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REVIEW

Role of implant diameter on long-term survival of dental implants placed in posterior maxilla: a systematic review

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Abstract
Objective We speculated that the long-term survival of narrow or conventional diameter (<5 mm) implants is higher than that of wide-diameter implants (≥5 mm) when placed in posterior atrophic maxillae. The aim of this paper was to systematically review indexed literature regarding the influence of implant diameter on long-term survival of dental implants placed in posterior maxilla.
Materials and methods The addressed focused question was "Does implant diameter influence long-term survival of dental implants placed in posterior maxilla?" Databases were searched from 1986 till June 2014 using the following MeSH terms: "dental implants," "dental implant-abutment design," "maxilla," and "survival." Review articles, case reports, letters to the editor, unpublished data, and studies published in languages other than English were excluded. Reference list of potentially relevant original and review studies was hand-searched.
Results The initial search yielded 51 studies. Scrutiny of the titles and abstracts reduced the number of clinical studies included in the present review to 19. Mean age of the patients ranged between 37 and 60 years. Cylindrical and tapered implants were used in 12 and 3 studies, respectively. In all studies, threaded, rough-surfaced dental implants with diameters ranging between 3.0 and 5.5 mm were used. In all studies, follow-up periods and cumulative survival rates ranged between 5 and 15 years and 80.5 and 100 %, respectively.
Conclusion and clinical relevance The role of implant diameter on long-term survival of dental implants placed in posterior maxilla is secondary. A well-designed surgical protocol, achievement of sufficient primary stability at the time of implant placement, and pre- and postsurgical oral hygiene maintenance visits are critical factors that influence the long-term survival of dental implants placed in posterior atrophic maxilla.

Keywords Dental implant · Diameter · Implant survival rate · Posterior maxilla · Maxillary tuberosity

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Introduction

Implant diameter and geometry have been reported to have a distinct effect on stress distribution in the cortical plate [1, 2]. In a longitudinal clinical study, Small and Tarnow [3] reported that placement of wide-body implants (with diameter 5 mm or more) exerts excessive pressure on the buccal bone thereby inducing its resorption and gingival recessions. However, recent experimental results by Santiago et al. [2] showed that oblique loading of wide-body implants improved stress distribution to bone tissue and decreased stress as compared to when implants were loaded axially. Conversely, Haas et al. [4] reported no significant influence of implant diameter and/or length on the cumulative survival rate (CSR) of implants. Implant surface characteristics are another factor that influences primary stability and the process of bone formation around implants [5, 6]. Clinical and histologic evidence has shown a more favorable implant–bone interface on rough-surfaced implants as compared to smooth-surfaced implants [7].

It is known that the location and anatomy of the jaw influence healing and overall outcome of dental implant treatment [8, 9]. The posterior maxilla has challenged clinicians by posing many limitations to implant treatment. This anatomical region endures lower mechanical forces due to its thinner cortical layer and low density of the spongiosa as compared to the mandible [10, 11]. Moreover, maxillary sinuses (particularly in atrophic posterior maxillae) restrict available bone volume thereby limiting future implant placement. Subantral augmentation or sinus lifting procedures were therefore developed to increase the vertical height of the bone from the alveolar crest to the floor of the sinus [12].

Since the upper jaw is mainly composed of type 4 bone and that the alveolar bone height is compromised in the posterior maxillae (particularly in atrophic ridges) [11], we were tempted to speculate that the long-term CSR of narrow or conventional diameter (<5 mm) implants is higher than that of wide-diameter implants (≥5 mm) when placed in posterior atrophic maxillae. With this background, the aim of the present review was to systematically scrutinize indexed literature with respect to the influence of implant diameter on long-term survival of dental implants placed in posterior maxilla.

Materials and methods

Classification of implants on the basis of diameter

Implants with diameters ≤3.75 mm were classified as "narrow-diameter implants (NDI)," those with diameters >3.75 mm but less than 4.5 mm were classified as "conventional diameter," and implants with diameters >5 mm were considered "wide-diameter implants (WDI)" [13].

