Bone Formation after Sinus Membrane Elevation and Simultaneous Placement of Implants without Grafting Materials – A Systematic Review

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ABSTRACT

Background: Rehabilitation of the atrophied edentulous maxilla is complicated. Often the residual bone height is insufficient for implant placement due to crestal bone resorption and pneumatization of the sinus. The most common treatment has been a two-stage surgery using autogenous or synthetic grafting materials placed in the maxillary sinus before implant therapy. The sinus lift technique was introduced by Boyne et al. (1980) and much research has been done to evaluate this technique where the implants have been placed emerging into the sinus without grafting. This paper consists of a review of the literature available on sinus membrane elevation with simultaneous implant placement without the use of grafting materials and a comparison between lateral approach sinus floor elevation (LASFE) and osteotome sinus floor elevation (OSFE).

Materials & Methods: PubMed was used as database to search for articles. Also, relevant journals and systematic reviews were evaluated. Clinical studies with sinus lift without grafting materials with simultaneous implant placement were included. A minimum of 6 months follow-up was an inclusion criteria. Experimental studies and studies with less than ten implants were excluded.

Results: 22 articles were included, nine studies using LASFE and 13 using OSFE. The implant survival rate was 98.9% and 97.9% respectively. The MBL was 0.4 – 2.1±0.5 mm for LASFE and 0.2±0.8 – 1.4±0.2 mm for OSFE. New bone formation was 1.7±2.0 – 7.9±3.6 mm and 2.2±1.7 – 4.5±1.9 mm respectively.

Conclusion: This review shows that grafting materials are not necessary to achieve a high implant survival rate. Some advantages with the less invasive non-grafting method are a decreased patient discomfort and a shorter treatment time. Both LASFE and OSFE without grafting have good outcomes. The surgeon should choose technique considering personal experience and the individual patient situation.
INTRODUCTION

Tooth loss can be caused by dental caries and periodontal disease, but also by trauma and other diseases in the oral cavity (Lesolang et al., 2009). The loss of teeth results in a resorption of the alveolar crestal bone and in the posterior maxilla in some cases it also triggers the maxillary sinus to expand (Sharan and Madjar, 2008). The crestal bone resorption in combination with the pneumatisation of the maxillary sinus leads to a reduced alveolar bone height in the posterior maxilla (Borges et al., 2011). Implant therapy is a common way of rehabilitating this area. However, to achieve good primary and secondary implant stability, the treatment is dependent on a certain amount of crestal bone to be successful (Corbella et al., 2013). Therefore, different methods have been practiced to reconstruct the edentulous maxilla with a severely resorbed crestal bone height with implant therapy.

One treatment method is to increase the volume of the bone by either grafting the area with synthetic or allogene bone, or to use an autogenous transplant. This is a two-stage method and was introduced by Tatum (1977) and Boyne et al. (1980) among others. The graft is, after surgery, left to heal and controlled by radiographs before replacing lost teeth with implants.

Unfortunately, harvesting autogenous bone often causes much discomfort for the patient and is also related to several risks. One risk is morbidity in the area where the graft is harvested. Other risks are postoperative bleeding and increased risk for infection (Boffano and Forouzanfar, 2014). Furthermore, cases of acute maxillary sinusitis have been reported (Alkan et al., 2008) and also cases of hematomas, disturbed wound healing and sequestration of bone in the sinus (Timmenga et al., 2001). A disadvantage using non-autogenous grafting materials such as BioOss; derived bovine bone, which is very similar to human bone, is the cost. Since the rehabilitation of the edentulous maxilla with implants is already an expensive treatment, using grafting materials will add to the cost resulting in a greater financial burden for the patient (Thor et al., 2007). Treating the edentulous maxilla without bone grafting would have certain benefits such as a shorter overall treatment time, more cost efficiency and a less invasive procedure.
Some studies have shown that placement of the implant in to the sinus without grafting materials can stimulate new bone formation in the sinus cavity (Lundgren et al., 2004). This is possible when a blood clot is isolated in an enclosed space, where the grafting materials usually is placed. The blood cells induce new bone formation by stimulating the bone precursor cells to evolve to osteoclasts. The activated osteoclasts in their turn activate the bone forming osteoblasts to start producing bone (Borges et al., 2011). Two techniques have been identified; the lateral technique (LASFE) and the osteotome technique (OSFE).

