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Microthreaded Implants and Crestal Bone Loss: A Systematic Review

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Abstract:	This systematic literature review investigated the effect of microthreaded-neck dental implants on crestal bone loss. Using the participants, interventions, comparison groups, outcomes, and study design (PICOS) system, we addressed the following focused question: Do microthreaded-neck dental implants positively affect the crestal bone level around dental implants? We searched 3 electronic databases to find articles published between January 1995 and June 2016 that contained any combination of the following keywords: dental implant, microthread, microthreaded, crestal bone level, crestal bone loss, and alveolar bone level. We excluded case reports, review articles, letters to the editor, commentaries, and articles published in a language other than English. We found a total of 70 articles. After eliminating duplicates and applying PICOS eligibility criteria, we selected only articles that reported the results of randomized controlled trials, prospective or retrospective cohort studies, case-control studies, cross-sectional studies, or other types of clinical trials that compared the microthreaded implant design to other implant designs. We were left with 23 articles for review. The 23 articles reported crestal bone loss ranging from 0.05 mm to 0.9 mm, with a range of 12 to 96 months of follow-up. Less crestal bone was lost with dental implants that had a microthreaded neck design than with machined-surface or conventional rough-surface dental implants. Thus, microthreaded dental implants are a better choice than are implants with other designs. Future studies should use standardized imaging techniques to to evaluate the placement of these implants in bone-augmented sites.

Microthreaded Implants and Crestal Bone Loss: A Systematic Review

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Abstract

This systematic literature review investigated the effect of microthreaded-neck dental implants on crestal bone loss. Using the participants, interventions, comparison groups, outcomes, and study design (PICOS) system, we addressed the following focused question: Do microthreaded-neck dental implants positively affect the crestal bone level around dental implants? We searched 3 electronic databases to find articles published between January 1995 and June 2016 that contained any combination of the following keywords: dental implant, microthread, microthreaded, crestal bone level, crestal bone loss, and alveolar bone level. We excluded case reports, review articles, letters to the editor, commentaries, and articles published in a language other than English. We found a total of 70 articles. After eliminating duplicates and applying PICOS eligibility criteria, we selected only articles that reported the results of randomized controlled trials, prospective or retrospective cohort studies, case-control studies, cross-sectional studies, or other types of clinical trials that compared the microthreaded implant design to other implant designs. We were left with 23 articles for review. The 23 articles reported crestal bone loss ranging from 0.05 mm to 0.9 mm, with a range of 12 to 96 months of follow-up. Less crestal bone was lost with dental implants that had a microthreaded neck design than with machined-surface or conventional rough-surface dental implants. Thus, microthreaded dental implants are a better choice than are implants with other designs. Future studies should use standardized imaging techniques to to evaluate the placement of these implants in bone-augmented sites.

Key words: Microthreaded implants, marginal bone, crestal bone loss, crestal bone level, dental implant design

Introduction

Tooth loss can be caused by periodontal disease, abscess formation, trauma, or vertical tooth fracture. Common consequences of tooth loss include progressive alveolar bone resorption and decreased masticatory performance.[1] Edentulism causes two serious problems: disability, because it limits a patient's ability to speak and eat, two essential tasks in life; and handicap, because important changes are necessary to compensate for the deficiencies.[1] Both problems have been associated with a negative impact on psychosocial well-being, especially among elderly patients.[1,2] Douglass et al[2] estimated that, in the United States, nearly 38 million adults are in need of 1 or 2 complete dentures.

Tooth replacement with dental implants has led to an important revolution in modern clinical dentistry. Brånemark first introduced osseointegrated dental implants to allow firm anchorage of titanium implant screws into living bone, a process referred to as osseointegration.[3] The long-term clinical success of dental implants depends mainly on the preservation of the bony support around the implant, which is usually evaluated with radiographic images.[4]

Albrektsson et al[5] proposed criteria for assessing and evaluating the success of implant survival; these criteria included marginal bone remodeling of less than 2.0 mm in the first year after implant placement and less than 0.2 mm each year thereafter. These changes are usually related to the use of implants with a conventional machined surface and a conventional neck design.[5]

Recently, several studies have shown that implants with a rough surface and a microthreaded-neck design may improve the preservation and stabilization of crestal bone.[6,7] Friberg and Jemt[7] reported that TiUnite implants with a rough surface exhibit a higher success rate than that associated with turned Brånemark implants that have a machined surface. Abuhussain et al[8] reported that the presence of microthreads up to the neck of the implant positively affects the retention of crestal bone. Moreover, microthreads around the implant neck may enhance initial implant stability in the presence of an underprepared osteotomy (i.e., implant bed preparation), thereby contributing to the achievement of better primary stability, which in turn may help reduce the length of time required for the healing phase.[6-8]

However, this positive effect of the microthreaded design on the level of crestal bone is subject to several factors that may change the biological behavior of bone. These factors, which affect optimal long-term treatment outcomes of implant therapy, especially in the esthetically sensitive anterior region, include the following: bone quality and quantity, soft-tissue biotype,[9] condition of the adjacent teeth,[10] distances to the adjacent teeth,[11-13] biologic width and the platform-switching (PS) concept,[14-16] implant design at the macro, micro, and nano levels, as well as implant dimensions,[6-8,17] abutment design at the macro, micro, and nano levels,[18] augmentation procedures, including type of procedures and materials and membranes used,[19] surgical procedures, including soft-tissue management and time point of insertion,[20-22] depth of implant insertion,[23] times of loading and restoration, prosthetic procedures used and frequency of secondary-component replacement,[24,25] provisional and definitive restorations, patient compliance, oral hygiene, smoking, nutrition, and intervals between dental visits.[18]

