Sinus Augmentation versus Short Implants in the Atrophic Posterior Maxilla: A Systematic Review of Patient Related Risk Factors

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ABSTRACT

Aim This systematic review was performed in an attempt to identify individual patient risk factors when deciding between these treatment modalities for the atrophic maxilla. The objective of this study was to provide complication-based treatment recommendations to help clinicians to make this decision by comparing the use of short implants or sinus augmentation procedures in conjunction with standard length implants.

Methods Online databases (Google Scholar, PubMed, Medline, Embase and the Cochrane library) were searched to identify Level 1 English language studies published since 2005 that assessed short and long term clinically assessed complications following surgery for implant placement in the posterior maxilla, involving sinus augmentation procedures in conjunction with standard length implants or short implants.

Results Of 76 articles identified, 20 were included. The complications identified were failure to integrate/loss of osseointegration, biological and technical complications. Patient-related risk factors were identified for some biological and technical complications. Short implants lead to fewer biological complications but carry a higher risk of technical complications.

Conclusions The available evidence does not allow for definitive treatment recommendations; however, several patient-related risk factors have been identified which should be considered when choosing a treatment modality. For sinus augmentation procedures these include amoxicillin allergy, sinus anatomy, preoperative sinus pathology, smoking, uncontrolled diabetes, and the use of anticoagulant medications in the presence of cardiovascular disease. Where short implants are used, a crown-to-implant ratio ≥ 2 and the use of implants with a diameter <4mm could lead to technical complications. Although these findings provide useful information for clinicians, much more research is needed in the future to formulate definitive clinical guidelines.

INTRODUCTION

Replacing lost teeth in the posterior maxilla with dental implants depends upon the availability of alveolar bone. Pneumatization of the maxillary sinus is a physiological process that is exacerbated by the loss of the maxillary molars. When coupled with the loss of alveolar ridge height that follows tooth extraction, it can lead to a deficiency in the bone height that is available for the placement of endosseous implants in the posterior maxilla (1). This lack of vertical bone height necessitates the use of either conventional length implants in conjunction with a sinus augmentation procedure or the use of short implants.

Procedures used to elevate the maxillary sinus floor were first published in the 1980s and have become the most common surgical intervention for increasing the amount of bone available for implant placement in this region (2). Variations in sinus augmentation protocols (including techniques and graft materials) make it difficult to define the procedure and draw conclusions (3). The available research surrounding both lateral and transcrestal approaches is unclear because success criteria and length of follow-up vary, making comparison difficult not just between the different approaches but also within the individual protocols (4). Therefore, for the purposes of this research, all surgical interventions involving the maxillary antrum that increase the volume of bone availability for implant placement will be considered as sinus augmentation.

The use of short implants has provided an alternative to sinus augmentation. The definition of short implants is subject to much debate. The latest Europe-

an consensus conference in 2016 in Cologne agreed that implants are short if their length is ≤8mm (5). Subsequent research has mostly intended to use this as the accepted definition. Controversy exists because there is evidence to suggest that within the range of implant lengths that are ≤8mm, the success rates vary as the implant length changes (6). It is therefore important to avoid forming broad clinical conclusions by grouping all the implants that are shorter than a defined length together. For the purposes of this research, however, the accepted definition of short implants is ≤8mm.

