 1.8 microtextured microgrooves	Microtextured microgrooves implant is better at maintaining marginal bone than microtextured machined collar implant after 1 year of treatment
2	Thoma *et al*. (2018) [22]	Switzerland, Austria, Poland, Spain, USA	Implant length Brand: Astra Tech Implant System Osseospeed 4.0S; Dentsply Sirona Implants, Molndal, Sweden Group short: 6 mm Group graft: 11–15 mm	There is no significantly different result from both treatment modalities
3	Carmo Filho *et al*. (2018) [23]	Brazil	Implant shape Brand: Signo Vinces Dental Implants Integra: Cylindrical implant 4.00 mm diameter 0.6 mm narrow pitch triangular threads 1.10 mm flat cervical collar Duo: Tapered implant 4.60 mm diameter 1.0 mm stride trapezoidal thread 1.90 mm cervical necklace 0.45 mm triangular narrow step microthreads Compact: Cylindrical implant 4.00 mm diameter 1.0 mm large pitch trapezoidal threads Infra: Tapered implant 4.60 mm diameter 1.5 mm large pitch trapezoidal threads	Implant macrogeometry did not significantly influence primary stability nor peri-implant health during the 90 days healing period. However, it influenced secondary stability onset
4	den Hartog *et al*. (2017) [24]	The Netherlands	Implant collar design Brand: Smooth (Replace Select, Tapered, Nobel Biocare AB, Goteborg, Sweden), Rough (NobelReplace Tapered Groovy, Nobel Biocare AB), and Scalloped (NobelPerfect, Groovy, Nobel Biocare AV) Smooth (machined) 1.5 mm Rough with grooves Scalloped rough with grooves	Scalloped implant showed less good results compared to smooth and rough microgrooved collar in anterior single tooth replacement
5	Pohl *et al*. (2017) [25]	Austria, Switzerland, Poland, Spain, USA	Implant length Brand: Astra Tech Implant System Osseospeed 4.0S; Dentsply Sirona Implants, Molndal, Sweden Group short: 6 mm Group graft: 11-15 mm	Short implant showed better result in single-tooth restoration placed in posterior maxillary compared to longer implant
6	Khorsand *et al*. (2016) [26]	Iran	Implant collar design Brand: (Superline, Dentium, Seoul, South Korea) in the control group and (Implantium, Dentium, Seoul, South Korea) in the test group Implant length: 10–12 mm Implant diameter: 3.8 mm Platform diameter: 4 mm Test: implant with 3 mm microthread on coronal area Control: implant without microthread	The microthread on the implant collar could not have a positive effect in maintaining bone level around the implants placed in fresh socket
7	Schincaglia *et al*. (2015) [27]	Italy, Switzerland, Austria, Poland, Spain, USA	Implant length Brand: Astra Tech Implant System Osseospeed 4.0S; Dentsply Sirona Implants, Molndal, Sweden Group short: 6 mm Group graft: 11-15 mm	Both groups showed similar outcomes
8	Gehrke *et al*. (2015) [28]	Brazil	Implant shape and pitch size Brand: Group 1 (Implacil De Bortoli, Sao Paulo, Brazil), Group 2 (Neodent,	Treatment using a conical implant with wide pitch