The biologic width around the tooth or implant involves the dimensions of periodontal and peri-implant soft-tissue structures, such as the gingival sulcus, the junctional epithelium, and the supracrestal connective tissues. According to Tarnow et al,[11] the bone facing the oral cavity is invariably covered by periosteal tissue, connective tissue, and epithelial tissue, all of which may vary in thickness. Cohen[26] defined the clinical concept of biologic width to include the dimensions of the epithelial and connective tissue attachments. The dentogingival complex additionally includes the vertical dimension of the gingival sulcus. According to measurements conducted by Gargiulo et al,[27] the average biologic width (from the base of the sulcus to the alveolar bone margin) is 2.04 mm, of which 0.97 mm is the epithelial attachment and 1.07 mm is the connective tissue attachment. These dimensions, however, are in no way static but are subject to interindividual variation (from tooth to tooth and from patient to patient) and also to variation according to gingival types and implant concepts.[11,26,27]

Published reports have shown that the resorption of crestal bone around the implant platform does not begin until the implant is uncovered and exposed to the oral cavity.[11,28-31] This exposure will lead to bacterial contamination of the gap between the implant and the superstructure.[11,28-31] Bone remodeling will continue until the vertical and horizontal biologic width has been created and stabilized, with an average bone loss of 1 to 2 mm circumferentially during the first year of restoration.[11] For this reason, a minimal distance of 3 to 4 mm should be maintained between 2 adjacent implants, and PS should be used, especially in the esthetic reconstruction zone, so that intact papillae and stable inter-implant bone can be obtained. As first defined by Tarnow et al in 1992[12] and modified in 2003,[13] the distance between the bony base of the papilla and the contact point of the superstructure should be less than 5 mm in expectation of complete filling of the interdental space with gingival tissue to form normal papillae, thus leading to an optimal esthetic outcome.

The PS effect was first observed in the mid-1980s. The implant abutment connection design meant that larger-diameter implants were often restored with narrower abutments (Ankylos or Friadent implants; Dentsply, York, PA, USA; Bicon, Jamaica Plain, MA) because congruent abutments were often still unavailable. As it later turned out, this was a remarkable coincidence. The abutments used with conventional implant types are generally flush with the implant shoulder in the contact zone. With many implant systems, this positioning results in the formation of a microgap between the implant and the abutment. Published studies have shown that bacterial contamination of the gap between the implant and the abutment adversely affects the stability of the periimplant tissue.[32-34]

Depending on the positive fit of internal or external connections at the implant abutment interface, contamination of the microgap results in a flow of bacteria and initiates the formation of inflammatory connective tissue in the region of the implant neck, depending on the insertion depth of the implant.[32] This phenomenon, described by Ericsson et al[30] as abutment inflammatory cell infiltrate, was considered to be a biological protective mechanism against the bacteria residing in the microgaps, explaining the plaque-independent vertical and horizontal crestal bone loss (CBL) of approximately 1 to 2 mm that occurs during the first year after implant placement. The PS concept requires that this microgap be placed away from the implant shoulder and closer to the axis so that the distance of this microgap from the bone is increased.[35-37] This method generally implies the use of a reduced-diameter abutment, according to the microbiological considerations outlined above, and delivers a measure of protection for the marginal bone. The preservation of periimplant bone is particularly important in the esthetic zone.

The design of the most current generation of implants includes a continuous micro-rough or nano-rough surface extending to the implant neck, along with microthreads in the cervical region. Integrating the PS concept in the presence of a completely rough implant surface plays a central role in moving the microgap on the implant platform closer to the implant axis, thereby counteracting bone resorption tendencies. Implants with a continuous micro-rough and nano-rough titanium surface extending to the implant neck facilitate osseointegration along the entire length of the implant, involving the entire implant surface. The microthreads in the cervical region result in the transmission of functional loads to the adjacent bony structures, supporting the formation of trabecular bony structures and stabilizing the region in question.

The aim of this systematic review was to evaluate and analyze the effect of a microthreaded-neck implant on CBL, as determined by various clinical trials.

Materials and Methods

Addressed Question and Eligibility Criteria

The following focused question was addressed: Do microthreaded-neck dental implants positively affect the crestal bone level around dental implants? Publications to be included in this review reported the results of original clinical studies that measured CBL during a reported follow-up period.

Search Strategy

We extensively searched 3 electronic scientific databases: PubMed/MEDLINE (National Center for Biotechnology Information); Dentistry and Oral Science Source

(DOSS; searched through EBSCO); and the Cochrane Register of Controlled Trials (searched through EBSCO) to find articles published between January 1995 and June 2016. To be considered for inclusion in this review, published articles were required to contain some combination of the following keywords: microthread, microthreaded, dental implant, crestal bone level, CBL, and alveolar bone level. No limits were applied to the initial search. This electronic search was followed by hand-searching (checking the reference lists of the relevant review articles and eligible studies for additional publications).

This systematic review was conducted according to the Preferred Reporting Items for Systematic Review and Meta-analysis Protocols (PRISMA-P) guidelines.[38] Ultimately, the search was limited to published peer-reviewed articles. Titles of articles were thoroughly scrutinized to exclude publications that did not clearly compare microthreaded implants to other types of implants. Whenever the titles of the articles were not sufficiently informative to allow us to judge their relevance, we also scrutinized the abstracts to determine whether the articles qualified for the study.

