SHORT DENTAL IMPLANTS: A SYSTEMATIC REVIEW

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ABSTRACT:

The advanced technologies have led to the increased use of implants even in the most critical cases. Short implants are considered to be a most frequent alternative to other surgical techniques where bone availability is less and reduced. This review outlines the effectiveness and clinical outcomes of using short implants as a valid treatment option in the rehabilitation of edentulous atrophic alveolar ridge. Recentlyshort implants are considered as a viable alternative in patients with reduced alveolar bone height to avoid more invasive surgical procedures. Short implants simplify the implant treatment, reduce patient morbidity, shorten the duration of treatment, and make the treatment less expensive. Studies have shown that short implants can have the same success rates when compared to long implants by decreasing the lateral forces to the prosthesis, eliminating cantilevers, increasing implant surface area and improving implant to abutment connection. Short implants can be considered as an effective treatment alternative in resorbed ridges. Short implants can be considered as a viable treatment option in atrophic ridge cases in order to avoid complex surgical procedures required to place long implants. With improvement in the implant surface geometry and surface texture, there is an increase in the bone implant contact area which provides a good primary stability during osseous-integration.

The aim of this systematic review and meta-analysis was to analyze the impact of the use of short implants on their survival and on peri-implant bone loss, evaluating the influence that length, diameter, and crown-to-implant ratio (C/I) have on these parameters. This systematic review was based on guidelines proposed by the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA). An electronic database search was conducted using terms related to the use of short implants in partially or totally edentulous patients. A total of two databases were consulted in the literature

search: Scopus and PubMed. After eliminating the duplicate articles and assessing the ones which met the inclusion criteria,46 Papers were included for the qualitative analysis.

Keywords:*Short implants, Atrophy, Success rate*
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INTRODUCTION:

Current technical developments in dental implants in combination with advanced surgical techniques and biomaterials have led to an increase in the indications for placement of implants and implant related prosthetics. For the prevention of atrophy of alveolar ridges after tooth extraction, socket or ridge preservation, reconstruction of the alveolar crest by augmentation with autologous bone or bone substitute materials of different origins have become the most reliable treatment approach to establish a sufficient implantation bed.

Various procedures such as maxillary sinus floor elevation, bone grafting, guided bone regeneration, distraction osteogenesis, and vertical and horizontal bone augmentation are being recently used to enhance bone width and height in atrophied ridges[1].However, there are problems associated with these augmentation techniques such as high cost and increased treatment time, increased postoperative morbidity and increased risk of complications[2,3] Therefore, short implants, zygoma, or pterygoid implants (Esposito & Worthington, 2013) are suggested as alternatives to avoid bone augmentation for the accommodation of standard implants, which tend to have greater morbidity and requires longer healing times[4,5].

Renouard and Nisand defined short implants as an implant with a designed intra bony length of 8 mm or less[6]. The European Consensus Conference of European Association of Dental Implantologist in 2011 approved the classification of implants given by Olate et al., which states, implants are usually referred to as short if their length measures <8 mm, 9-13 mm in length as a medium and long implant are usually understood to be over 13 mm in length[7].

Due to compromised general health and individual demands of the patient, minimally invasive methods play an important role to restore oral function along with patient satisfaction. Thus, the development and scientific investigation have stated that short implants are indicated, as they seem to allow placement of dental implants in the molar region of the atrophic maxilla and, at the same time, avoid the need for sinus augmentation procedures.

Short implants are considered as a viable alternative in patients with reduced alveolar bone height to avoid more invasive surgical procedures[8,9,10]. Short implants simplify the implant treatment, reduce patient morbidity, shorten the duration of treatment, and make the treatment less expensive.

Review selection and Data extraction

The results of the search are presented in the form of flow diagram.

The search yielded the total of 112 articles which were screened from indexed data base such PUBMED and Scopus. After screening, the total of20 papers were included and then reviewed.The papers with duplicate records (23), outcomes that were not relevant (21), Out of scope (10)insufficient study design description (12) were excluded from the review.