			Curitiba, Brazil) Implant length: 13 mm Implant diameter: 3.5 mm Group 1: Conical implant with wide pitch (1 mm) Group 2: Semiconical implant with narrow pitch (0.5 mm)	provided better implant stability in moderate bone density
9	Weerapong *et al*. (2018) [29]	Thailand	Implant length Brand: PW+Dental Implant System Test group: short implant (6 mm) Control group: standard implant (10 mm)	The outcomes between the short implant and standard implant treatment are comparable
10	Enkling *et al*. (2013) [30]	Germany	Platform switching Brand: SICace, SIC Invent AG, Basel Platform switching: platform diameter 3.3 mm and shoulder diameter 4 mm Standard platform: platform and shoulder diameter are 4 mm each	The use of the platform switching concept in implants did not prevent bone resorption
11	Telleman *et al*. (2017) [31]	The Netherlands	Platform switching Brand: (Certain Prevail, Biomet 3i, Palm Beach Gardens, Florida, USA) in the test group and (XP Certain, Biomet 3i) in thecontrol group Implant shape: Cylindrical Implant length: 8.5 mm Test: Platform switching implant with 0.35 mismatch (4 mm in diameter) and 0.40 mismatch (5 mm in diameter) Control: Platform-matched implant	Both groups showed comparable 5 years treatment results
12	Telleman *et al*. (2013) [32]	The Netherlands	Platform switching Brand: (NanoTite Certain Prevail, Biomet 3i, Palm Beach Gardens, FL, USA) in the test group and (NanoTite XP Certain, Biomet 3i) in the control group 8.5 mm (short) implant with surface modification using CaP particle Test: Platform switching implant with 0.35 mismatch (4 mm in diameter) and 0.40 mismatch (5 mm in diameter) Control: Platform-matched implant	The 8.5 mm platform-switched implant provided significantly less peri-implant bone loss after 1 year in function
13	Camarda *et al*. (2021) [33]	Canada	Implant Collar Design Two-piece parallel-sided implant, platform-matched, and 0.6 mm pitch height Brand: (1) Screw-Vent, (2) Swede-Vent, (3) Standard Brånemark System Machined collar, microtextured fixture, and 3.6 mm internal connection Microtextured collar and 1.2 mm internal connection Machined collar and 1.2 mm internal connection	Implants with the 1.2 mm machined collar limited bone loss to 1 mm in 25 years of treatment
14	Samieirad *et al*. (2019) [34]	Iran	Implant Shape Brand: Bone-Level and Laser-Lok BioHorizons Parallel-sided implant with 4.5 mm platform Tapered implant with 4.5 mm platform	Tapered implants lead to less postoperative pain severity compared with cylindrical implants

Countries

The researches in these 14 articles were conducted in 12 countries, namely: The USA, Switzerland, Austria, Poland, Spain, Brazil, the Netherlands, Iran, Italy, Thailand, Germany, and Canada. Some studies were carried out in multiple countries.

Implant brands/manufacturers

In total, 1397 implants from 19 different brands were used in the studies using cylindrical/parallel-sided and tapered implant bodies by (Astra Tech Implant System Osseospeed 4.0S; Dentsply Sirona Implants, Molndal, Sweden), Signo Vinces Dental Implants, (Superline, Dentium, Seoul, South Korea), (Implantium, Dentium, Seoul, South Korea), (Neodent, Curitiba, Brazil), (SICace, SIC Invent AG, Basel, Switzerland), (Certain Prevail, Biomet 3i, Palm Beach Gardens, Florida, USA), (XP Certain, Biomet 3i), Screw-Vent, Swede-Vent, Standard Brånemark System, Bone-Level BioHorizons, (Zimmer Biomet Dental, Palm Beach, GL, USA), Signo Vinces Dental Implants, (Replace Select, Tapered, Nobel Biocare AB, Goteborg, Sweden), (NobelReplace Tapered Groovy, Nobel Biocare AB), (NobelPerfect, Groovy, Nobel Biocare AV), (Implacil De Bortoli, São Paulo, Brazil), PW + Dental Implant System, and Laser-Lok BioHorizons [21–34].

Implant macrodesign

Implant collar

Research by Randall *et al*. compared the 0.5 mm nonthreaded microtextured design above the 1.8 mm microtextured microgrooves implant collar and the 1.0 mm machined collar above the 1.5 mm nonthreaded microtextured collar [21] den Hartog *et al*. evaluated the use of a 1.5 mm smooth (machined) design on the implant collar compared to microgrooves on rough and scalloped rough implant collar [24, 35, 36]. A study by Khorsand *et al*. used implants with the length of 10–12 mm, 3.8 mm implant diameter, and 4 mm platform diameter with different collar designs. The test group consisted of implants with 3 mm microthreads configuration at the coronal area of the screw and the control group consisted of implants without microthreads [26]. Camarda *et al*. used implants with a diameter of 3.75 mm and compared implants with smooth collar to the microtextured collar [33, 37-39].