We used the criteria developed by Dixon-Woods et al[39,40] to assess the quality of the studies included in this review. To be considered of high quality, studies had to meet the following criteria: clarity of the research questions to be addressed; suitability of quantitative methods in relationship to aims and objectives; and appropriate sampling technique with regard to the research questions and data generation. We then reviewed the high-quality articles in full for inclusion in the study, using a quality-assessment tool for quantitative studies.[41] This tool assesses the internal and external validity of each study. Internal validity is the extent to which the observed effects are applicable to the subjects in a study. External validity (generalizability or applicability) is the extent to which the effects detected in a study accurately reflect what can be expected in a target population beyond the subjects included in the study.

The following criteria were rated for each study: 1) selection bias (external validity), a condition in which the study sample does not represent the target population for whom the intervention was intended; 2) allocation bias, which can result from the way in which the intervention and control groups are assembled; for example, studies showing that comparison groups were not equivalent at baseline have a high level of allocation bias; 3) confounding, the presence of factors (other than the intervention) that may influence the outcome under investigation; 4) blinding (detection bias), which is important when outcomes may be subjective; 5) data collection methods, which determine whether the outcomes have been measured with valid and reliable instruments; 6) withdrawals and dropouts (attrition bias), indicating, for example, differences between the intervention and control groups in the number of withdrawals from the study; 7) statistical analysis, including a sample size sufficiently large to have the ability (or power) to detect significant differences between comparison groups; the lack of a statistically significant effect could be due to insufficient numbers of subjects rather than to ineffectiveness of the intervention; and 8) intervention integrity, which indicates that the study measured 5 dimensions of the intervention: adherence, exposure, quality of delivery, participant responsiveness, and program differentiation (to prevent contamination).

Inclusion Criteria

For inclusion in this review, articles were required to meet two criteria: 1) articles must have compared microthreaded implants to another type of implants; and 2) the study must have used one of the following methods: randomized controlled trial (RCT), prospective cohort study, retrospective cohort study, case-control study, cross-sectional design, or another clinical trial design that could determine an answer to the main study question. For RCTs, we used 5 criteria for assessment: 1) randomization method described, 2) allocation concealment reported, 3) intention-to-treat analysis performed, 4) blinded assessment stated, and 5) a priori power calculation performed. For cohort and other studies, the following criteria were used: 1) representative sample of adequate size, 2) well-matched samples, 3) adjustment for confounders in analyses, 4) blinded assessment stated, and 5) dropouts reported (for prospective studies only). Methodological quality and risk of bias were assessed independently by the reviewers according to Cooper.[42]

Exclusion Criteria

Articles were excluded from the study if they met one or more of the following criteria: 1) publication in a language other than English: 2) a low level of evidence, such as studies with a small sample size, finite-element studies, literature reviews, and laboratory studies, case reports, review articles, letters to the editor, and commentaries.

Results

Study Selection

Our preliminary search of the 3 databases yielded 70 articles (Figure 1). Of these, 4 were excluded because they were not published in English. Article whose titles clearly indicated that they did not compare microthreaded implants with other implants were also excluded. After we eliminated duplicate articles from the list, we were left with 40 articles; we reviewed the abstracts of those articles for relevance in terms of addressing the main research questions. This review eliminated another 17 articles, leaving us with 23 articles for complete review with a quality assessment tool.

Of the 23 studies reviewed,[43-65] 15 were considered to have a low risk of bias, 7 were categorized as having a moderate risk of bias, and 1 was considered to have a high risk of bias (Table). Most of the studies with a low risk of bias were RCTs. Most other cohort studies were considered to have a moderate risk of bias, and the studies with a high risk of bias were mainly case-series studies. The main weakness detected in all reviewed studies was failure to blind participants and providers to the types of implants used.

A summary of the studies, methods, results, and outcomes is presented in the Table.

General Characteristics

Fifteen studies[43-48,51,53-55,58-61,65] used prospective designs, and 8[49,50,52,56,57,62-64] used a retrospective design and were performed either in dental health centers or in universities. The total number of patients in the included studies ranged from 9 to 59 patients. The mean age of the participants in the studies ranged from 40 to 64 years, and their actual age ranged from 19 to 85 years (Table). Two studies[46,59] used CT scans to measure CBL, whereas 18 studies used standardized periapical radiographs.[43-45,48-54,56,57,60-65] Three studies[47,55,58] used panoramic radiographs to follow up the changes in CBL (Table).

Surgical and Prosthetic Strategies

The total number of microthreaded implants placed in the included studies ranged from 17 to 118 implants (Figure 2). In 18 studies,[47-61,63-65] implants were placed in pristine bone, whereas in 5 studies[43-46,62] they were placed in fresh sockets (Table). Eleven studies[46,49,52,56,57,59,60,62-65] used Astra Tech implants (Astra Tech AB, Mölndal, Sweden), which are made of pure grade 4 titanium and have a moderately rough surface blasted with titanium dioxide particles, as well as a microthreaded implant collar. Two studies[47,55] used Replace Straight Groovy implants (Nobel Biocare AB, Göteborg, Sweden). Lee et al[51] and Piao et al[54] used Hexplant implants (Warantec Co, Seoul, South Korea), whereas Khorsand et al[43] and Song et al[53] used Implantium implants (Dentium, Seoul, South Korea) (Table). Three studies[44,45,58] used MIS implants (MIS-Implants Inc., Shlomi, Israel). Inhex (Mozo-Grau, S.L. Valladolid, Spain), Osstem (HIOSSEN Implant Canada INC. Vancouver, BC, Canada), and Oneplant (Warantec, Seoul, South Korea) implants were used in one study each.[48,50,61]

Five studies[44-46,52,62] used immediate loading of prostheses, and 17 studies[43,47,48-51,53-55,57-61,63-65] used conventional loading. De Bruyn et al[56] used both immediate and early loading protocols. Single or splinted crowns were fabricated for 14 studies,[43,45,46,49,51,53,54,57,58,60-63,65] whereas fixed partial denture (FPD) prostheses were made for 6 studies.[44,47,48,50,55,64] Van de Velde et al[52] constructed complete fixed prostheses with cantilever. De Bruyn et al[56] and Cooper et al[59] loaded implants with removable overdenture prostheses (Figure 3, Table).