Focused question

The addressed focused question was "Does implant diameter influence long-term survival of dental implants placed in posterior maxilla?"

Eligibility criteria

The following eligibility criteria were imposed: (1) original studies performed on humans; (2) intervention: influence of implant diameter on long-term survival of dental implants placed in posterior maxilla; and (3) studies with follow-up periods of at least 5 years.

Literature search strategy

As a first step, PubMed/MedLine (National Library of Medicine, Bethesda, MD), EMBASE, OVID, and Google Scholar databases were searched from 1986 up to and including June 2014 using the following MeSH terms: "dental implants," "dental implant-abutment design," "maxilla," and "survival." Review articles, case reports, letters to the editor, unpublished data, and studies published in languages other than English were excluded. In the next step, reference list of potentially relevant original and review studies was hand-searched. Pattern of the present systematic review was customized to primarily summarize the relevant information (Fig. 1).

Results

The initial search yielded 51 studies. Scrutiny of the full texts of these articles reduced the number of clinical studies included in the present review to 19 [14–32]. Excluded studies and reasons for exclusion are shown in Appendix 1.

Characteristics of studies included

All studies [14–32] were clinical and were performed at universities and/or healthcare centers. The number of participants ranged between 10 and 731 individuals, and most of the patients were males. Mean age of participants ranged between 37 and 60 years. In these studies [14–32], numbers of dental implants placed in atrophic posterior maxillae ranged between 12 and 2,132 per study. In all studies [14–32], implants were threaded and had rough surfaces. In 17 studies [14–17, 19–27, 29–32], implants were placed in healed sites. Ormianer et al. [18] and Krennmair et al. [28] placed implants in healed and fresh extraction sites. Cylindrical and tapered implants were placed in 12 studies [16, 17, 19, 21, 22, 24, 26, 28–32] and 4 studies [14, 15, 18, 25], respectively. In two studies [23, 27], tapered and cylindrical implants were used, whereas in the study by Buddula et al. [20], implant geometry remained unknown (Table 1).

Table 2 summarizes the characteristics of studies with reference to guided bone regeneration, sinus augmentation, implant placement torque, and time until loading. In summary, guided bone regeneration (GBR) and sinus augmentation were performed in 11 [16–18, 20, 22–24, 26, 28, 29, 32] and 11 studies [16–18, 21–24, 26, 28, 29, 32], respectively. Out of the four studies [19, 21–23] that reported the implant insertion torque, two studies [22, 23] used a torque of less than 20 Ncm and two studies [19, 21] placed implants at a torque of 35 Ncm. In 13 studies [14, 16, 17, 22–26, 28–32], delayed loading was performed, and in four studies [15, 19, 27, 33], implants were immediately loaded. Immediate and delayed loading was carried out in one study [18]. In studies by Buddula et al. [20] and Nedir et al. [21], implant loading protocol remained unclear.

In nine studies [14–16, 19, 22, 23, 29–31], cigarette smokers were included. In these studies [14–16, 19, 22, 23, 29–31], numbers of smokers ranged between 4 and 301 individuals. There were 24 and 4 bruxists in studies by Mangano et al. [14] and Rodríguez et al. [16], respectively. In all studies