Despite comparable survival rates between short implants placed into native bone and standard implants that are placed using sinus augmentation (7), peri and post-operative complications exist that are specific to each treatment modality (8,9). There is a burgeoning evidence base of level 1 therapeutic studies (10) that describe the complications related to short implants and to sinus augmentation individually, categorizing the short- and long-term complications and associated risk factors. There is far less research available that compares the treatment options in the context of the occurrence of complications in the presence of certain risk factors, thus providing clinical indications for the use of each modality. Of the existing level 1 research, Xu et al. (11) compared standard and short implants but did not consider sinus augmentations. Of those that compare short implants and sinus augmentations, Thoma et al. (9) compared implant survival rates only. Additionally, several studies considered the complication rates between short implants and sinus augmentation groups (6,12,13). Nielsen et al. (14) compared implant survival and marginal bone loss. Cruz et al. (15) compared survival, surgical complication and prosthetic complication rates between short implants and sinus augmentation. Palacios et al. (16) compared marginal bone loss, implant failures and prosthetic failures between short implants and sinus augmentation groups. Although Yan et al. (17) looked at implant survival as a primary outcome, complications were considered in the outcomes, but these were not considered in the context of risk factors. Additionally, the defined length for short implants varies between these studies. Complications related to sinus augmentation studies can be broadly classified as relating to anatomy, pathology, or prosthetics (2). They can be further divided into intra-operative and post-operative complications which can be affected by pre-operative conditions. In 2010, Manor et al. (18) followed up sinus augmentation patients for at least a year and concluded that the intra-operative complications have a negligible long-term effect on the post-operative complications despite other studies describing potential and theoretical risks. It was found that anatomical factors and pre-operative sinus pathology were risk factors in the development of chronic sinusitis following sinus augmentation. This is one of the few available studies looking at risk factors for complications following sinus augmentation that combines a longer follow-up period of more than a year with a larger sample size of 137 individuals. It therefore stands to reason that short implants should be the preferred treatment modality in the absence of prosthetic risk factors. Where these risk factors exist, sinus augmentation might be considered. The anatomical and pre-operative conditions of the individual patient need to be weighed up when choosing the appropriate treatment for a patient with any of these risk factors.

Comparative studies that involve short implants in conjunction with sinus augmentation are less helpful because of the outcomes that they consider. However, there is a robust evidence base surrounding the complications associated with short implants and sinus augmentation individually that can be compiled and used to produce recommendations for indications of each treatment. The main difficulties in reaching this goal have been the small sample sizes available in the existing research and the lack of continuity in methodology that has been used to explore and thus compare these risk factors, as well as relatively short follow-up periods. The presence of multiple risk factors has been a challenge, with no way to statistically separate these. How this data translates to real world treatment guidelines is debatable due to intra-surgeon variability and the question of whether all risk factors can be accounted for in a privately funded, primary care setting (19). Patient factors such as bone density and further investigations such as blood tests may not be practicably viable, therefore it was decided that focusing on pragmatic factors would best lead to the production of clinical recommendations that are truly applicable to the majority of dentists providing implants for patients in a primary care setting. Without all the considerations, however, these recommendations may not be possible to make. If nothing else, this research may inspire further research that can one day lead to robust treatment guidelines.

Once risk factors were identified for each described complication, an attempt was made to formulate indications for implant placement in the posterior maxilla where ≤8mm bone height exists according to individual patient risk factors. Difficulties occurred in making recommendations for circumstances where multiple risk factors exist and therefore impair the production of definitive parameters for treatment choices. Without robust data that looks at the relative importance of each risk factor in relation to the other, it may be difficult to recommend anything further than exercising clinical judgement for certain circumstances.

The existing evidence base does not consider the individual patient's risk factors when considering the treatment modality of choice between short implants and sinus augmentation. The aim of this study is to provide indications for short implants or sinus augmentation based on each patient's complication-based risk factors. These recommendations will be especially useful in the presence of prosthetic risk factors, pre-operative sinus