Marginal Bone Resorption Measurements and Follow-up Period

In the 23 included studies, the follow-up periods ranged from 12 to 96 months: 18 studies[43,45,46,48,50-58,60-64] used follow-up periods ranging between 12 and 36 months, and 5 studies[44,47,49,59,65] used follow-up periods of 40 months or longer (Table). CBL measurements after loading ranged from 0.05 mm to 0.9 mm. Generally, the smallest CBL measurements (0.05 ± 0.11 mm) were found around Astra tech implants fabricated and conventionally loaded with FPD prostheses after 12 months of follow-up.[64] The largest CBL measurements (0.9 ± 0.26 mm) were found around non-occlusal MIS Implants immediately loaded with fixed prostheses after 60 months of follow-up (Table).[44]

Discussion

The systematic review evaluated the effect of microthreaded-neck implant geometry on CBL as described in the published reports of various clinical trials. The CBL measurements varied across these reports because of differences in implant systems, loading protocols, types of prostheses used, and differences in the imaging systems used. Interestingly, the Astra tech implants resulted in the lowest measurements of CBL (0.05

mm) when they were loaded conventionally with FPD prostheses but resulted in the highest measurements when they were immediately loaded with overdenture prostheses.[56,64] This variation may be explained by the differences in the loading protocol between the two studies. Elsayed et el[66] reported that the immediate-loading protocol exerted a negative effect on the amount of CBL associated with locator-retained mandibular overdentures.[66] In two studies, Nickenig et al[47,55] reported CBL measurements of 0.7 mm after 60 months of loading for Replace Straight Groovy implants conventionally loaded with FPD prostheses and measurements of 0.5 mm after 24 months of loading.

The radiographic evaluations of CBL around implants in the included articles yielded variable results because the studies used different imaging systems. Of the twenty-three studies, eighteen (78%) used periapical radiographs for CBL measurement.[43-45,48-54,56,57,60-65] The reference points for CBL measurement also differed between studies. The most commonly used points were the implant shoulder,[45,46,49] the implant neck,[64] the top of the implant,[50,52,61] the implant-abutment interface,[51,54] the border between the polished surface and the sandblasted and acid-etched (SLA) surface of the implant,[53] the lower edge of the smooth bevel of the coronal part of the implant,[56] and the border between the titanium oxide–blasted surface and the machined surface of the implant.[60]

Several studies compared CBL around microthreaded rough-surface implants and around conventional rough-surface implants without microthreading and found that CBL was greater around conventional rough-surface implants.[51,54,60,61] Lee et al[51] reported that CBL was 0.95 mm around Brånemark TiUnite implants (Brånemark TiUnite Mk III;

Nobel Biocare AB) and 0.59 mm around Hexplant implants (Hexplant; Warantec Co) after 3 years of follow-up. Piao et al[54] found 1.24 mm of CBL around Brånemark TiUnite implants and 0.42 mm of CBL around Hexplant implants after one year of follow-up. The amount of CBL increased as healing time increased.

One study[52] compared the amount of CBL associated with machined-surface implants and with microthreaded rough-surface implants; and 3 studies compared the amount of CBL associated with machined-neck implants and with microthreaded-neck implants. All of the studies found that the amount of CBL around machined-surface and machined-neck implants was higher than that around microthreaded implants.[47,55,61] Van de Velde et al[52] reported that CBL around machined Brånemark implants (Nobel Biocare AB) was 1.52 mm, whereas CBL around surface-modified Astra Tech implants with a microthreaded neck (TiOblast; AstraTech AB) was 0.70 mm. In two studies, Nickenig et al[47,55] found that CBL around machined-neck implants (Replace Select Straight; Nobel Biocare AB) was 1.1 mm after 2 years of follow-up and 1.4 mm after 5 years of follow-up. In contrast, CBL around rough-surfaced microthreaded implants (Replace Straight Groovy; Nobel Biocare AB) was 0.5 mm after 2 years and 0.7 mm after 5 years of follow-up.

Microthreaded dental implants were placed in pristine bone in all but 5 of the studies[43-46,62]; in these 5 studies, implants were placed immediately in fresh extraction sockets. CBL measurements in these 5 studies ranged from 0.3 to 0.9 mm around implants during 2 to 5 years of follow-up.[43-46,62] None of these studies compared the placement of microthreaded implants in pristine bone, fresh extraction sockets, or grafted bone. Altintas et al[67] recently published the results of a study showing that, after 45 months of follow-up, there were no significant differences in the implant success rates between groups in which conventional rough-surface implants were placed in fresh extraction sockets or in mature healed bone.[67]