Fig1: Flow diagram of the review search and identification of PUBMED and Scopus journals is displayed below. The papers included in the study were review papers, short communications, systematic review and meta-analysis papers. The papers excluded were conference papers, newsletters, communications from dental magazines and online non indexed web source data. The total of 20 articles were included in the systematic review.

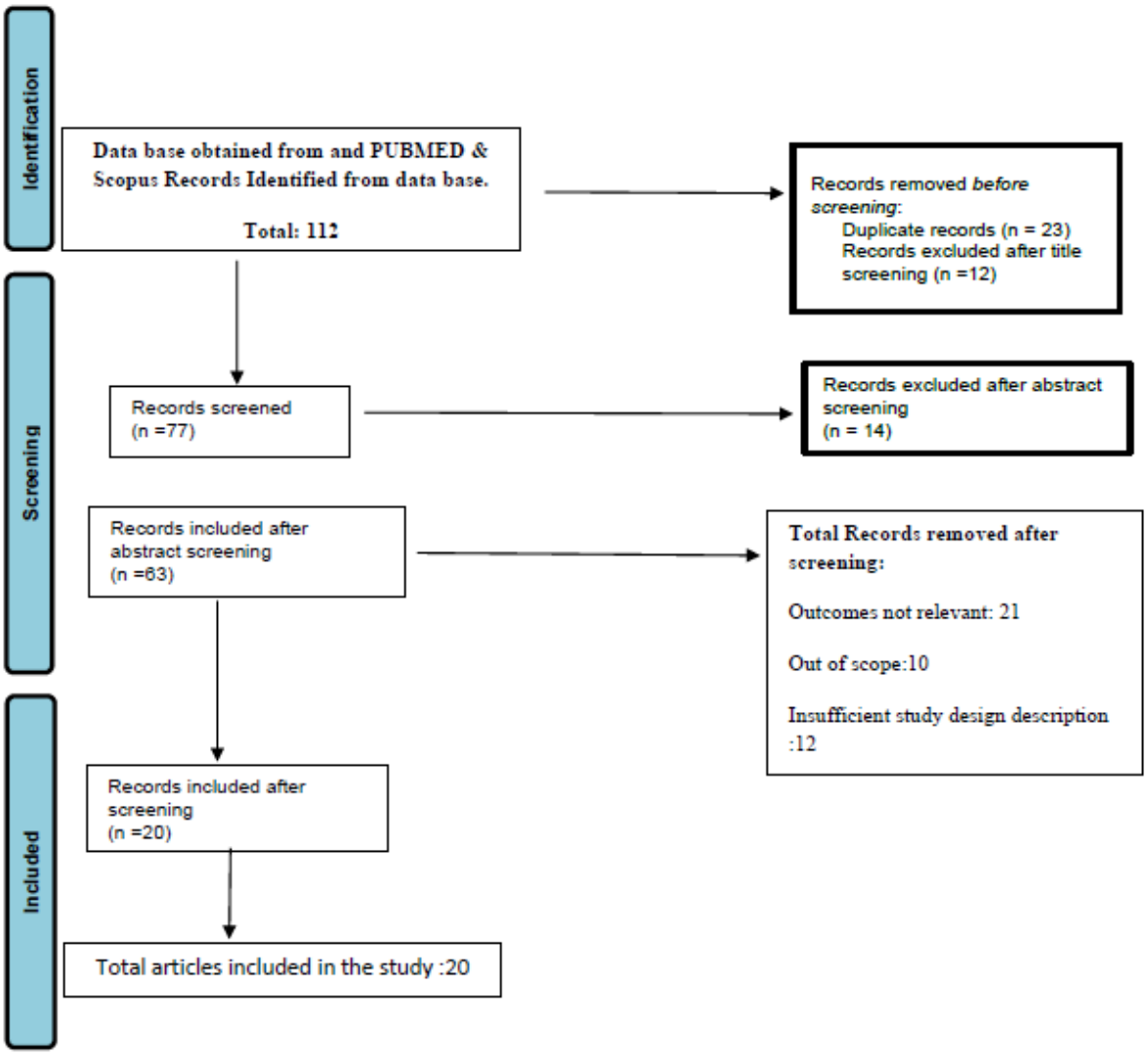

Fig1: Flow diagram of the review search and identification

RATIONALE FOR SHORT IMPLANTS:

When stress is applied to the natural tooth, it is distributed to the underlying bone along the entire root length due to the presence of periodontal ligament as the tooth tends to pivot around the center of the root but in case of implants, where periodontal ligament is absent, the greatest magnitude of stress concentration is seen at the crest which tapers apically up to 5 mm from the crest. Stress concentration in the apical region is much lesser[11]. Most endosteal dental implants are fabricated from alloyed or pure titanium with a modulus of elasticity (stiffness) approximately 5 times greater than dense cortical bone. A basic mechanical principle states that when two materials of different moduli of elasticity are placed together with no intervening material and one is loaded, the stress concentration can be observed where the two materials first come into contact[12]. These stress contours form a V-shaped or u-shaped pattern, with greater magnitude near the point of first contact, which corresponds to the crest of the bone[13]. The phenomenon of higher crestal stress next to the implant is confirmed in photo elastic and two-dimensional or three-dimensional finite element analysis (FEA) studies when an implant

is placed within a bone simulant[14,15].Increase in implant length will increase the total surface area of the implant and improve the primary stability by increasing the bone implant contact (BIC). But the area that transfers the compressive and tensile loads to bone that is, functional surface area (FSA) is confined to the crestal 5-7 mm. Increasing the length of the implant will not change this where as a short implant with a wider diameter provides both, improved primary stability and increased FSA.

Chris M et al in 1998[16]studied short (6-mm) non-submerged dental implants multicenter clinical trial of 1 to 7 years.The study was conducted to verify the use of short implants in limited bone height. In a 6-year period 253 short implants with a length of 6 mm were placed into 126 patients, who were followed up from 1 to 7 years. Altogether 7 implants were removed; 6 of these were located in the maxilla and 1 in the mandible. The quality of survival was comparable with the clinical results of longer implants from the same implant system. The study concluded that the clinical results of the short implants used in the study were favorable, it is recommended that they be used in combination with longer implants, especially when used in the less dense bone that is often seen in the maxilla.

The study of Guljé et al. (2013)[1] reported a 97% survival rate for the short implants group with two implant failures before and one failure after loading yet prior to the 1-year follow-up. The group with longer implants had a 99% survival rate with one implant lost after loading and prior to the one-year follow-up. In a split-mouth study design, Esposito et al. (2014)[17] found a 92% survival rate for short implants and 97% for longer implants placed in areas previously submitted to vertical augmentation, either with interpositional block grafts or maxillary sinus augmentation depending on indication and anatomic location. Similar to that, Rossi et al. (2016)[18] in a 5-year follow-up study reported lower survival rates for short implants (86.7%) compared to longer implants (96.7%).

BIOMECHANICAL CONSIDERATION:

They have been categorized as follows

1. Diagnostic

a) Implant diameter: Implant diameter is more efficient than implant length for dissipation of stresses, because the area receiving maximum effort is the bone crest and very little stress is transferred to the apical portion. An increase in the length would therefore improve only primary stability but wider implant would not only increase the primary stability but also the functional surface area at the crestal bone level leading to better distribution of occlusal forces. Finite element analysis has also supported this concept and demonstrated that implant length might not be the principal factor which can influence the transfer of occlusal loads to the bone-implant interface[19].

b) Crown/implant ratio: Increased crown/implant ratio can act as a vertical cantilever leading to further crestal bone loss and implant failure. However, improvements of surfaces and implant systems along with proper force orientation and load distribution have allowed high crown/implant ratios to be applied with success.[20]

c) Bone quality: It is the primary factor for short implant success[21]. Areas with type III and type IV bone show more failures regardless of the implant surface treatment. The combination of short implant length and poor bone quality reduces the implant stability during implant placement and the healing period.

d) Lack of cantilevers: A cantilever magnifies the forces directly proportional to the height of the crown. It creates six different potential rotation points on the implant body.[20] Eliminating cantilevers favors biomechanics and increased treatment predictability.

e) Number of implants: Use of multiple implants will increase the functional surface area to resist occlusal forces.[20]

f) Implant design: The implant surface area can be increased by [22]:

I. Thread number: More the number of threads per unit length in the same axial plane more is

the implant surface area in contact with the bone.