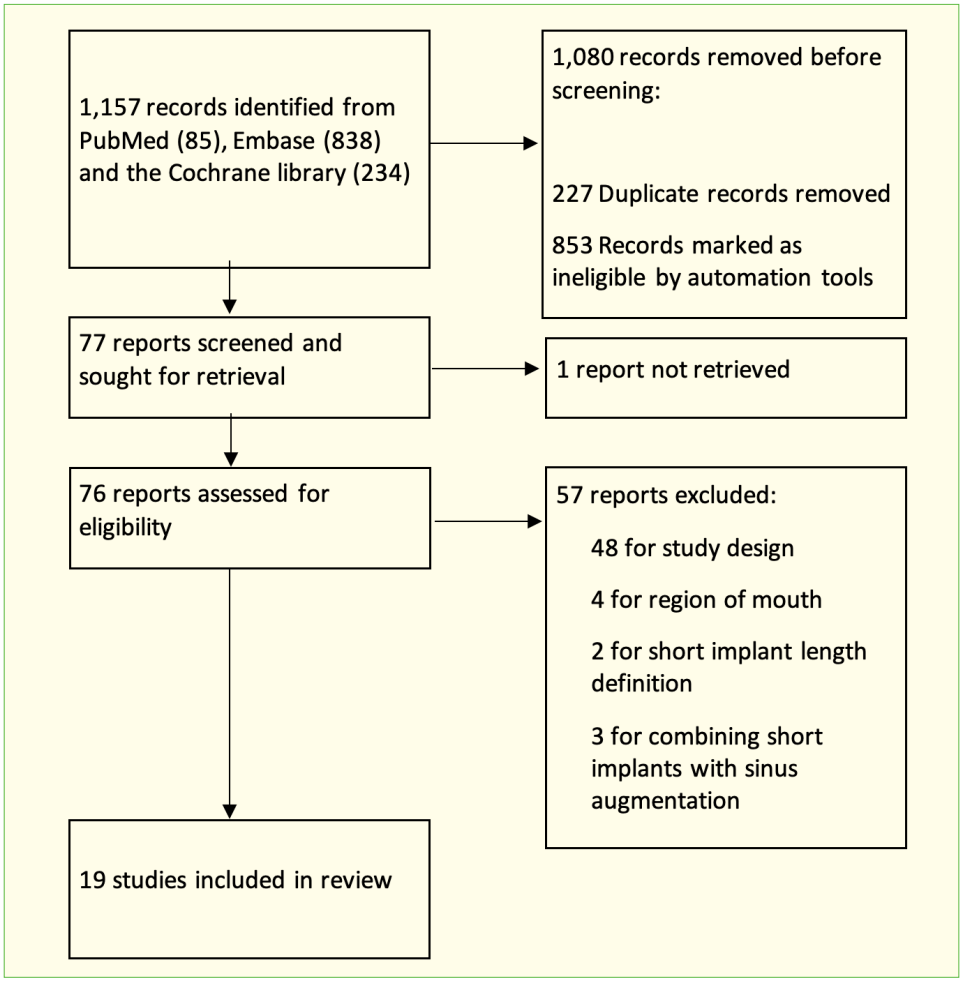

FIG. 1
Excluded Studies and Reasons for Exclusion.
Prisma Flow diagram showing the details of the data search, identification, and selection process.

conditions and anatomical factors in circumstances where choosing between short implants and sinus augmentation may not be straightforward.

MATERIALS AND METHODS

Study Design

The study design was a systematic review of studies that looked at risk factors for clinically assessed complications following short implants or sinus augmentation in the posterior maxilla.

Search Strategy

Online databases were used to search for qualifying studies (PubMed, Embase and the Cochrane library). A manual search of the papers cited in the studies identified by the electronic search was also carried out. The keywords and Boolean operators that were used to search the electronic databases were: ("implant" or "dental implant") AND ("short implants" OR "sinus augmentation") AND ("complications") AND ("posterior maxilla").

Screening

The inclusion criteria (Table 1) were level 1 English language studies published since 2005 that assessed short- and long-term complications following surgery for implant placement in the posterior maxilla involving sinus augmentation or short implants, not combining both modalities. Including these studies reduced the possible bias and this timeframe accounted for evolving implant designs and surgical technique trends. These studies also defined short implants as ≤8mm (if applicable) and considered short implant placement in the posterior maxilla only. This ensured that the conclusions drawn were not affected by anatomical differences in other parts of the mouth where short implants might be considered. The studies that matched the above criteria were reviewed to determine whether each clinically assessed complication could be attributed to individual patient risk factors.

The outcome measures were the established patient-specific risk factors that affect the clinically assessed complications arising from each treatment modality. This may allow for clinical guidance to be formed on indications for the use of short implants or sinus augmentation.

The screening of articles was conducted in two stages. Abstracts of articles were initially checked to see if they met the inclusion criteria. Full texts were then obtained and checked to see whether the publication was either judged to have met the selection criteria or if further clarification was needed. Included articles and their charac-

	Inclusion	Exclusion
Publication	English Language	Any language other than English
	Published since 2005	Published in or before 2004
Study Design	Level 1 Studies	Studies that are level 2 or below
	Studies that define short implants as ≤8mm	Studies that define short implants as >8mm
	Studies assessing implant placement in the posterior maxilla	Studies assessing implant placement in areas of the mouth other than the posterior maxilla
	Surgery involving sinus augmentation or short implants (≤8mm) but not both	Implant placement involving the combined use of short implants and sinus augmentation procedures
Study Outcomes	Studies assessing short- or long-term complications	Studies that do not assess complications following surgery for implant placement

The inclusion and exclusion criteria for the study "A Systematic Review of Sinus Augmentation Vs Short Implants"

TABLE 1. Inclusion and Exclusion Criteria

teristics were recorded in a table (Table 2). Excluded articles and reason for exclusion were recorded in a PRISMA flow diagram (Figure 1).