Because the follow-up period of most of the studies included in this review[43-65] was no longer than 96 months, the relationship of CBL to the number of disconnections or reconnections of superstructure components was not sufficiently clarified. A recent study[25] found that implants with a PS design are associated with less CBL during the healing process and as their abutments are disconnected than are non-platform-switched (NPS) implants with a comparable number of disconnections and reconnections. The average vertical bone resorption around NPS implants after 4 disconnections or reconnections was 1.09 mm ± 0.25 mm, and the average horizontal bone resorption was 0.98 mm ± 0.27 mm. The average vertical bone resorption around PS implants after 4 disconnections or reconnections was 0.24 mm ± 0.08 mm, and the average horizontal bone resorption was 0.24 mm ± 0.13 mm. The difference in the average horizontal and vertical bone resorption around NPS and PS implants was statically significant ($P < 0.05$). There were statistically significant differences in average mesial and distal bone resorption values around PS implant adjacent to a tooth ($P < 0.05$).[25]

The results of this systematic review agree with those of animal studies and finite-element studies. A recent study evaluated the effect of implant macrodesign and position related to the bone crest on CBL associated with the placement of implants immediately after tooth extraction. All immediately placed implants are associated with some CBL, and both implant macrogeometry and implant placement relative to the bone crest influence the CBL around these implants. Apical positioning of the implant does not enhance remodeling of the bone crest.[68]

Alharbi et al[69] evaluated CBL after immediate placement of Straumann Bone Level implants (Straumann, Andover, MA) and OsseoSpeed implants (Dentsply) in fresh extraction sockets in Beagle dogs. Neither type of implant was associated with significant changes in CBL, although both types of implants resulted in some CBL. Both types of implants induced a similar bone response after immediate implantation at 4 and 12 weeks.[69]

Negri et al[70] evaluated bone remodeling and soft-tissue reactions around immediate nonocclusal loaded implants with various collar configurations in Beagle dogs. The results suggest that tissue alterations that occurred during 1, 2, and 3 months of healing were in part related to the functional adaptation of the alveolar ridge that occurred after the implant nonocclusal loading in the two separate collar configurations. The microthreaded design may have played a role in maintaining CB.[70]

A new experimental microthreaded scalloped (MTS) implant design was compared to a conventional flat platform implant by measurements of the CBL at various inter-implant distances in a canine model. Radiographic results showed that the experimental MTS implants were associated with substantially less CBL (0.81 ± 0.34 mm) than were the FT implants (1.60 ± 0.42 mm). Histologic measurement also demonstrated that there was significantly less marginal bone loss around the MTS implants (0.74 ± 0.41 mm) than around the FT implants (1.53 ± 0.52 mm; $P < .001$). There was no statistically significant difference in bone loss between the 2-mm and the 5-mm inter-implant distances for either the MTS or the FT implants ($P > .05$).[71]

Park et al[72] evaluated the effect of the microthreaded geometry of 4 types of scalloped-design titanium implants on MBR. The type 1 implant had a machined scalloped collar; type 2 had a SLA scalloped collar; type 3 had horizontal microthreads; and type 4 had parabolic microthreads parallel with the scalloped conical margin. Two implants of each type were randomly installed into the mandible of a Beagle dog immediately after tooth extraction. Definitive prostheses were delivered immediately after surgery. After 12 weeks of healing, the dog was put to death, and microtomography was performed. Type 4 specimens exhibited a marginal bone loss pattern definitively analogous to the scalloped margin. In this preliminary study, microthreaded geometry affected the MBR pattern of scalloped design implants.[72]

Abrahamsson and Berglundh[73] analyzed bone tissue reactions at the sites of implants with or without a microthreaded configuration in dogs. Radiographic examination showed that the marginal bone level was well preserved at both test and control implant sites during the entire 16-month period. The degree of contact between bone and implant within the marginal portion of the implants was significantly higher for the test (microthreaded) implants (81.8%) than for the control implants (72.8%). The authors suggested that the microthreaded configuration offered improved the conditions for osseointegration.[73]

Choi et al[74] examined the effects of thread size in the implant neck area on peri-implant tissues in terms of bone-to-implant contact (BIC) and hard- and soft-tissue dimensions. No remarkable complications were observed during the healing period in either group. Resonance frequency testing found no significant differences between groups. Radiographic evaluation showed that control group lost more bone than did test group with microthreaded implants, but this difference was not statistically significant. Micro-CT analysis showed no significant differences between the groups in BIC and bone-implant volume (BIV) values and soft-tissue height. Histologic analysis found no significant differences between groups in BIC ratio, bone density, or bone loss. However, soft tissue height was significantly greater in control group than in test group (P = 0.0004). Thread size in the implant neck area was not associated with differences between groups in peri-implant hard or soft tissues.[74]

A finite-element comparison of von Mises stresses between two thread designs was performed to assess the influence of implant-thread geometry on biomechanical load transfer. The results of the study showed that 4-fold microthreading improves stress distribution within the implant body by 43.85%, on the abutment by 15.68%, on its superstructure by 39.70%, and within cancellous bone by 36.30%, as compared to single-pitch microthreading. The effective stress transfer to the cortical bone is lowered by 60.47% with single-pitch microthreading. Single-pitch microthreading dissipates lower stresses to cortical bone, whereas the implant body, the abutment, and the superstructure absorb more stress. These differences in stress have a positive effect on BIC and contribute to the preservation of crestal bone. An implant with single-pitch microthreading will thus be preferable in areas in which less cortical bone is available.[75]

A reduction in abutment diameter (i.e., PS) resulted in the translation of less stress to the crestal bone in the microthread implants.[76]

The microthreaded design was found to be more effective in reducing shear stress under off-axis loading, which dominates in the oral cavity. However, higher peak compressive stress and strain around the microthreaded implant were found to be localized in a smaller bone volume. The biomechanical rationale of the microthreaded design may reduce the risks of marginal bone loss caused by overloading.[77]

Peak stress levels associated with scalloped implants varied by microthreaded designs, connection configurations, and loading direction. The conical PS connection seemed to be more important for a scalloped implant than for the microthreaded design in reducing the loading stresses exerted on the surrounding bone. Scalloped implants without microthreading and a with a conical PS connection or with closed microthreading and a conical PS connection exhibited consistently lower buccal bone stress than did flat-top implants in areas in which the bone had a sloping and scalloping shape.[78]

Dental implants with laser-ablated coronal microgrooves reduce peri-implant CBL. However, laser microgrooves appear to inhibit apical migration of crevicular epithelium and to promote true attachment of peri-implant gingiva. The formation of an interface between connective tissue and the implant collar that is more like that of a natural tooth will improve the long-term performance of dental implants.[79]

In addition, the huge variation between the findings and the radiographic parameters of the studies using surgical and prosthetic protocols may minimize the positive impact of the microthreaded-neck implants on CBL.