With the lateral technique a window is opened in the lateral sinus wall (Figure 2) into the maxillary sinus with care taken to avoid tearing of the sinus membrane. The sinus membrane is then carefully dissected off the bone walls and held up while the implant is placed into the sinus cavity through the alveolar crest. The sinus membrane, also called the Schniderian membrane, is then positioned to rest on the implant, which will function as a tent pole. The bony wall is replaced and the mucoperiost flap is sewed back at its place (Lundgren et al., 2004). The membrane, the sinus floor and the lateral wall form an enclosed space for the blood clot, which stimulates new bone formation.

The osteotome technique is based on a crestal approach (Figure 3). This technique is described in a report by Bruschi et al. (1998). The incision is made on the alveolar crest and the implant preparation in the bone is made with a regular implant drill. Different osteotomes are then used to elevate the Schniderian membrane on the sinus floor through the prepared entrance. When the implant is placed, it lifts the membrane and holds it up with the aim to keep the membrane intact. All implants have a flat-top design which reduces the risk of perforating the Schniderian membrane when placing the implant. However, perforations can be caused while dissecting the membrane from the bone wall in the sinus if the surgeon is incautious.

In events where the membrane is perforated the size of the perforation decides whether it needs to be repaired or can be left to heal (Thor et al., 2007). Some studies have shown that sinus membrane perforations have no impact on the implant survival rate if treated appropriately. Apart from the membrane perforation, there is no other evidence of long-term implant or sinus-related complications after sinus elevation.
with simultaneous implant placement when using either the osteotome or the lateral technique (Al-Almaie et al., 2013).

The residual bone height at the implant placement site is of great importance when choosing implant length when using both OSFE and LASFE techniques. A lower RBH requires a shorter implant. According to Fenner et al. (2009), a more predictable osseointegration is attained if the RBH is higher than 6 mm, although RBH lower than 4 mm did not hinder osseointegration of the implant. Implants placed at sites with a lower RBH than 6 mm had more failures. Also, the crestal bone loss was significantly lower at sites where the RBH was higher than 8 mm.

When an implant is installed, there is always some loss of crestal bone at the implant site. This phenomenon is called “crestal bone loss”. There are no full investigations of the factors that cause this bone loss but plaque accumulation around the abutment has been discussed, as well as subgingival placement of the implant abutment interface (Barboza et al., 2002). In cases where the crestal bone loss is high this can lead to implant failure.

Different methods can be used when evaluating the stability of a dental implant. To evaluate the primary stability of the implant, the resonance frequency analysis (RFA) can be used. Using RFA, the level of osseointegration of the implant is measured. A transducer is connected to the implant, which produces a vibration at the abutment site. The vibration that appears in the implant is then analyzed and translated into an ISQ (implant stability quotient) value (Meredith et al., 1997). ISQ values for implants that are successfully integrated range from 57 to 82 (Park et al., 2011; Degidi et al., 2012).

The insertion torque is another method to evaluate primary implant stability. The torque value is a measurement of the bone quality at the implant site, the cutting ability of the implant and the friction between the implant surface and the bone. The torque value is measured in Newton. The insertion torque is measured continuously whilst inserting the implant. Good bone quality, high friction between the implant and the bone and a wide diameter of the implant compared to the prepared bone site are factors that result in a high insertion torque. A high insertion torque signifies good primary stability of the implant (Park et al., 2011).
A method to evaluate the secondary implant stability is to measure the mean bone gain on the sinus floor. The bone height is measured at baseline and thereafter at different follow-up periods. The bone gain or loss is then possible to calculate. For these measurements different radiographs are needed. Intraoral radiographs can be used, although it can be difficult to compare bone height at baseline and at follow-up as this requires that the radiographs are taken from exactly the same angle. With the use of a CBCT the precision of the measurements is much higher. Also, it allows for a 3D-analysis of the sinus structures (Fornell *et al.*, 2012).

Implants can be either tapered or not. There are also different implant surfaces to choose from when planning the implant treatment. Some implants are smooth-surfaced whilst other are rough on the surface. Rough implant surfaces can be achieved by blasting, acid etching or using different coatings (Cochran DL, 1999). The implant shape and surface can have an impact on the implant stability and the amount of new bone formation, which is reflected on in the discussion.