RESULTS

Quality Assessment

Seven of the twenty included studies were judged to be at high risk of bias. The short follow-up period of less than one year accounted for four of these (27,28,29,32), whilst two studies were funded by implant manufacturers and therefore at higher risk of funding bias (22,37). One study lost the majority of participants to follow-up, and although the follow-up period was four years, only 42 of the original 201 participants (20.8%) were followed up in the final year (35).

Complications

The complications observed in the included studies can be broadly divided into four categories (Table 3.):

1. General unspecified complications
2. Failure to osseointegrate or a loss of osseointegration of the implant
3. Biological complications
4. Technical complications

Despite implant survival and complications being categorised separately in some research (38), the loss of osseointegration of an implant can also be considered a biological complication (39). For the purposes of this study, implant survival and a failure to osseointegrate were therefore grouped together and considered to be one category of complications.

General unspecified complications

Esposito et al. (30) found that the sinus augmentation group experienced a greater number of complications at treated sites up to a year after loading than short implant groups. Fan et al. (21) notes a complication rate of 63% for sinus augmentation versus 10% for short implant. Imam et al. (31) reported a complication rate of 3.7% (4/106) for sinus augmentation. Sanz et al. (23) published a 14.3% sinus augmentation complication rate (36 complications in 252 surgeries for 217 patients receiving 406 implants) versus a 3.6% complication rate for short implants. In a randomised controlled trial (RCT) of 53 participants in 2017, Bechara et al. (20) found that over a three-year follow-up period, no implants in the short implant group failed to integrate or lost integration, however two implants lost integration in the sinus augmentation group. Both failures occurred within two months of surgery. Similarly, a systematic review by Thoma et al. (9) concluded that implants with sinus augmentation had up to a 17% higher failure rate than implants in native bone. However, the mean follow-up for the studies used to form this conclusion was only eight months.

Conversely, longer-term RCT with a follow-up of seven years by Hadzik et al. in 2021 (22) saw 100% survival in sinus augmentation and short implant groups at 3 years. After 3 years, two out of 15 implants were lost, both from the short implant group.

A systematic review by Sanz et al. (23) found no difference in survival between sinus augmentation and short implant groups at 18 months. However, it should be noted that only five RCTs of sufficient quality were included in the study. The outcome was supported by Yan et al. (17) where a systematic review with follow-up of greater than two years found no difference between sinus augmentation and short implant survival rates.

Two studies mentioned unspecified biological complications and discussed the difference in rates between sinus augmentation and short implant groups, with both reporting a higher rate of biological complications in the sinus augmentation group. A systematic review by Vetromilla et al. (26) reported a 2.5% biological compli-

Author & Year of Publication	Study Type	Short Implant Defined Length	Follow-up Period	Number lost to follow-up?
Bechara et al. 2017 (20)	RCT	6mm	3 years	1/53
Fan et al. 2017 (21)	Systematic Review	5-8mm	1-5 years	N/A
Hadzik et al. 2021 (22)	RCT	6mm	7 years	0
Sanz et al. 2015 (23)	Systematic Review	≤8mm	N/A	N/A
Shi et al. 2021 (24)	RCT	6mm or 8mm	3 years	26/199
Thoma et al. 2015 (9)	Systematic Review	≤8mm	8 months (mean)	N/A
Thoma et al. 2018 (25)	RCT	6mm	5 years	0
Vetromilla et al. 2021 (26)	Systematic Review	≤8mm	1-3 years	N/A
Yan et al. 2019 (17)	Systematic Review	≤6mm	3 years	N/A
Zhang et al. 2017 (27)	RCT	6mm	3 months	0
Barone et al. 2005 (28)	RCT	N/A	5 months	0
Danesh-Sani et al. 2016 (29)	Systematic Review	N/A	N/A	N/A
Esposito et al. 2014 (30)	Systematic Review	N/A	N/A	N/A
Imam et al. 2018 (31)	Systematic Review	N/A	1-2 years	N/A
La Monaca et al. 2018 (32)	RCT	N/A	6 months	0
Leung et al. 2021 (33)	Systematic Review	N/A	>2 years	N/A
Lie et al. 2015 (34)	RCT	N/A	2 years	0
Luongo et al. 2020 (35)	Prospective Cohort Study	N/A	Y (1-5 years)	year 1: 46/201, year 2: 42/201, year 3: 39/201, year 4: 32/201
Pommer et al. 2011 (36)	RCT	N/A	N/A	N/A
Tallarico et al. 2017 (37)	Prospective Cohort Study	N/A	Y (1 year)	1/30