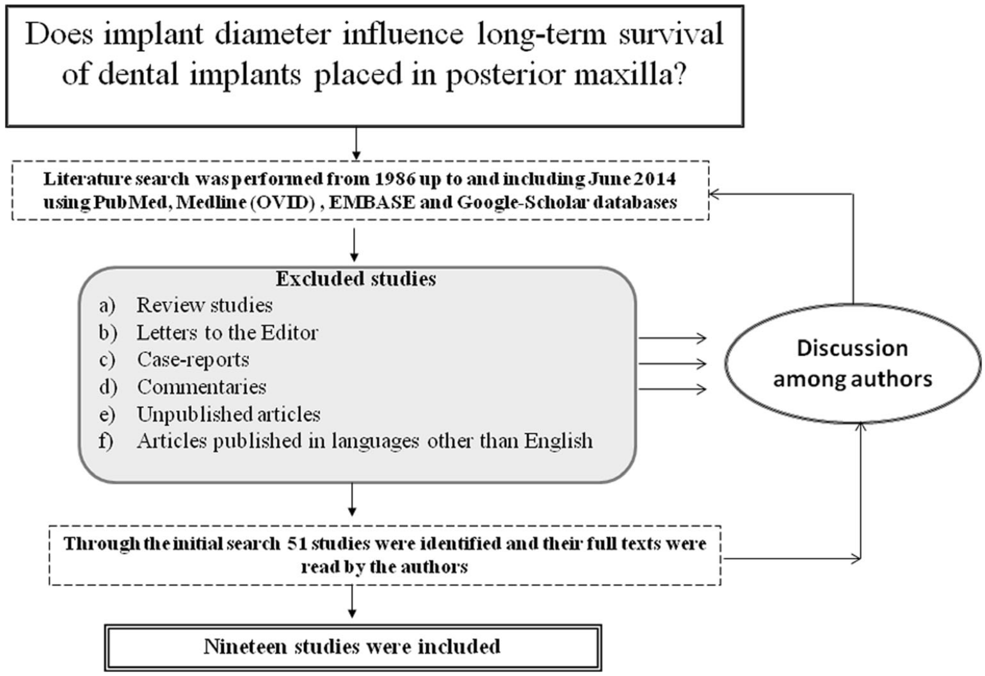

Fig. 1 Literature search protocol

[14–32], participants had good oral hygiene and were free of periodontal disease. In five studies [19, 20, 26, 30, 31], participants had previously diagnosed systemic disorders such as diabetes, cardiovascular disorders, arthritis, and infections with human immunodeficiency virus and hepatitis C virus (Table 3).

Summary of outcomes

In seven studies [14, 17, 19, 20, 22, 28, 32], contribution of implant diameter on CSR could not be commented upon since all implants had a standardized diameter. In 12 studies [15, 16, 18, 21, 23–27, 29–31], implant diameter did not influence the overall CSR (Table 1).

Discussion

From the results of the present systematic review, it was exigent to assess the overall effect of implant diameter on implant survival in the posterior maxilla. An explanation in this regard maybe derived from the fact that there was an inconsistency in the methodology of the studies [14–32] that fulfilled our eligibility criteria. For example, in the study by Rodriguez et al. [16], implants with diameters of 3.75, 4.0, and 4.2 mm were used. Likewise, in the study by Ormianer et al. [18], implant diameters ranged between 3.7 and 4.7 mm. Moreover, in some studies included in the present review, GBR [16–18, 20, 22–24, 26, 28, 29, 32] and sinus lift [16–18, 21–24, 26, 28, 29, 32] were performed around implants placed in posterior maxilla. Furthermore, in some studies, implants were placed in fresh extracted sockets [18, 28], whereas in others, implants were placed in healed sites [14–17, 19–27, 29–32]. It is speculated that the overall effect of implant diameter on implant survival could have been assessed in case methodology of studies included in this review were comparable. Hence, additional studies with standardized protocols are needed in this regard.

Studies [34–37] have attempted to classify dental implants on the basis of diameter; however, to our knowledge, from indexed literature, a consensus in this regard is yet to be established. We therefore considered implants with diameters ≤3.75 mm as NDI, implants with diameters >3.75 mm but less than 4.5 mm as conventional diameter implants, and those with diameters >5 mm as WDI [13]. From the literature reviewed, it was observed that cumulative survival rates of NDI and WDI placed in posterior atrophic maxillae were comparable. For example, Mangano et al. [14], Oliveira et al. [17], Manso and Wassal [22], and Krennmair and Waldenberger [28] used implants with consistent diameters of 4.1, 4.1, 3, and 5.5 mm, respectively. In each of these studies, the CSR ranged between ~95 and 100 %. These results are in contradiction to our hypothesis as they suggest that implant diameter does not influence long-term survival of dental implants placed in posterior atrophic maxillae. However, it is pertinent to mention that other studies [20, 26, 29], included in the present review, used NDI as well as WDI in their respective patient population instead of using implants with consistent diameters. Peleg et al. [26] used implants with diameters ranging between 3.25 and 4.7 mm thereby incorporating both NDI and WDI. Although the CSR of implants in