Fixture shape

Carmo Filho *et al*. (2018) examined the effects of two groups of cylindrical implant bodies with two groups of taper implant bodies on implant stability. These four groups of implant bodies had different geometries. The implant diameter ranged between 4.00 mm and 4.60 mm. Threads were divided into 0.6 mm narrow pitch triangular threads, 1.0 mm stride trapezoidal threads, 1.0 mm and 1.5 mm large pitch trapezoidal threads. The implant neck design was divided into a flat cervical collar and a cervical collar with triangular narrow steps [23]. Gehrke *et al*. compared conical implants with 1 mm (wide) pitch and semiconical implants with 0.5 mm (narrow) pitch. Both groups of implants had a diameter of 3.5 mm and 13 mm in length [28]. Samieirad *et al*. compared parallel-sided and tapered implant bodies with the platform diameter of 4.5 mm [34, 40]. Schincaglia *et al.*, Pohl *et al.*, and Thoma *et al*. compared the use of short implant (6 mm) and the implant with a length of 11–15 mm [22, 25, 27]. Weerapong *et al*. (2019) compared implant bodies of 6 mm and 10 mm in length [29, 41].

Platform design

Enkling *et al*. compared the effects of a platform switching implant with a 4 mm shoulder diameter and a 3.3 mm abutment diameter (circular step: 0.35 mm) and a platform matching implant with a 4 mm diameter [30, 42]. Telleman *et al*. and Telleman *et al*. compared the platform matching implant and platform switching design with 0.35 mm circular step (4 mm in diameter) and 0.40 mm (5 mm in diameter) [31, 32].

Implant macrodesign plays a significant role in the treatment. Both in achieving initial stability and distributing masticatory force from the prosthesis to the bone. The fourteen articles obtained examined the implant bodies with various macrogeometries, such as collar and thread designs, fixture shapes, and platform types.

Implant collar design

The implant collar also known as crest module holds the components of the dental prosthesis in a two-piece implant system. In contrast to the implant body which designed to transfer occlusal forces to the bone, the implant collar is often designed to reduce bacterial invasion. The shape of the implant collar is generally parallel-sided, divergent (flared), and convergent (tapered) [13, 43]. However, none of the 14 articles in this study specifically addressed the shape of implant collar, they instead focused on the surface design of the implant collar.

Implant collar is divided into smooth and rough surfaces. The smooth surface/machined collar **(Figure 2)** was developed to decrease plaque accumulation and improve hygiene. However, its integration with hard tissue is questionable since when put below the bone crest, it might increase shear pressures and cause bone loss, whereas implants with rough collar often demonstrated better retention of crestal bone level [21, 43]. Another feature that is often found in an implant collar is microthreads **(Figure 2)**. The concept of microthreads was developed to maintain the marginal bone and soft tissue around the implant. The presence of retentive elements (microthreads) in the crest module will relieve some of the pressure allowing the crestal bone to maintain its height. The addition of microthreads to the crest module can improve bone-implant contact while also preserving marginal bone [43].

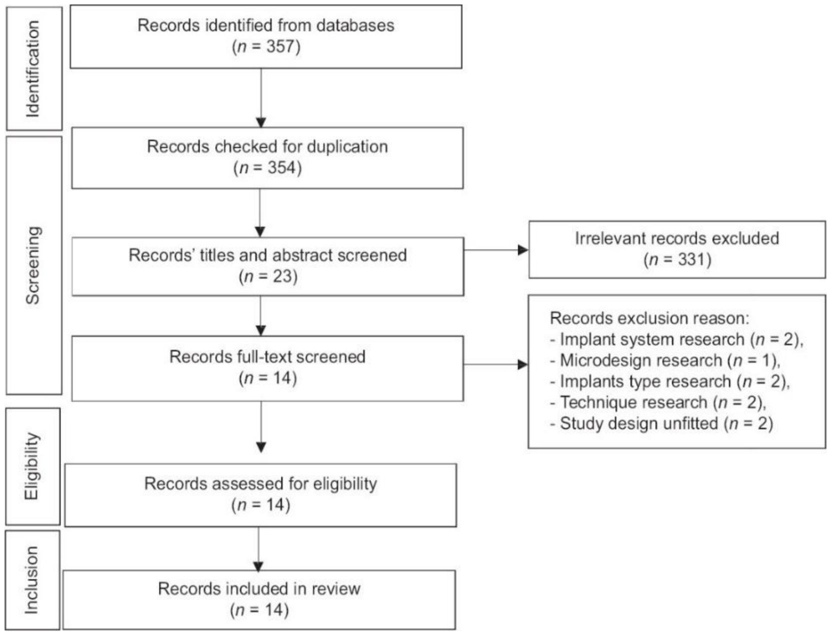

Figure 1. Preferred reporting items for systematic reviews and meta-analyses flow-chart. n – the amount of articles