The aim of this study is to investigate the bone formation in the sinus elevation procedure without the use of grafting materials and simultaneous placement of implants. It also intends to compare the lateral and the osteotome techniques, to discuss which of the methods is more preferable and to evaluate the clinical outcome of the method for sinus membrane elevation with simultaneous implant placement without the use of grafting materials.

**MATERIALS & METHODS**

PubMed is a database containing scientific articles, primarily on life science and biomedical topics. This database was used to search for published articles about the sinus lift procedure. Different key words were used such as “sinus floor elevation”, “osseointegration” and “maxillary sinus”. The key words were inserted in the PubMed search-builder as medical subject headings (MeSH). MeSH-terms are used when searching for scientific articles as a thesaurus to facilitate the search process.
Search strategy:
The first search was to find MeSH-terms related to our subject. The MeSH-terms found and used for further searching were; "paranasal sinuses", "membranes", "osteogenesis", "dental implants", "maxillary sinus", "sinus elevation", "osseointegrated implants", "maxillary sinus floor augmentation", "bone formation", "sinus membrane", "sinus membrane lift" and "implant therapy". These MeSH-terms were combined in different constellations and used in the PubMed search builder. The combinations used were:

- “paranasal sinuses” AND “membranes” AND ”osteogenesis” AND ”dental implants”
- ”dental implants” AND ”maxillary sinus” AND “membranes”
- “osteogenesis” AND “paranasal sinuses”
- “osteogenesis” AND “maxillary sinus” AND “dental implants”

These combinations yielded 413 articles.

The advanced search function in PubMed was also used. Here, the search was restricted to only “Title/Abstract” in the builder field. The following combinations were used:

- “sinus elevation” AND “dental implants”
- “osseointegrated implants” AND “maxillary sinus”
- “maxillary sinus floor augmentation” AND “bone formation” AND “sinus membrane”
- “maxillary sinus” AND “sinus membrane elevation” AND “bone formation” AND “dental implants”

These combinations yielded 72 new articles.

The language of the studies in the search was restricted to English.
Defining the criteria

Some articles were directly excluded after reading only their titles, as they were not relevant to the subject. Abstracts of the articles not excluded at the first stage were read. Thereafter further articles were excluded based on irrelevance. At this stage there were 51 articles left, and the inclusion and exclusion criteria were defined.

Inclusion criteria

Studies on sinus elevation with and without bone graft were considered. Also, studies on implants placed in the maxillary sinus regardless of number of implants placed in the same sinus were considered. Studies made on less than ten implants were excluded as well as studies with a follow-up period of less than 6 months. Studies on sinus elevation without simultaneous implant placement were not relevant for this review and were also excluded, as were experimental studies.

Twenty-five articles were included for full-text reading. After reading these, three more articles were excluded, as they did not fulfill the inclusion criteria.

After summarizing all articles, a table for the results was made in excel. All data was inserted in the tables.

Level of evidence

There are different levels of scientific evidence in studies depending on how a study is designed (Figure 1). The highest level of evidence is a meta-analysis. A meta-analysis is a statistical method, where the results from different independent original studies are pooled together. All the studies have the same hypothesis and the same study design, with the aim to identify patterns and differences of different treatments. The second highest level of evidence is a systematic review. It differs from the meta-analysis in the presentation of the studies included. A search strategy is presented for others to replicate the search and find the same articles. Also, inclusion criteria are defined to narrow the search. In a systematic review the included studies are presented individually in a table or a graph (Uman, 2011). When a systematic review results in several articles with comparable outcomes, a meta-analysis can be made. The highest level of evidence in an original study is a randomized controlled trial (RCT) (Bolton, 2001). The study is designed to decrease the risk of bias as the
participants are randomized into either a test-group or a control group without knowing which group they belong to. This study design is called a blinded study. Sometimes RCTs are double-blinded which has an even higher level of evidence. The clinicians in a double-blinded study are not aware of which participants belong to which group (Si et al., 2013).

This paper is a systematic review. Due to the different study designs in the included articles, a meta-analysis could not be made. Of the 22 studies included we had three randomized controlled trials (RCT), five prospective studies, four retrospective studies, one case-series report and one follow-up study. In eight of the clinical studies the study type was not defined. Since this review includes three RCTs, the evidence level is high (Ib). The highest evidence level (Ia) is reached when including a meta-analysis of randomized controlled trials, which was not the case in this review (Shekelle et al., 1999).