Table 1 Characteristics of studies included

Authors	Patients (n)	Implants (n)	Implant design	Threaded?	Implant surface	Implant diameter (mm)	Follow-up	CSR (%)	Comments
Mangano et al. [14]	194	124[a]	Tapered	Yes	Rough	4.1	Up to 10 years	95.8	The contribution of implant diameter on CSR could not be commented upon since all implants had a standardized diameter.
Romanos et al. [15]	20	163[a]	Tapered	Yes	Rough	3.5, 4.5, and 5.5	5.2 years (smokers) 8.2 years (nonsmokers)	98.9 96.9	Implant diameter did not influence the overall CSR.
Rodríguez et al. [16]	392	454[a]	Cylindrical	Yes	Rough	3.75, 4, and 4.2	6 years	96.5	Implant diameter did not influence the overall CSR.
Oliveira et al. [17]	10	24[a]	Cylindrical	Yes	Rough	4.1	9 years	100	The contribution of implant diameter on CSR could not be commented upon since all implants had a standardized diameter.
Ormianer et al. [18]	46	173[c]	Tapered	Yes	Rough	3.7–4.7	10 years	99	Implant diameter did not influence the overall CSR.
Maló et al. [19]	242	968[a,b]	Cylindrical	Yes	Oxidized	4	5 years	93	The contribution of implant diameter on CSR could not be commented upon since all implants had a standardized diameter.
Buddula et al. [20]	48	62[a]	NA	Yes	Rough	3.3–5	5 years	80.5	The contribution of implant diameter on CSR could not be commented upon since all implants had a standardized diameter. However, implants placed in the posterior maxilla were more likely to fail than those placed in anterior maxilla.
Nedir et al. [21]	17	25[a]	Cylindrical	Yes	Rough	4.1 and 4.8	5 years	100	Implant diameter did not influence the overall CSR.
Manso and Wassal [22]	45	160[a]	Cylindrical	Yes	Rough	3	10 years	98.05	The contribution of implant diameter on CSR could not be commented upon since all implants had a standardized diameter.
Lambert et al. [23]	40	102[a]	Cylindrical and tapered	Yes	Rough	4.1 and 4.3	6 years	98	Implant diameter did not influence the overall CSR.
Ridell et al. [24]	21	23[a]	Cylindrical	Yes	Rough	3.75 or 4	8 years	100	Implant diameter did not influence the overall CSR.
Valerón and Valerón [25]	92	152[a]	Tapered	Yes	Rough	3.75–4	Up to 10 years	94.7	Implant diameter did not influence the overall CSR.
Peleg et al. [26]	731	2,132[a]	Cylindrical	Yes	Rough	3.25–4.7	9 years	97.9	Implant diameter did not influence the overall CSR.
Degidi and Piattelli [27]	3	12[a]	Cylindrical and tapered	Yes	Rough	4–5.5	7 years	93.5	Implant diameter did not influence the overall CSR.
Krennmair and Waldenberger [28]	114	74[c]	Cylindrical	Yes	Rough	5.5	~5 years	97.3	The contribution of implant diameter on CSR could not be commented upon since all implants had a standardized diameter.
Simion et al. [29]	14	38[a]	Cylindrical	Yes	Rough	3.5–5.5	Up to 7 years	92.1	Implant diameter did not influence the overall CSR.
Attard and Zarb [30]	35	46[a]	Cylindrical	Yes	Rough	3.75	Up to 15 years	94	Implant diameter did not influence the overall CSR.
Attard and Zarb [31]	39	133[a]	Cylindrical	Yes	Rough	3.75, 4, and 5	~8 years	91.6	Implant diameter did not influence the overall CSR.
Hürzeler et al. [32]	133	340[a]	Cylindrical	Yes	Rough	4	5 years	98.8	The contribution of implant diameter on CSR could not be commented upon since all implants had a standardized diameter.