TABLE 2. Characteristics of Included Studies This table lists the included studies, showing the authors and year, publication type, defined length of short implants, follow-up period and number of participants lost to follow-up.

cation rate in the short implant group versus 14.8% in the sinus augmentation group over 1-3 years. Similarly, although the focus of the study was on technical complications, Thoma et al. (25) reported a 5-year biological complication rate of 7.3% (9 out of 124 implants in 90 patients) in the sinus augmentation group versus 4% in the short implant group (5/124). These complications included the presence of fistula, swelling, infection and implant failure.

A systematic review by Sanz et al. (23) found an increased risk of biological complications in the sinus augmentation group, most of which were membrane perforations that did not compromise the outcome. They found that when these perforations were taken out of the 14.3% sinus augmentation complication rate, the complication rate dropped to 3.6% and was fairly equal between sinus augmentation and short implant groups. This data was based on short term data and so the potential long-term effects of the membrane perforations may not have been fully realised. Similarly, Tallarico et al. (37) reported zero failures in thirty sinus augmentations with one membrane perforation.

	Subcategory	Studies mentioning the complication (out of 20)
General unspecified complications		
	N/A	4
Failure to osseointegrate / loss of osseointegration		
	N/A	7
Biological		
	Unspecified	3
	Sinus membrane perforation	10
	Sinus infection	4
	Swelling	4
	Peri-implant bone loss, peri-implant mucositis and peri-implantitis	4
	Postoperative bleeding	2
	Intraoperative bleeding	2
	Graft failure	1
	Impaired healing	1
	Infection	1
Technical		
	Unspecified	5
	Screw fracture	4
	Ceramic chipping	4
	Screw loosening	3
	Crown decementation	3

TABLE 3. Referenced Categories and Frequencies of Complications for Short Implants and Sinus Augmentation Procedures. These are the categories and subcategories of the complications associated with short implants or regular length implants used in conjunction with sinus augmentation procedures.

Bechara et al. (20) reported a chronic sinus infection following sinus augmentation in 2% (1/45) patients. This was accompanied by complete graft loss and the loss of two implants. This was noted to be early, within two months of surgery, and having occurred on a smoker with periodontal disease. Fan et al. (21) listed sinusitis as a complication with sinus augmentation (63%) experiencing a higher complication rate than short implants (10%). Although the breakdown and consequences of these complications are unclear, they are all reported as being inflammatory in nature.

Bechara et al. (20) reported swelling alone in 31% of patients (14/45) following sinus augmentation and swelling accompanied with pain in an additional patient (7% of all patients with swelling, 1/14) compared to no swelling in the short implant group. They concluded that sinus augmentation has a significantly increased risk of swelling ($P<0.0001$) versus short implants following surgery.

Leung et al. (33) suggested a fourfold increase in the risk of swelling in the presence of uncontrolled diabetes in implant placement involving sinus augmentation. Luongo et al. (35) identified more swelling and bruising in the sinus augmentation group but found that this resolved within a week without any long-term implications. Thoma et al. (25) found an increased risk of biological complications including swelling following sinus augmentation versus short implants but did not specify the incidence.