**Ethical considerations**

Since this paper is a systematic review and is based on previous patient studies, there were no ethical dilemmas in the compilation of the patient data.

**RESULTS**

A summary of the article selection is shown in Figure 4. After the first search, 51 articles were selected for abstract reading. Thereafter, 25 articles were applicable to the inclusion criteria. All 25 articles were read in full-text, which lead to an exclusion of another three articles leaving a total of 22 articles included in this review.

A compilation of all data is presented in Table 1. The studies are divided into two different tables presenting the different techniques used when elevating the sinus membrane; LASFE (lateral approach sinus floor elevation) (Table 2) and OSFE (osteotome sinus floor elevation) (Table 3).
LASFE

The studies on LASFE are presented in Table 2. Here, a total of nine articles were included. Two of these were comparative studies of implant installation with and without grafting in the sinus. The articles studied included a total of 618 implants placed in sinuses with simultaneous elevation using the lateral technique. Implant length varied from 9 to 18 mm and the mean residual bone height (RBH) ranged from 4.0 to 7.5±2.2 mm. The mean follow-up time was 23 months with 6 months as the shortest follow-up time and 5 years as the longest. Marginal bone loss (MBL) was measured in four of the studies and varied from 0.4 to 2.1±0.5 mm. Bone regeneration was detected in all studies ranging from 1.7±2.0 to 7.9±3.6. In cases where ISQ was registered the implants showed good primary stability. Sinus perforations were noted in three of the studies. The mean implant survival rate was 98.9%.

OSFE

The studies on OSFE are presented in Table 3. Here, a total of 13 articles were included. Three of the studies compared sinus elevation with and without grafting. Altogether 542 implants placed using no grafting materials were studied in the articles. Implant length varied from 6.0 to 14.5 mm and the mean RBH ranged from 2.4±0.9 to 10.4±0.7 mm. The shortest follow-up time was 9 months and the longest was 5 years, resulting in a mean follow-up time of 23.3 months. After implant installation the MBL was measured and ranged from 0.2±0.8 to 1.4±0.2 mm, although this was not measured in two of the studies. Similar to the LASFE technique new bone formation (NBF) was detected and registered ranging from 2.2±1.7 to 4.5±1.9 mm. In two of the studies NBF was not measured but the results were predictable. Sinus perforations were noted in seven of the studies (Table 3). All studies together had an overall mean survival rate of 97.9%.

DISCUSSION

This systematic review, where sinus membrane elevation with simultaneous implant placement without the use of grafting materials has been studied, shows that a high
implant survival rate can be achieved without grafting materials (Table 1). New bone formation around the implant in the sinus cavity can be predicted using either LASFE or OSFE (Table 2 and 3).

Comparing the two techniques, LASFE and OSFE, this review shows that the marginal bone loss was greater using the LASFE technique. Using the LASFE technique the MBL varied from 0.4 to 2.1±0.5 mm, whereas with the OSFE technique the MBL varied from 0.2±0.8 to 1.4±0.2 mm. Since the LASFE technique requires a mucoperiostal flap and is more invasive than the OSFE technique, the expected inflammation during healing is greater than the inflammation after implant placement with OSFE. This inflammation can cause a more pronounced bone resorption, which may explain why the MBL was greater in the studies where LASFE technique was used.

However, the LASFE technique yielded more new bone formation (7.9±3.6 mm) than the OSFE technique (4.5±1.9 mm). The dissection of the Schneiderian membrane from the sinus wall using LASFE technique may yield a larger space for the blood to accumulate than the space using OSFE technique. A greater amount of blood cells can result in a higher activation of osteoclasts, which eventually leads to more osteoblast stimulation, and hence, more new bone formation. The survival rates between the two techniques were nevertheless comparable.

Perforations of the Schneiderian membrane were not presented in all the studies (Table 1). Still perforations were observed using both techniques. Smaller perforations did not seem to affect the implant survival rate (Schmidlin et al., 2008). Implants in sinus cavities with larger perforations, however, were often excluded from the studies (Si et al., 2013), meaning that large membrane perforations could have a negative impact on the implant survival rate.

The OSFE technique seems to be the most comfortable option from a patient point of view (Nedir et al., 2013). The technique is less invasive and no mucoperiostal flap is needed, thus the patient discomfort, implant healing time and postoperative pain are most likely decreased. The disadvantages with the OSFE technique could be a limited view of the operation field, which can lead to unnoticed accidental membrane
perforations resulting in a lower survival rate. Also, the OSFE technique makes it difficult to repair eventual perforations of the sinus membrane.