CSR cumulative survival rate, *SLA* sandblasted and acid-etched

[a] Implants were placed in healed sites

[b] Completely edentulous maxilla

[c] Some implants were placed in healed sites and in fresh extraction sockets

Table 2 Study parameters regarding bone regeneration, sinus augmentation, torque, and implant loading

Authors	GBR?	Sinus lift?	Torque (Ncm)	Immediate/delayed loading
Mangano et al. [14]	No	No	NA	Delayed
Romanos et al. [15]	No	No	NA	Immediate
Rodríguez et al. [16]	Yes (in 5 cases)[a]	Yes	NA	Delayed
Oliveira et al. [17]	Yes	Yes	NA	Delayed
Ormianer et al. [18]	Yes	Yes	NA	Immediate and delayed
Maló et al. [19]	No	No	35	Immediate
Buddula et al. [20]	Yes	NA	NA	NA
Nedir et al. [21]	No	Yes	35	NA
Manso and Wassal [22]	Yes	Yes	< 20	Delayed
Lambert et al. [23]	Yes	Yes	< 20	Delayed
Ridell et al. [24]	Yes	Yes	NA	Delayed
Valerón and Valerón [25]	No	No	NA	Delayed
Peleg et al. [26]	Yes	Yes	NA	Delayed
Degidi and Piattelli [27]	No	No	NA	Immediate
Krennmair and Waldenberger [28]	Yes	Yes	NA	Delayed
Simion et al. [29]	Yes	Yes	NA	Delayed
Attard and Zarb [30]	No	No	NA	Delayed
Attard and Zarb [31]	No	No	NA	Delayed
Hürzeler et al. [32]	Yes	Yes	NA	Delayed

[a] If buccal bone was damaged or missing, then GBR was performed

NA not available

atrophic posterior maxillae in the Peleg study [26] was ~98 %, the contribution of implant diameter in this regard remained masked. Similar arguments can be raised for studies by Buddula et al. [20], Simion et al. [29], and Attard and Zarb [31]. Further long-term clinical trials using dental implants with consistent diameters are warranted to clarify the role of implant diameter on survival of dental implants placed in posterior atrophic maxillae.

It has been reported that implant morphology and surface characteristics influence primary stability and long-term survival of dental implants [5, 6]. Studies [38–41] have shown that increased surface due to micro roughness enhances bone-to-implant contact early after implant placement. Implant surface roughness has been directly associated with an increased osteogenic response and degree of implant primary stability attained [42–44]. Results by Soskolne et al. [45] demonstrated that the numbers of monocytes attached to blasted titanium surfaces are significantly greater than those on machined surfaces. Furthermore, Butz et al. [46] showed that implant surface roughness influences the biomechanical quality of osseointegrated bone and that the bone integrated to the rough-surfaced implants is harder and stiffer than bone integrated to machined surfaces. All implants used in studies [14, 16–32] that fulfilled our eligibility criteria had rough (sandblasted and acid-etched or oxidized or hydroxyapatite coated) surfaces even though their diameters varied. This suggests that besides implant diameter, other factors, such as surface roughness of the implant, may also contribute in stabilizing implants in bone including posterior atrophic maxillae.