II. Thread depth: Deeper threads provide more implant surface area.

III. Thread shape: The square thread design has a higher implant-bone contact percent as compared to V-shape and reverse buttress thread designs.

IV. Implant surface: As compared to turned smooth surface, rough microtopography of implant surface increases the bone-implant contact surface area and accelerates osseointegration. It also compensates for inadequate crown/implant ratio.

2. Surgical Considerations:

a) Two step surgical protocol: A two stage surgery is advocated for short implants as it provides good primary stability during healing phase. The time elapsed between the surgical and load stage should be 4-6months for maxilla and 2-4 months for mandible[23].

b) Adapted surgical protocol: Enhanced initial implant stability can be achieved by eliminating a step in standard surgical protocol such as eliminating the countersink drill or eliminating the final drill in the standard drilling sequence[24] Soft bone drilling protocol should be followed in poor quality bone whereas, the final bone drilling is done with narrow drills rather than standard size drills.

3. Prosthetic:

a) Implant to abutment connection: Morse taper connection induces less marginal bone loss as compared to external hex abutment connection and also promotes bone growth over the implant shoulder[25]. Internal hex implant abutment connection shows a wider force distribution as compared to external hex connection[26]. Platform switching maintains the crestal bone for the entire length of the implant up to the collar level.

b) Occlusal table: Small occlusal table reduces the offset loads on the implant

c) Incisal guidance: Implants should follow a biomechanical approach similar to natural teeth to accommodate the higher bite forces in the posterior regions of the mouth. Incisal guidance of the anterior teeth eliminates lateral forces to the posterior teeth in all mandibular excursions.

d) Splinting: Splinting implants increases the functional surface area of support and transmits less force to the prosthesis, the cement, abutment screws and the implant bone interface especially when placed in soft bone.

Indications for short implants thus include, atrophic jaws, posteriorly resorbed maxillary ridges, cases with greater proximity to sinus, conditions with greater proximity to mandibular canal/mental foramen.

Overall, the percentage of patients that experienced biologic complications ranged from 0% to 26% in the short implant group and from 0% to 90% in the longer implant group. Two studies reported that there were no biologic complications (Felice et al., 2016; Sahrmann et al., 2016) [27], while two studies did not clearly assess this variable (Gulje et al., 2013; Rossi et al., 2016)[1,18]. Most of the complications were related to the immediate postoperative period, and included transient paresthesia of the lower lip, Schneiderian membrane perforation, and mandibular graft infection.

ADVANTAGES:

1. Bone grafting compensation for less alveolar ridge height is not necessary.
2. Less money, pain and time associated with various surgical procedures before placement of implant.
3. Complex surgical techniques are often associated with complications during surgery such as bleeding, perforation of the Schneiderian membrane or nerve injury and post-operatively such as transient or permanent alteration of mandibular sensation, graft and/or membrane exposure, infections and increased peri-implant bone loss. This can be avoided.
4. Osteotomy preparation is simplified since shorter bone preparation is required at the implant site which provides directaccess for water irrigation and reduces the possibility of bone overheating
5. Implant insertion is easier.
6.Angulation to load is improved with short osteotomy site since the basal bone beyond the

original alveolar ridge is not always located in the long axis of the missing tooth.