Conclusion and Recommendation

Within the limitation of the present systematic review, the results indicate that thread geometry affects the distribution of stress forces around the implant. A decreased thread pitch may positively influence implant stability. Deeper threads seem to have an important effect on stabilization for patients with poorer bone quality. The addition of threads or microthreads up to the crestal module of an implant may positively contribute to BIC and to the preservation of marginal bone.

Additional RCTs are necessary for evaluating CBL after the placement of microthreaded-neck dental implants in grafted bone, pristine bone, and extraction sockets with various loading protocols. These studies should document the number of disconnects or reconnects necessary for the abutments and the types of contaminants to the microgap at the implant-abutment connection.

Conflict of Interest

Authors report no conflicts of interest, and no funding or grant support was available for this systemic review.

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Table: Characteristics and outcomes of studies included in this review

Author	Year	Type of study	# of Pts	# of Implants	Follow-up (mo)	Loading Protocol	Type of Prosthesis	Implant Brand Name	Implant Design	CBL (mm)	Measure-ment Method	Implant Site
Khorsand et al[43]	2016	RCT, Prospective	16	22	12	Conventional	Single Crowns	Implantium, Seoul, South Korea	Microthreads up to the platform, rough surface, internal connection and platform switching	0.75 ± 0.32	PA	Fresh Socket
Calvo-Guirado et al[44]	2016	Prospective cohort study	53	71	60	Immediate non-occlusal loading	Fixed Prostheses	MIS-Implants Inc., Barlev, Israel	Microthreads up to the platform, rough-surface body and neck, internal connection and platform switching	0.90 ± 0.26	PA	Fresh Socket
Calvo - Guirado et al[45]	2015	Prospective cohort study	53	71	36	Immediate non-occlusal loading	Single Crowns	MIS Implants Inc., Shlomi, Israel	Microthreads up to the platform, rough surface, internal connection and platform switching,	0.86 ± 0.29	PA	Fresh Socket
Noelken et al[46]	2014	Prospective cohort study	20	37	24	Immediate	Crowns or FPDs	OsseoSpeed TM Astra Tech AB, Mölndal, Sweden.	Screw-shaped and self-tapping implants, conical implant–abutment interface, Micro-Thread Implant diameters 3.5, 4.0, 4.5, 5.0 mm with implant lengths 11 or 17 mm.	0.70 ± 0.58	CBCT	Fresh Socket

Nickenig et al[47]	2013	Prospective cohort study	34	70	60	Conventional	FPDs	Replace Straight Groovy, Nobel Biocare AB, Göteborg, Sweden.	Rough-surface microthreaded implants	0.70	Panoramic	Pristine Bone
Peñarrocha-Diago et al[48]	2012	RCT, Prospective	9	64	12	Conventional	Fixed Prostheses	Inhex, Mozo-Grau, S.L. Valladolid, Spain	Rough-surface, microthreaded, internal connection, and platform switching	0.12 ± 0.17	PA	Pristine Bone
Chang and Wennström[49]	2012	Retrospective cohort study	31	31	96	Conventional	Single Crowns	Astra Tech implants, Astra Tech AB, Mölndal, Sweden.	Pure titanium grade 4 and blasted with titanium dioxide particles, moderately rough surface, with microthreads	0.10 ± 1.30	PA	Pristine Bone
Yun et al[50]	2011	Retrospective cohort study	27	79	12	Conventional	Fixed Prostheses	Osstem GS III implants, HIOSSEN Implant Canada INC. Vancouver, BC, Canada	Tapered body with angle of 1.5°; microthreads in the upper part; double threads in the lower part	0.16 ± 0.08	PA	Pristine Bone
Lee et al[51]	2010	RCT, Prospective	21	45	36	Conventional	Single or Splinted Crowns	Hexplant; Warantec Co, Seoul, South Korea	Advanced blasted and etched surface; surface roughness, Ra 1.44 micron; microthreads in the implant neck and progressive square type	0.59 ± 0.30	PA	Pristine Bone

									power thread design			
Van de Velde et al[52]	2010	Retrospective cohort study	10	50	12	Immediate	Complete Fixed Prostheses with Cantilever	TiOblast microthread ; AstraTech AB, Mölndal, Sweden	Pure grade 4 titanium blasted with titanium dioxide particles; moderate rough surface with microthreads	0.81 ± 1.11	PA	Pristine Bone
Song et al[53]	2009	Prospective cohort study	20	20	12	Conventional	Splinted Crowns or FPDs	Implantium, Dentium, Seoul, South Korea	Screw-shaped, threaded implants made of commercially pure titanium with a sandblasted, large grit, acid-etched (SLA) surface; microthreads to the top of the fixture	0.16 ± 0.19	PA	Pristine Bone
Piao et al[54]	2009	RCT, Prospective	21	45	12	Conventional	Single or Splinted Crowns	Hexplant; Warantec Co, Seoul, South Korea	Advanced blasted and etched surface; surface roughness, Ra 1.44 micron; microthreads in the implant neck and progressive square type power thread design	0.42 ± 0.27	PA	Pristine Bone
Nickenig et al[55]	2009	Prospective cohort study	34	70	24	Conventional	FPDs	Replace Straight Groovy, Nobel Biocare AB,	Rough-surfaced microthreaded implants	0.50	Panoramic	Pristine Bone