Several studies [47–52] have shown that tobacco smokers and immunocompromised individuals (such as patients with poorly controlled diabetes and individuals undergoing cancer therapy) are more susceptible to periodontal disease and implant loss as compared to individuals with well-controlled diabetes and nondiabetic individuals. Moreover, it has also been reported that habitual smoking impairs healing following periodontal surgical interventions [53]. From the studies [14, 16–32] included in the present review, we identified three studies [20, 26, 30] in which some participants undergoing dental implant treatment exhibited an immunocompromised health status. However, the CSR of implants placed in the entire population of each study ranged between ~80 and ~98 %. We were allured to speculate that these patients may have undergone periodontal therapy prior to implant treatment and were routinely seeking medications from their healthcare providers for their systemic disorders. This could have helped reduce the oral and systemic proinflammatory proteins thereby yielding high implant CSR [54]. Experimental results by Lee et al. [55] and Schlegel et al. [56] have also reported that implants with rough surfaces present a tendency to promote new bone formation in healthy and induced hyperglycemic conditions. Moreover, most studies in which implants were placed in smokers showed uneventful healing. It is probable that these patients either quit or significantly reduced their smoking habits following implant placement that enhanced implant CSR. However, further studies are warranted to assess

Table 3 Patients' habits and general health status in the studies included

Authors	Patients' habits and health status			
	Smokers	Bruxism	Poor oral hygiene/ periodontal disease	Medical health status
Mangano et al. [14]	35	24	None	Healthy
Romanos et al. [15]	8	None	None	Healthy
Rodríguez et al. [16]	301	4	None	Healthy
Oliveira et al. [17]	None	None	None	Healthy
Ormianer et al. [18]	None	None	None	Healthy
Maló et al. [19]	9	None	None	Healthy and patients with diabetes, CVD, HIV, and hepatitis C
Buddula et al. [20]	None	None	None	Head and neck cancer patients
Nedir et al. [21]	None	None	None	Healthy
Manso and Wassal [22]	10	None	None	Healthy
Lambert et al. [23]	4	None	None	Healthy
Ridell et al. [24]	None	None	None	Healthy
Valerón and Valerón [25]	None	None	None	Healthy
Peleg et al. [26]	None	None	None	Patients with diabetes and cardiovascular diseases were included
Degidi and Piattelli [27]	None	None	None	Healthy
Krennmair and Waldenberger [28]	None	None	None	Healthy
Simion et al. [29]	4	None	None	Healthy
Attard and Zarb [30]	7	None	None	Healthy (~50 % had controlled medical conditions)
Attard and Zarb [31]	152	None	None	Patients with diabetes, arthritis, and cardiovascular diseases were included
Hürzeler et al. [32]	None	None	None	Healthy

the long-term survival of dental implants placed in atrophic posterior maxillae of chronic smokers and immunocompromised individuals.

Studies on animal models [57–59] have demonstrated that sinus augmentations match with the biologic concept of GBR; however, implants are usually placed after approximately 6 months of GBR. In nearly 60 % studies, bone height under the maxillary sinus floor was 4–5 mm, and sinus augmentation protocols were adopted in atrophic posterior maxillae to increase the bone height for future implant placement. None of the studies included in this review used growth factors (GFs) as adjuncts to conventional GBR. Studies have shown that GFs exhibit the potential to enhance tissue regeneration by a series of events including cell chemo-attraction, differentiation, and proliferation [60]. The platelet- derived growth factor has a stimulatory effect on DNA replication and chemotaxis of osteoblasts, fibroblasts, leukocytes, monocytes, neutrophils, periodontal, and alveolar bone cells. This suggests that the use of GFs as adjuncts to conventional GBR in posterior atrophic maxillae expedites subantral bone formation as compared to when conventional GBR is used alone for sinus augmentation. However, further studies are needed in this regard.

Results reported in the present review are in accordance with those reported by Sohrabi et al. [61]. In this study [61], the authors reviewed the survival of NDI (diameter 3.5 mm or less). In total, 41 studies were assessed and the results showed that survival rates reported for NDI are comparable to those reported for standard WDI and were independent of the surgical technique adopted (flap or flapless surgery). However, the authors were unable to correlate implant survival rates with implant surface characteristics (machined and rough surfaces) since high survival rates were reported for all studies included in their literature review [61].