Figure 2. Machined (left) and microthreaded (right)

In a 5-year study, den Hartog *et al*. found that using a rough design with microgrooves and machined on the implant neck produced better outcomes than using a scalloped design [24, 44]. Scalloped implant **(Figure 3)** is a shoulder design that is higher in the proximal and lower in the buccal and palatal area. This design was intended to minimize bone loss and maintain esthetics in the buccal and lingual areas [43, 45]. However, this was not proven as the marginal bone loss (MBL), bleeding on probing (BOP), and probing depth (PD) assessments showed otherwise. The highest survival rate was obtained by the rough group, namely 100%, while the smooth and scalloped groups both had survival rate of 96.2% [24].

Figure 3. Scalloped shoulder (left) and flat shoulder (right)

The study by Randall *et al*. found that using a 0.5 mm nonthreaded microtextured design over 1.8 mm microtextured microgrooves was better at maintaining marginal bone within 1 year of treatment than using a 1.0 mm machined collar over 1.5 mm nonthreaded microtextured **(Figure 4)** [21].

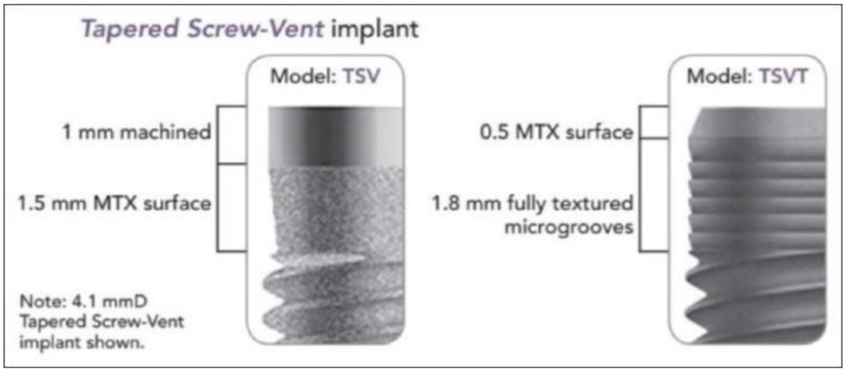

Figure 4. Variation of machined and rough implant collar

Meanwhile, according to Khorsand *et al*. and Camarda *et al.*, the use of a machined collar showed better results in maintaining marginal bone height than microthreaded or microtextured implant collar [26, 33]. Apart from the results of measuring the marginal bone height, Camarda *et al*. found that the PD and bleeding index in the machined collar group had slightly better results than the microtextured collar group [33].

Implant design

Implant body design is generally divided into implant shape, length, and diameter. In general, the shape of endosteal implants is parallel-sided (cylindrical) and tapered **(Figure 5).** Tapered implants are known as cylindrical implants with the diameter narrowing toward the apex. Parallel-sided implants on the other hand, have the same diameter along the implant body to the apex [11, 46, 47].

Figure 5. Parallel-sided implant (left) and tapered implant (right)

Carmo Filho *et al*. (2018) and Samieirad *et al*. compared cylindrical and tapered implants, while Gehrke *et al*. compared conical and semiconical implant bodies **(Figure 6)**. Conical is another name for tapered implants. Semiconical is the shape of a fixture that is cylindrical in the coronal region but becomes tapered at the apex [23, 28, 34].

Figure 6. Conical implant (left) and semiconical implant (right)

Many studies have proven the correlations between implant shape and the primary stability of the implant. Implant stability can be measured using the implant stability quotients (ISQ) measurement that is also believed as an indicator for possible implant failure [48, 49]. Tapered or conical implants had a higher ISQ value than a cylindrical implant. While cylindrical implants are more considered for the posterior region due to their diameter [50].