The survival rate of short dental implants was found to increase from 80 to > 90% over time[28] This is also confirmed in recent studies. For short dental implants supporting single crowns and fixed bridges especially in the mandible, a 2-year success rate of 97% [29] and a 5-year outcome of 92.2% [30] are reported. Otherwise, the success rate of 100% in the maxilla (3-year outcome)[30] are reported.

Summary of Studies on Short Implants:

Sr No	Author	Year	Study	Results
1	Chiapasco et al[31]	1966-2005	The study evaluated the success of different techniques for ridge augmentation and the survival rate of dental implants placed after ridge augmentation. They included studies with a minimum follow-up of 6 months which evaluated one of the following procedures: • guided bone regeneration • onlay bone grafts • inlay grafts • bone splitting for ridge expansion • distraction osteogenesis • revascularized flaps.	Survival rates for implants ranged from 92% to 100% with guided bone regeneration, 60% to 100% with onlay bone grafts. 91% to 97.3% with ridge expansion. 90.4% to 100% with distraction osteogenesis, 88.2% with revascularized flaps
2	Wyatt et al.[32]	1998	Studied 77 patients with 230 machined implants with a follow-up of 12 years	Survival rate of short implants was 75% whereas that of long implants was 95%

3	Friberg et al[33]	2000	Studied the severely atrophic edentulous mandibles that were rehabilitated with short (6 to 7 mm) Brånemark implants.	Survival rate of 95.5% at 5 years and 92.3% at 10 years follow-up.
4	Misch et al[22]	2000-2007	Retrospectively evaluated 273 patients who were treated with 745 short implants (7 or 9 mm long) in the posterior mandibular partially edentulous regions	Survival rate of 98.9%.was reported.
5	Weng et At[34]	2003	Conducted a study on 493 patients with 1179 implants with a follow-up of 72 months	Survival rate of 74% with 7mm implants, 81% with 8.5mm implants and 93.1% with >10mm implants.

6	Renouard and Nisand et al[6]	2006	The study reviewed 53 studies in which 13 studies were devoted to short implants while 21 studies provided data on the implant length.	The authors noted higher failure rates in older studies, which involved machined-surface implants placed in inferior bone quality and restricted anatomical sites.However, more recent studies reported survival rates for short implants similar to those of long implants.
7	Grant et al[35]	2009	The study evaluated the overall success rate of short implants (8 mm in length) placed in the partially or completely edentulous mandible and restored with fixed or removable prostheses.	Survival rate obtained was 99% in the mandible. It was concluded that short implants provide a predictable treatment alternative to bone grafting and nerve lateralization for the atrophic mandible

8	Kotsovilis et al[36]	2009	Conducted the meta-analysis to detect whether there was any significant difference in survival between short (≤ 8 or < 10 mm) and conventional (≥ 10 mm) rough surface dental implants placed in totally or partially edentulous patients.This meta-analysis included 37 articles.	The study concluded that the placement of rough surface short implants was as effective a treatment modality as long rough-surface implants.
9	Esposito et al[5]	2011	Conducted a study on 60 patients comparing 6.3mm with 9.3mm implants associated with vertical augmentation.	Found more complications with augmented patients and less bone loss, less time, less cost and less morbidity with short implants
10	Annibali et al[9]	2012	Conducted a systematic review and meta-analysis.	Concluded that more long term follow-up results are required to support the use of short implants

11	Nisand and Renouard et al[37]	2014	Reviewed studies on short implants	Survival rates and reduced treatment cost and time when compared to long implants assisted by advanced surgical procedures.
12	Vasquez et al.[38]	2014	Documented complication rate in 200 sinus lift procedures.	Found that Schneiderian membrane perforation occurred in 25.7% of the cases

CONCLUSION:

Based on the literature reviews, short implants if applied correctly can be an effective alternative to other more complex dental implant procedures. Short implants simplify the implant treatment, reduce patient morbidity, shorten the duration of treatment, and make the treatment less expensive. There is less amount of literature at present to conclude on the long-term success of short implants versus conventional length implants, therefore implants longer than 10mm are still recommended where height of bone is available. Further studies are required to evaluate the long term success rates of implants.

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