								Gothenburg, Sweden.				
De Bruyn et al[56]	2009	Retrospective cohort study	37	54	18	Early loaded	Overdenture Prostheses	TiOblast microthread; AstraTech AB, Mölndal, Sweden.	Pure grade 4 titanium blasted with titanium dioxide particles; moderately rough surface, with microthreads; 4 X 8-17mm	0.80 ± 0.48	PA	Pristine Bone
Kwon et al[57]	2009	Case Series Retrospective	17	17	12	Conventional	Crowns	MicroThread, Astra Tech, Mölndal, Sweden	Microthreaded, conical seal, and platform-switched design implant	0.16 ± 0.17	PA	Pristine Bone
Bratu et al[58]	2009	Prospective cohort study	46	46	12	Conventional	Crowns	MIS-Implants Inc., Shlomi, Israel	Microthreads up to the platform, rough surface, internal connection and platform switching	0.69 ± 0.25	Panoramic	Pristine Bone
Cooper et al[59]	2008	Prospective cohort study	59	118	60	Conventional	Overdenture Prostheses	TiOblast microthread; AstraTech AB, Mölndal, Sweden	Pure grade 4 titanium blasted with titanium dioxide particles, moderately rough surface, with microthreads	+0.09 ± 0.79	CT	Pristine Bone
Lee et al[60]	2007	Prospective cohort study	17	17	36	Conventional	Splinted Crowns	TiOblast microthread; AstraTech AB, Mölndal, Sweden	Pure grade 4 titanium blasted with titanium dioxide particles, moderately rough surface, with microthreads	0.24± 0.13	PA	Pristine Bone

Shin et al[61]	2006	Prospective cohort study	38	38	12	Conventional	Single or Splinted Crowns	Oneplant; Warantec, Seoul, South Korea	Sandblasted and acid-etched (SLA) surface and microthreads in the implant neck	0.18 ± 0.16	PA	Pristine Bone
De Kok et al[62]	2006	Retrospective cohort study	25	39	30	Immediate	Single Crowns	Astra Tech, Waltham, MA	Pure grade 4 titanium blasted with titanium dioxide particles, moderately rough surface, with microthreads	0.30 ± 0.39	PA	Fresh Socket
Puchades-Roman et al[63]	2000	Retrospective	30	30	24	Conventional	Single Crowns	Astra Tech implants; Astra Tech AB, Mölndal, Sweden	Pure grade 4 titanium blasted with titanium dioxide particles, moderately rough surface, with microthreads	0.45	PA	Pristine Bone
Nordin et al[64]	1998	Retrospective	10	25	12	Conventional	FPDs	Astra Tech implants; Astra Tech AB, Mölndal, Sweden	Pure grade 4 titanium blasted with titanium dioxide particles, moderately rough surface, with microthreads	0.05 ± 0.11	PA	Pristine Bone
Norton[65]	1998	Prospective cohort study	31	33	48	Conventional	Single Crowns	Astra Tech implants, Astra Tech AB, Mölndal, Sweden	Pure titanium grade 4 and blasted with titanium dioxide particles, moderate rough surface, with microthreads.	0.61	PA	Pristine Bone

Immediate, within 24 hr after implant placement; Conventional, 3 to 6 months after implant placement.

Abbreviations: CBCT, cone beam computed tomography; CBL, crestal bone loss; CT, computed tomography; FPD, fixed partial denture; PA, periapical radiographs; RCT, randomized controlled trial.