Fan et al. (21) listed peri-implant bone loss, peri-implant mucositis and peri-implantitis amongst the inflammatory complications affecting implants following sinus augmentation and short implant placement but the incidence of each individual complication was not noted. Sanz et al. (23) concluded that the RCTs included in their systematic review had a follow-up that was too short to provide definitive data on peri-implantitis. Shi et al. (24) reported similar incidences of peri-implant mucositis of 25.8% (34/132) in the sinus augmentation group and 26.9% (18/67) in the short implant group. Likewise, peri-implantitis was reported to occur in only 5 patients, 3/132 (2.3%) in the sinus augmentation group and 2/67 (3%) in the short implant group. Yan et al. (17) grouped together peri-implant mucositis and peri-implantitis for data collection purposes and found an equal incidence between sinus augmentation and short implants of 13.8% (54/392). Anticoagulant medications and anti-platelet drugs are two aspects of anticoagulant therapy. Whilst anti-platelet drugs have shown no relevant increase in postoperative bleeding for implant procedures, anticoagulant medications can increase the risk of postoperative bleeding in major oral surgery. This is especially the case when combined with cardiovascular disease. Major oral surgery includes aspects of sinus augmentation such as raising extensive flaps or placing implants where osteotomy preparation might potentially extend outside the bony envelope. Therefore, anticoagulant medication is a risk factor for postoperative bleeding with sinus augmentation but not with short implants (33).

Bechara et al. (20) reported an incidence of intraoperative bleeding of 6.7% (3/45) in the sinus augmentation group versus none in the short implant group. They concluded that sinus augmentation has a significantly increased risk of postoperative bleeding ($P=0.049$) versus short implants following surgery. Leung et al. (33) confirmed that this risk is further increased in patients having sinus augmentation that have cardiovascular disease and are taking anticoagulant medications.

Leung et al. (33) noted an increase in complication rates in smokers undergoing sinus augmentation with bone grafting. They also found that patients with amoxicillin allergy experienced infection of the graft material (9/1,874 patients, 0.5%) versus no graft failures in patients

without amoxicillin allergy. Additionally, patients with uncontrolled diabetes were more prone to decreased graft turnover.
Leung et al. (33) also found impaired wound healing in sinus augmentation patients with uncontrolled diabetes as well as sinus augmentation patients that smoke. Both groups of patients were also found to be at higher risk of membrane exposure and flap dehiscence.
Thoma et al. (25) noted the incidence of biological complications that include infection in both the sinus augmentation and short implant groups but did not specify the rate of occurrence.
Despite Lie et al. (34) and La Monaca et al. (32) reporting no technical complications in their RCTs, most other studies involved some degree of technical complications. The nature of these was not specified in a few studies. Esposito et al. (30) found that there was insufficient evidence to form a conclusion about the rate of technical complications between sinus augmentation and short implant groups. Bechara et al. (20) had no prosthetic complications in sinus augmentation and short implant groups in three years. Sanz et al. (23) identified a 2% prosthetic complication rate in the short implant group and 0% in the sinus augmentation group. In 2015, Thoma et al. (9) found complication rates to be similar between sinus augmentation (1.8%) and short implants (3%). In 2018, Thoma et al. (25) found a 5-year technical complication rate at patient level to be 47.7% for short implants and 30.4% for sinus augmentation.

Patient Related Risk Factor	Complication
Anterior regions of the sinus with steep walls	Higher risk of perforation
The presence of blood vessels in the sinus walls	Higher risk of bleeding
Preoperative sinus pathology (membrane thickness >2mm)	Higher risk of infection
Smoking cigarettes, and perhaps electronic cigarettes through the similar oxidative stress that they create (33)	Higher risk of infection, impaired healing, and excessive pain.
Uncontrolled diabetes	Higher risk of swelling, graft failure, infection, bleeding, and impaired healing
Amoxicillin allergy	Higher risk of graft failure
Anticoagulant medications in the presence of cardiovascular disease	Higher risk of bleeding

TABLE 4. Patient related risk factors that can lead to complications in sinus augmentation procedures. These are the patient related risk factors and the complication each cause when sinus augmentation procedures are performed for dental implant placement.

DISCUSSION

The primary research studies that were included had relatively small sample sizes and/or short follow-up periods. This was further underlined by the systematic reviews included which cited the lack of homogeneity of studies, small sample sizes and short follow-ups as reasons for the low quantity of data available for analysis. Better quality, more standardised, larger primary studies need to be done to compare sinus augmentation and for short implants over a longer period. The outcome measures need to be standardised to produce sufficient data regarding complications.
Further factors that have not been standardised but could significantly influence the outcomes of sinus augmentation and short implant studies include:

- Techniques used for sinus augmentation- approach (transcrestal versus lateral window), graft materials and instrumentation (40).
- Implant design, including prosthetic connection and implant diameter.
- Prosthetic design, including materials, occlusal schemes, single units versus splinted restorations.
- Oral hygiene compliance and status of subjects.