Using the LASFE technique, the surgeon has a better view of the operation field. Dissection of the Schneiderian membrane is easier and perforations of the membrane can easily be noticed and repaired when occurring. Since this technique is more invasive it is also more technique sensitive and more dependent on the surgeons skills. Also, the postoperative discomfort for the patient is greater due to the necessity of a mucoperiostal flap and additional drilling in the bone when creating the lateral window.

When using grafting materials, the golden standard is to use autogenous bone, which is correlated with donor-site morbidity, uncontrolled resorption and limited availability (Borges et al., 2011). However, Nedir et al. (2013) concluded that the use of grafting materials resulted in a greater bone gain, although it was not a prerequisite for new bone formation. The study by Lai et al. (2010) showed that the use of grafting materials had no significant impact on the implant survival rate compared to sinus elevation without grafting materials, but the grafting material could be used to maintain the space under the Schneiderian membrane. This review shows that there is no need for grafting materials to achieve a predictable result with good implant survival and new bone formation. Also, using the LASFE and OSFE techniques without grafting materials can reduce additional treatment cost and greater patient discomfort can be avoided.

The influence of the implant shape and surface on new bone formation and implant stability has been discussed in some of the articles included in this review. According to Nedir et al. (2013) the use of tapered implants gave better primary stability and less crestal bone loss than non-tapered implants. Moreover, the tapered shape of the implant could prevent the implant from sinking into the sinus when loaded (Kim et al., 2013). Cochran (1999) concluded that a rough implant surface lead to a better contact between the bone and the implant compared to smooth surfaces. Still, Cochrane also reached the conclusion that both smooth and rough titanium implants could achieve high success rates, as well as hydroxyl apatite-coated implants.
The choice of technique between LASFE and OSFE has been dependent on the residual bone height. Some authors (Corbella et al., 2013, Pjetursson et al., 2009) have shown that the OSFE technique is the method of choice when RBH is greater than 5 mm and dissuade the use of OSFE when the RBH is less. The limited view of the operation field has been discussed as a disadvantage with the OSFE technique as it demands a more experienced surgeon to achieve a successful treatment result if RBH < 5 mm. The LASFE technique has been the recommended technique when RBH < 5 mm as it facilitates the implant placement thanks to a better view of the operation field (Corbella et al., 2013). However, Nedir et al. (2013) showed that the osteotome technique could be used even in severely atrophic maxilla with good outcome.

It seems to be more convenient to use OSFE when RBH is > 5 mm, but Nedir et al. (2009, 2013) and Al-Almaie (2013) have shown that OSFE is also applicable in cases where RBH < 5 mm. This implies that there is no correlation between RBH and choice of technique. If this is the case, LASFE technique should be used only in cases where a good view of the operation field is required, since this method is more invasive and causes more patient discomfort than OSFE. However, the surgeon should always consider his or hers experience and knowledge before choosing technique and also take into consideration the number of implants intended to be placed in the same sinus. The LASFE technique can be preferable when placing numerous implants, as the view of the operation field is more favorable.

The correlation between implant survival rate and RBH has been discussed in many articles. In a study by Lai et al. (2010) there was no significant difference in survival rate with implants placed in sites with RBH < 4 mm and implants placed in sites with a greater RBH. However, Pjetursson et al. (2008) reported that the implant survival rate was significantly lower in sites with RBH < 4 mm. This was also shown earlier in a study by Rosen et al. (1999) where the survival rate dropped from 96% to 85.7% when RBH was < 4 mm. A study made by Summers (1998) showed similar results, where two out of six implants placed in sites with RBH lower than 4 mm where lost. In conclusion, the implant survival rate can be affected by many different factors and RBH cannot be singled out as the only factor for implant survival.