Implant length is a dimension from the platform to the apex of the fixture. Longer implants have been studied to have a higher success rate and prognosis, but shorter implants have been shown to have worse success rates due to decreased stability. However, shorter implants are preferred in circumstances where the alveolar bone has had significant resorption [46]. The implant lengths used in these 14 articles vary from 6 mm and 8.5 mm long implants classified as short implants and 10–15 mm as the longer implants **(Figure 7)** [22, 25–27, 29, 31, 32].

Figure 7. A 6 mm short implant (left) and 10 mm standard implant (right)

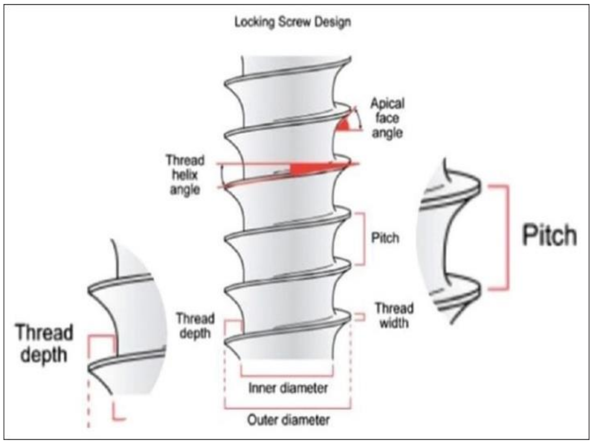

Figure 8. Thread pitch and depth

The compatibility of implant diameter to the length of the implant will increase the surface area of the implant, allowing for force transfer to the bone. Larger implant diameters are better at resisting occlusal forces, especially in the molar region [10]. The implant diameters mentioned in these 14 articles vary from 3.5 mm, 3.8 mm, 4 mm, 4.6 mm, and 5 mm [23, 26, 28, 30–32].

Carmo Filho *et al*. (2018) found no effect of implant geometry on primary stability during the 90-day healing period. However, the implant geometry affects the onset of secondary stability [23]. According to the results of Gehrke *et al*. the use of conical implants with a wide pitch resulted in better implant stability in moderate-density bone seen from the higher ISQ value right after implant placement [28]. The length of the implant resulted in no significant difference in survival rate, PD, BOP, and MBL according to the study by Thoma *et al*. and Schincaglia *et al*. [22, 27] Weerapong *et al*. (2019) stated that short implant treatment on immediate loading showed comparable results to standard length implants based on survival rate, ISQ, and MBL values [29]. According to a 1-year study by Pohl *et al*. short implants were found to be better for single-tooth restorations in the posterior maxilla. It can be seen from the score of PD, BOP, and MBL in the short implant group which are better [25].

Thread design

Threads are components that surround the fixture and play a role in increasing the surface area to distribute occlusal forces to the bone. Threads on implants are important for primary stability, especially in areas with low bone density. The thread's geometric characteristics affect how stress is transferred from the implant to the bone. Threads in implants have three components, namely pitch, depth, and shape **(Figure 8)** [11].

Pitch is measured parallel to the implant's long axis and is defined as the distance between one location on one thread and another position on an adjacent thread. Smaller thread pitch increases surface area that contributes to better stress distribution in the surrounding bone. Pitch can be measured by dividing the implant's length by the number of threads. When implants of the same length are compared, the narrower the pitch means more threads [11, 20]. The use of a 1 mm wide pitch resulted in better implant stability than the 0.5 mm narrow pitch in a study by Gehrke *et al*. [28] However, based on the research of Carmo Filho *et al*. (2018), the use of implants with a thread pitch of 0.6 mm, 1.0 mm, and 1.5 mm did not show any differences in implant stability value [23]. The assessment of the primary implant stability is frequently used in research that focuses on implant pitch size. This is because the consideration of choosing the pitch size will affect the primary stability of the implant, especially in the bone whose load-bearing ability has weakened [20].