Complication rates are higher for sinus augmentation than short implants. Data regarding failure to integrate and loss of integration is conflicting and short term. Even in studies that were primarily aimed at determining the difference in survival rates between sinus augmentation and non-augmented implants in the posterior maxilla, not enough heterogenous studies were found that would allow for meta-analysis of the data. The follow-up period of the included studies was less than three years. The conclusion was, however, that implant survival appears to show greater variability in grafted sinuses (36%-100%) than in the posterior maxilla (non-grafted, 75%-100%) (41). This does not take implant length into account. A meta-analysis that looked at the survival rates of short implants for up to five years found that short implants were found to have higher variability and lower predictability in survival rates compared to longer implants (86.7%-100% survival for short implants versus 95%-100% for longer implants) (42). It remains to be seen which is the case when studies are done over a longer period and with both the factors of native bone and implant length considered. Two groups in this study (20,22) cited patient factors as reasons for failures. This suggests that the loss of integration was possibly due to smoking, poor oral hygiene, and periodontal factors or to a lack of compliance but is not specific to sinus augmentation or short implants.
Biological complication rates are higher in the sinus augmentation group and are mainly related to membrane perforations. There also appeared to be a greater risk of biological complications with the lateral window versus the transcrestal approach (33). A meta-analysis of 1652

sinus surgeries revealed a perforation rate of 1/4 (25%) and concluded that an appropriately handled and treated membrane perforation shows comparable survival to an intact membrane. The use of piezo instruments, approach (lateral versus transcrestal), anatomical considerations, surgeon experience and presence of sinus pathology were stated as factors in membrane perforation (40). Other risk factors for complications for sinus augmentation are listed in Table 4.

The variation in reporting criteria and case definitions for peri-implant diseases is well documented (43) and makes it impossible to draw conclusions about the incidence and risk of peri-implant diseases for sinus augmentation and short implant groups. However, the more homogenous and defined data collected within each study included in this paper suggested that sinus augmentation and short implant groups experienced little difference between them regarding peri-implant diseases.

Technical complications are difficult to assess due to the lack of information regarding implant and restoration designs, incidence of each type of complication and the lack of long-term follow-up data. Despite the results suggesting no difference in technical complication rates between sinus augmentation and short implants, the background research included in some of these studies suggested that the increased crown-to-implant ratio (C/I) for short implants may be of significance.

From the limited and sometimes conflicting evidence available, a C/I of up to two is suggested to be acceptable and does not increase the risk of complications (26). High C/I prosthetic reconstructions seemed to carry a higher risk of technical complications without added risk to biological outcomes or survival rates (23). Non-axial forces or overloading can lead to prosthetic complications where an inappropriate C/I exist, but the effect of this can be mitigated using wider diameter implants of 4-8mm (17). Thoma et al. (25) suggest that the technical complications resulting from inappropriate C/I when using short implants are likely to occur between year one and three post-loading so restorations should be monitored more closely in this time. Earlier and later than this, the technical complication rates between sinus augmentation and short implants appear to be similar. This also explained why, and is acknowledged within the study, shortened follow-up periods of less than twelve months show no difference between sinus augmentation and short implants in this regard (9).

CONCLUSION

This study attempted to form treatment recommendations when the research into this field is in its relative infancy and not advanced enough to produce the quality and volume of data to allow for definitive recommendations. The available evidence did not allow for definitive treatment recommendations relating to the sinus augmentation or short implants as the preferred treatment modality when replacing missing teeth with implants in the posterior maxilla, where there exists a lack of vertical bone height to support standard length implants >8mm according to individual patient risk factors. However, along with patient and clinician opinion and preference, the patient factors in Table 4 should be considered when making this decision. Pre-operative cone-beam computerised tomography can help to identify anatomical features and pathology that can reduce the risk of complications especially when considering sinus augmentation.

If short implants are used, implants should be of wider diameters where possible, and restorations should be monitored particularly closely for prosthetic complications between years one and three post-loading.

This question should be revisited when a greater volume of long term, high quality, standardised data has been collected via research that is designed to answer this question for each risk factor and each treatment modality. Until then clinicians will have to use their best discretion when choosing between sinus augmentation and short implants.

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