Some authors have shown in their studies that the RBH can affect the outcome of NBF as the new bone formation is dependent on the amount of pressure that the
crestal bone is exposed to during implant installation. The pressure is measured in microstrains. According to Kim *et al.* (2013), the bone formation is greater than the bone resorption when the pressure on the bone is between 1500 and 3000 microstrains, which will result in a more pronounced NBF. However, microstrains ranging from 50 to 1500 result in equilibrium between bone formation and bone resorption, leading to a less pronounced NBF. Kim *et al.* (2013) and Balleri *et al.* (2010) have both shown in their studies that RBH < 5 mm resulted in greater NBF than in sites with RBH > 5 mm. In sites with RBH < 5 mm the occlusal load was in the range favourable for new bone formation. A thicker bone (> 5 mm RBH) is more tolerant to pressure, hence the load will not be enough to reach microstrains favorable to new bone formation.

In this systematic review, there was no significant difference in implant survival rate between implants placed in sites with RBH < 4 mm and implants placed in sites with RBH > 4 mm. Also, a more reduced RBH may result in greater NBF. However, there are yet relatively few publications on LASFE and OSFE compared to the traditional two-stage technique involving grafting materials.

**Conclusion**

Both LASFE and OSFE without the use of grafting materials have good outcomes and are predictable. The advantages with these graftless techniques are many. For one, they are less invasive as no graft needs to be harvested in another area of the body, which leads to less morbidity and a decreased risk for complications. Also, the overall treatment time is shorter and the techniques are more cost effective compared to the traditional technique using grafting materials. The implant survival rates are high and there is no need for grafting materials to achieve new bone formation. The surgeon should choose technique, LASFE or OSFE, considering personal experience and knowledge and also take into account the individual patient situation.
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REFERENCES


Table 1: A compilation of the 22 articles. W/wo = with/without graft; all data in orange represent cases with graft. RBH = residual bone height, MBL = marginal bone loss, NBF = new bone formation, ISR = implant survival rate, perf = number of perforations of the Schneiderian membrane. Numbers in red mark patients and data where grafting materials have been used.

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<th>Artikel</th>
<th>Year</th>
<th>Study Type</th>
<th>No. of Patients</th>
<th>No. of Implants</th>
<th>Technique</th>
<th>w/wo graft</th>
<th>Mean RBH (mm)</th>
<th>Mean Follow-up (months)</th>
<th>Implant Length (mm)</th>
<th>MBL (mm)</th>
<th>NBF (mm)</th>
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<td>181</td>
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<td>7.5±2.2</td>
<td>36</td>
<td>4.1 ±2.4/1.7 ±2</td>
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<td>10.8%</td>
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<td>6.5±2.4</td>
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Table 2: A compilation of studies made using the lateral approach sinus floor elevation technique. W/wo = with/without graft; all data in orange represent cases with graft. RBH = residual bone height, MBL = marginal bone loss, NBF = new bone formation, ISR = implant survival rate, perf = number of perforations of the Schneiderian membrane. Numbers in red mark patients and data where grafting materials have been used.

<table>
<thead>
<tr>
<th>Artikel</th>
<th>Year</th>
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<th>No. of Patients</th>
<th>No. of Implants</th>
<th>Technique</th>
<th>w/wo graft</th>
<th>Mean RBH (mm)</th>
<th>Mean Follow-up (months)</th>
<th>Implant Length (mm)</th>
<th>MBL (mm)</th>
<th>NBF (mm)</th>
<th>ISR</th>
<th>Perf</th>
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Table 3: A compilation of studies made using the osteotome sinus floor elevation technique. W/wo = with/without graft; all data in orange represent cases with graft. RBH = residual bone height, MBL = marginal bone loss, NBF = new bone formation, ISR = implant survival rate, perf = number of perforations of the Schneiderian membrane. Numbers in red mark patients and data where grafting materials have been used.

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<td>95.1%</td>
<td>6.7%</td>
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</tbody>
</table>
Figure 1: Level of evidence of different study types.

Figure 2: Illustration of the lateral technique in five steps. A bone window is removed from the lateral wall of the sinus. The Schneiderian membrane is carefully dissected from the sinus floor. The implant is then placed emerging into the sinus cavity with care taken not to perforate the membrane. The bone window is put back and a blood clot is isolated in the enclosed space. After the follow-up time new bone formation is detected.

Figure 3: Illustration of the osteotome technique in six steps. A hole is drilled in the crestal bone. An osteotome is inserted through the hole and used to dissect the Schneiderian membrane from the sinus floor. The implant is then placed emerging into the sinus cavity with care taken not to perforate the membrane. A blood clot is isolated in the enclosed space. After the follow-up time new bone formation is detected.
Figure 4: A summary of the article search process.