Conclusion

Within the limits of the present study, it is concluded that the role of implant diameter on long-term survival of dental implants placed in posterior maxilla is secondary. This is most likely due to the fact that other critical factors including implant surface roughness, implant insertion torque, achievement of sufficient primary stability at the time of implant placement, surgical protocol, and pre- and postsurgical oral hygiene maintenance also contribute in the long-term survival of dental implants placed in posterior atrophic maxilla.

Conflict of interest The authors declare that they have no conflict/s of interest related to the present study.

Appendix A: List of excluded studies (Reason for exclusion is shown in parenthesis)

Agliardi EL, Francetti L, Romeo D, Taschieri S, Del Fabbro M (2008) Immediate loading in the fully edentulous maxilla without bone grafting: the V-II-V technique. Minerva Stomatol 57:251–259, 259–263. (Short term results)

Anitua E, Orive G (2010) Short implants in maxillae and mandibles: a retrospective study with 1 to 8 years of follow-up. J Periodontol 81:819–826. (Short term results)

Balshe AA, Eckert SE, Koka S, Assad DA, Weaver AL (2008) The effects of smoking on the survival of smooth- and rough-surface dental implants. Int J Oral Maxillofac Implants 23:1117–1122. (Focused question not answered)

Becker W, Becker BE, Alsuwyed A, Al-Mubarak S (1999) Long-term evaluation of 282 implants in maxillary and mandibular molar positions: a prospective study. J Periodontol 70:896–901. (Short term results)

Block MS, Kent JN (1993) Maxillary sinus grafting for totally and partially edentulous patients. J Am Dent Assoc 124:139–143. (Review article)

Buddula A, Assad DA, Salinas TJ, Garces YI (2011) Survival of dental implants in native and grafted bone in irradiated head and neck cancer patients: a retrospective analysis. Indian J Dent Res 22:644–648. (Implant location in maxilla was unclear)

Choi SY, Jang YJ, Choi JY, Jeong JH, Kwon TG (2013) Histomorphometric analysis of sinus augmentation using bovine bone mineral with two different resorbable membranes. Clin Oral Implants Res 24 Suppl A100:68–74. (Short term results)

Cooper LF, Pin-Harry OC (2013) "Rules of Six"–diagnostic and therapeutic guidelines for single-tooth implant success. Compend Contin Educ Dent 34:94–98, 100–1; quiz 102, 117 (Review).

Corbella S, Taschieri S, Del Fabbro M (2013) Long-term outcomes for the treatment of atrophic posterior maxilla: A systematic review of literature. Clin Implant Dent Relat Res May 8. doi:10.1111/cid.12077. (Review)

Del Fabbro M, Rosano G, Taschieri S (2008) Implant survival rates after maxillary sinus augmentation. Eur J Oral Sci 116:497–506. (Review)

Di P, Lin Y, Luo J, Cui HY, Yu HY et al (2012) Effect of provisional restoration on shaping the contour of the soft tissue during maxillary single tooth implant procedure. Beijing Da Xue Xue Bao 44:59–64 (Article in Chinese).

Doan N, Du Z, Crawford R, Reher P, Xiao Y (2012) Is flapless implant surgery a viable option in posterior maxilla? A review. Int J Oral Maxillofac Surg 41:1064–1071. (Review)

Esposito M, Cannizzaro G, Soardi E, Pistilli R, Piattelli M et al (2012) Posterior atrophic jaws rehabilitated with prostheses supported by 6 mm-long, 4 mm-wide implants or by longer implants in augmented bone. Preliminary results from a pilot randomised controlled trial. Eur J Oral Implantol 5:19–33. (Short term results)

Fiorellini JP, Chen PK, Nevins M, Nevins ML (2000) A retrospective study of dental implants in diabetic patients. Int J Periodontics Restorative Dent 20:366–373. (Focused question not answered)

Froum SJ, Tarnow DP, Wallace SS, Rohrer MD, Cho SC (1998) Sinus floor elevation using anorganic bovine bone matrix (OsteoGraf/N) with and without autogenous bone: a clinical, histologic, radiographic, and histomorphometric analysis–Part 2 of an ongoing prospective study. Int J Periodontics Restorative Dent 18:528–543. (Short term results)