Fig. 1: Description of included records in the systematic review

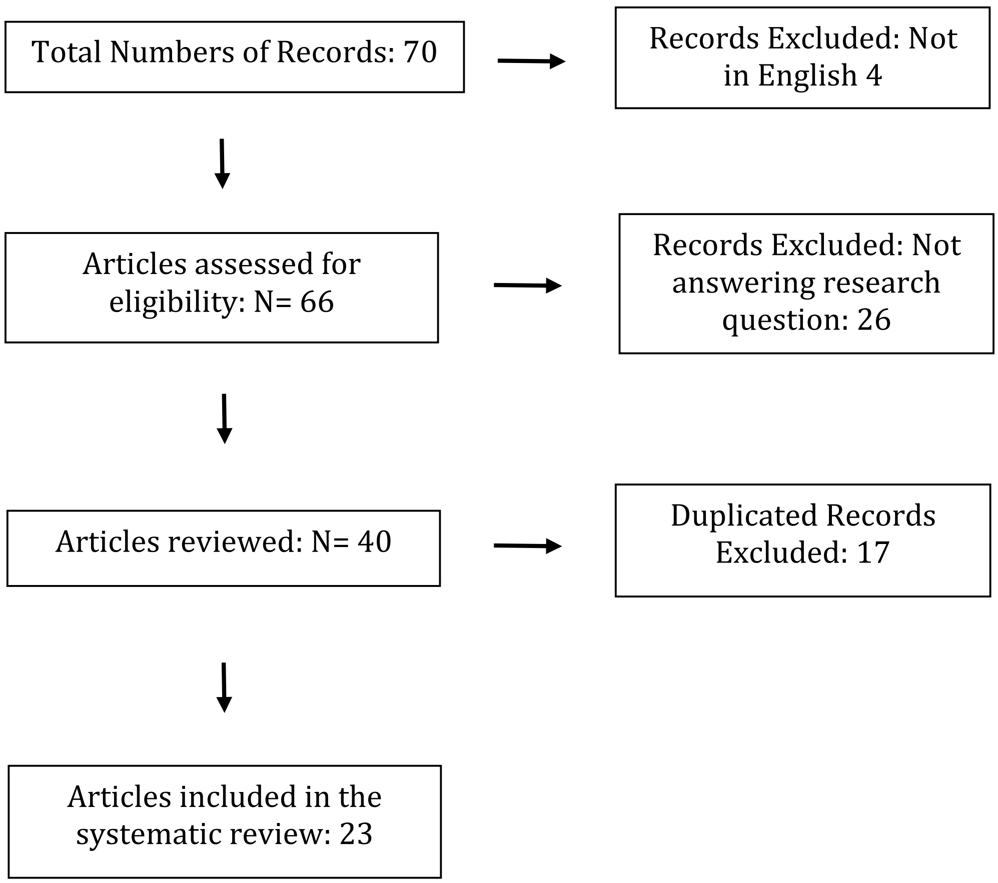


Fig. 2: Various microthread implants reported in the studies with CBL.

A. Osstem GS III.

B. MIS implant.

C. Astra Tech.

D. Nobel Biocare.

E. Hexplant.

F. Implantium.

G. Oneplant

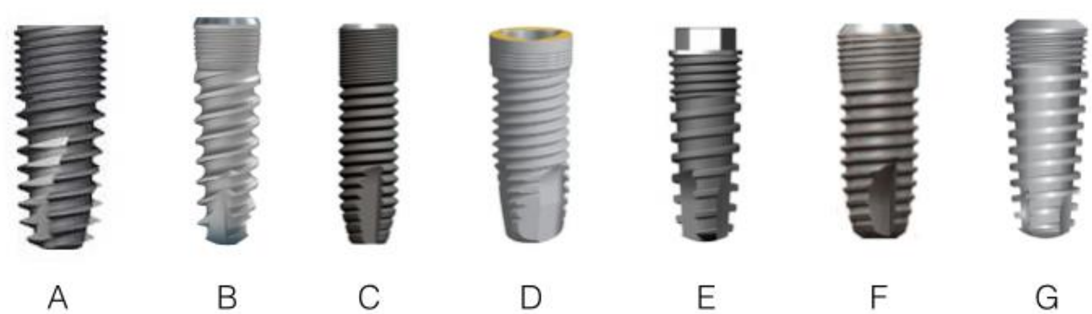
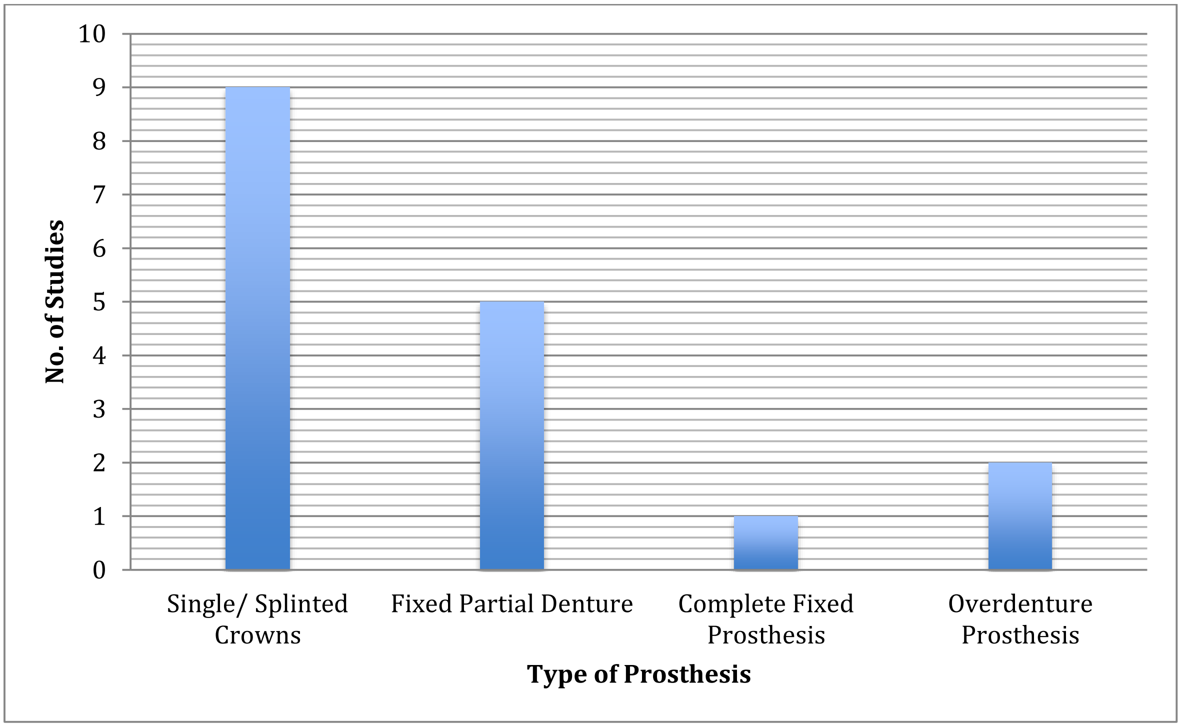


Fig. 3: Distribution of prosthesis types among the studies



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