Threads in implants are designed to maximize pressure delivery while minimizing stress to the bone and implant junction. Threads must also be able to provide good stability and a wider contact surface area. Thread shapes in dental implant designs include square, V-form, buttress, reverse buttress, and spiral. Thread shape, along with depth and pitch, influences how occlusal forces are delivered to the bony structures surrounding the fixture [11, 51]. Carmo Filho *et al*. (2018) used implants with triangular and trapezoidal threads **(Figure 9)**. A triangular thread form, also known as a standard V-thread, is a common type of thread. The trapezoidal implant's shape is designed to accommodate a relatively new concept in implant insertion: The formation of a "healing chamber." The presence of a healing chamber may make it more difficult to achieve primary implant stability, but it is expected to aid bone formation [23].

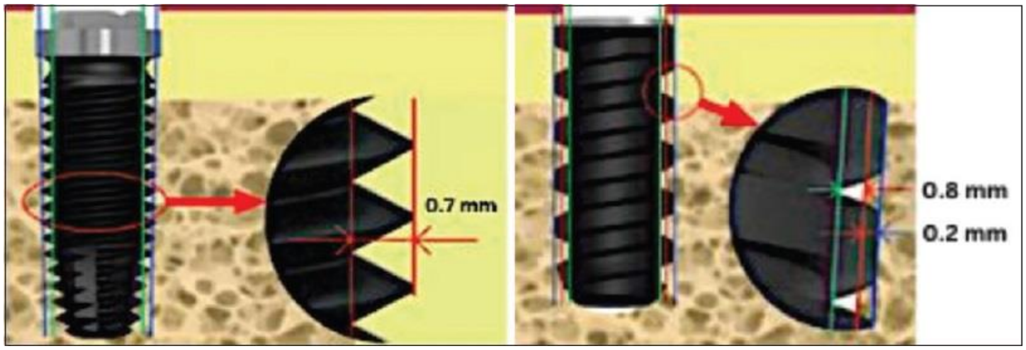

Figure 9. Triangular thread (left) and trapezoidal thread (right)

Platform design

There are two types of platforms in the implant system, namely platform switching and platform matching **(Figure 10)**. When the abutment and implant diameter at the connection are the same, this is referred to as platform matching. Platform switching, on the other hand, is when the abutment diameter is smaller than the diameter of the fixture in the connection area [11]. The difference in diameter results in a horizontal difference called a circular step or horizontal mismatch that allows horizontal expansion of the biological width. The switching platform concept was developed to control or reduce bone loss in the horizontal dimension. The presence of a shift of the connection toward the implant's center is considered to maintain the marginal bone from the high stresses in the implant-abutment junction area [52, 53].

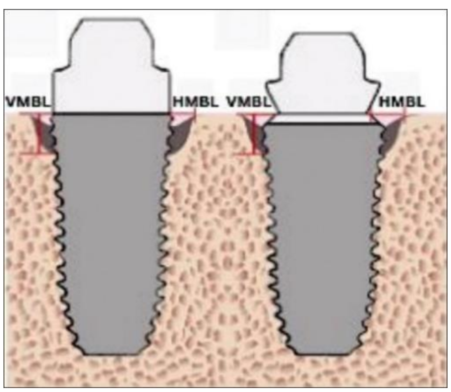

Figure 10. Platform matching (left) and platform switching (right). VMBL (Vertical Marginal Bone Loss); HMBL (Horizontal Marginal Bone Loss)

In a 3-year study, Enkling *et al*. found that platform switching with a circular step of 0.35 mm resulted in a marginal bone reduction similar to platform matching [30]. While in the 1-year study by Telleman *et al*. (2013) and 5 years by Telleman *et al*. (2017) showed that a platform switching design with a circular step of 0.35 mm and 0.40 mm in implants had a lower bone loss rate than the platform-matched design. In addition, platform switching implants had a higher survival rate than platform-matched implants, with 95.9% in the 1st year and 94.5% after 5 years in the study. The assessment of the implant bleeding index also showed a better score in the platform switching group (55.1%) than the platform matching (58.5%) [31, 32].

Conclusion

Macrodesign features that have been extensively studied in the past 10 years consist of implant collar design, implant body shape, thread design, and platform type with each featured design has its avail. Variations in thread geometry and implant collar design are frequently noted as the implant develops. More research on implant macrodesign as well as the effects of different designs on the outcome of dental implant treatment is needed.

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Conflict of interest: None

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Ethics statement: None

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