Jin PY, Lin Y, Qiu LX, Li JH (2005) Retrospective analysis of maxillary sinus augmentation for endosseous implants. Zhonghua Kou Qiang Yi Xue Za Zhi 40:441–444. (Article in Chinese)

Kanno T, Mitsugi M, Paeng JY, Sukegawa S, Furuki Y et al (2012) Simultaneous sinus lifting and alveolar distraction of a severely atrophic posterior maxilla for oral rehabilitation with dental implants. Int J Dent 2012:471320. (Short term results)

Lang NP, Pun L, Lau KY, Li KY, Wong MC (2012) A systematic review on survival and success rates of implants placed immediately into fresh extraction sockets after at least 1 year. Clin Oral Implants Res 23 Suppl 5:39–66. (Review article)

Maiorana C, Sigurtà D, Mirandola A, Garlini G, Santoro F (2005) Bone resorption around dental implants placed in grafted sinuses: clinical and radiologic follow-up after up to 4 years. Int J Oral Maxillofac Implants 20:261–266. (Short term results)

Migliorança RM, Coppedê A, Dias Rezende RC, de Mayo T (2011) Restoration of the edentulous maxilla using extrasinus zygomatic implants combined with anterior conventional implants: a retrospective study. Int J Oral Maxillofac Implants 26:665–672. (Short term results) Romanos GE, Nentwig GH (2009) Immediate functional loading in the maxilla using implants with platform switching: five-year results. Int J Oral Maxillofac Implants 24:1106–1112. (Short term results)

Naert I, Koutsikakis G, Duyck J, Quirynen M, Jacobs R (2000) Biologic outcome of single-implant restorations as tooth replacements: a long-term follow-up study. Clin Implant Dent Relat Res 2:209–218. (Short term results)

Nedir R, Bischof M, Vazquez L, Nurdin N, Szmukler-Moncler S (2009) Osteotome sinus floor elevation technique without grafting material: 3-year results of a prospective pilot study. Clin Oral Implants Res 20:701–707. (Short term results)

Nevins M, Langer B (1993) The successful application of osseointegrated implants to the posterior jaw: a long-term retrospective study. Int J Oral Maxillofac Implants 8:428–432. (Focused question not answered)

Olson JW, Dent CD, Morris HF, Ochi S (2000) Long-term assessment (5 to 71 months) of endosseous dental implants placed in the augmented maxillary sinus. Ann Periodontol 5:152–156. (Short term results)

Palarie V, Bicer C, Lehmann KM, Zahalka M, Draenert FG et al (2012) Early outcome of an implant system with a resorbable adhesive calcium-phosphate coating–a prospective clinical study in partially dentate patients. Clin Oral Investig 16:1039–1048. (Short term results)

Rokn A, Ghahroudi AR, Hemati S, Soolari A (2011) Comparison of peri-implant bone loss and survival of maxillary intrasinus and extrasinus implants after 2 years. J Dent (Tehran) 8:130–137. (Short term results)

Romanos GE (2004) Present status of immediate loading of oral implants. J Oral Implantol 30:189–197. (Review article)

Romanos GE, May S, May D (2014) Implant-supporting telescopic maxillary prostheses and immediate loading. Clin Implant Dent Relat Res 16:412–418.

Romanos GE, Nentwig GH (2008) Immediate loading using cross-arch fixed restorations in heavy smokers: nine consecutive case reports for edentulous arches. Int J Oral Maxillofac Implants 23:513–519. (Short term results)

Shatkin TE, Shatkin S, Oppenheimer BD, Oppenheimer AJ (2007) Mini dental implants for long-term fixed and removable prosthetics: a retrospective analysis of 2514 implants placed over a five-year period. Compend Contin Educ Dent 28:92–99; quiz 100–101. (Short term results)

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