Sinus lift grafting materials and immediate implant placement: A systematic review

Dr. Kashif Hafeez 1
Dr. Aiyeshah Wahaj 2
Dr. Muhammad Sohail Zafar 3
Dr. Sana Shahab 4

1 BDS, MFDS(RCSI), FFDS(RCSI), FFDS(RCSEd)
   Postgraduate Dental Foundation Trainer, Oxford
   Deanery: Broadshires Dental Practice, Carterton,
   Oxon, OX18 1JA, UK
2 BDS, FCPS. Postgraduate Resident, Department of
   Orthodontics, Dr. Ishrat-ul-Edad Khan Institute of
   Oral Health Sciences, Dow University, Karachi,
   Pakistan
3 BDS, MSc, PhD, FADI, FICD, Assistant Professor,
   College of Dentistry, Taibah University, Madinah Al
   Munawwarah, Saudi Arabia.
4 BDS, MSc. Department of Dental Materials Science,
   Sir Syed College of Medical Sciences for Girls,
   Karachi, Pakistan

Corresponding Author
Dr. Muhammad Sohail Zafar
E-mail: drsohail_78@hotmail.com

Access this Article Online

www.idjsr.com
Use the QR Code scanner to access this article online in our
database
Article Code: IDJSR SE 0166

Abstract

Sinus lift is one of the intricate methods of increasing
bone height in the posterior maxilla. Graft materials
are used to provide the height and hence increase the
implant support and success rate. Successful
osseointegration of dental implants required a stable
and sufficient amount of bone. There are different
types of bone grafting materials including autogenous
bone grafts, allografts and xeno grafts. Other newly
used materials such as platelet rich plasma is also
found to have optimal results. The current study was
aimed to assess the implications of dental implants
after immediate sinus augmentation and type of graft
materials which are suitable to support the sinus lift
procedures. A data search was performed based on
available electronic data bases (Cochrane data base,
Medline/PubMed) for articles published from 1990-
2013. Sinus lift is combined with various graft
materials to increase the bone height. The long term
survival of implant depends on surgical techniques,
bone volume, graft materials and Implant surface
features.

Keywords: Endosseous implant, Bone grafting
materials, Hydroxyapatite (HA).

Introduction

Surgical placement of dental implant is a demanding
 technique particularly if alveolar bone height is
compromised in the posterior maxillary region. Multiple
surgical methods have continuously been
adopted to encounter these clinical problems
including reduced alveolar ridge height and density1.
3. The most common surgical procedure for obtaining
clinically adequate bone height before the placement
of endosseous implants in the maxilla is grafting of
the maxillary sinus floor. The sinus augmentation
 technique was discovered about forty years ago. This
was achieved using the autogenous cancellous bone
material from the lateral iliac crest and repaired
though Caldwell-Luc technique. Later on, various
methods were discovered in the precision of the sinus
grafting techniques1-6. This was performed to make
the procedure more comprehensive yet clinically an
effective way to increase bone height.
A wide range of materials including allografts,
exenografts and alloplastic grafts have been used for
bone substitution to make implantation more
predictable and successful clinically5,7-9. Implant
success is found to have dictated by primary stability
factors such as implant diameter, shape, thread forms
and pitch values. Secondary stability factors included
the host environment where bone density plays a vital
role in their placement and successful
osseointegration. For example, osseointegration can
be enhanced using osteogenic surface coated dental
implants10.
Radiographic techniques including cone beam
tomography is frequently used for anatomic
assessment of oro-dental tissues11-13. For example,
computed tomography is used to assess the core basal
value and density of alveolar bone in order to make
sinus augmentation valuable in long term. This
review discusses the significance of sinus lift procedures with immediate dental implant placement in combinations with different graft materials. Based on previous clinical studies, clinical survival predictability of graft materials and implant success rate has been discussed.

**Material and Methods**

A data search was performed based on available electronic data base (Cochrane, Medline and PubMed) for studies published during 1990-2013. The search strategy was based on search terms such as; endosseous implant, bone grafting, sinus lift, and implant survival. Inclusion criteria included the sinus lift procedure with significant results using proper implant techniques.

**Table 1**: Lekholm classification scheme for evaluating bone and dental implant

<table>
<thead>
<tr>
<th>Type</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Dense bone that delivers great cortical anchorage; limited vascularity</td>
</tr>
<tr>
<td>II</td>
<td>Delivers better cortical anchorage for primary stability and better vascularity</td>
</tr>
<tr>
<td>III</td>
<td>Soft bone texture</td>
</tr>
<tr>
<td>IV</td>
<td>Least successful soft bone texture</td>
</tr>
</tbody>
</table>

Exclusion criteria included syndromic patients, interrupted treatment timings, bone graft failures with no conclusive results, immunocompromised, post-operative infections, autoimmune diseases, history of trauma or re-implant procedures, tumor and systematic metabolic diseases. In order to evaluate the quality of bone and dental implant placement, Lekholm classification scheme\textsuperscript{14} was used (Table 1).

**Results**

Initial search recovered 3510 peer reviewer papers (figure 1) and reduced to 1724 after filtering out duplicate papers. After going through the titles, abstracts and full texts of 279 papers we excluded 151 papers because of high risk of bias. Considering the inclusion criteria carefully, only 40 papers were included in the review.

**Figure 1**: Article screening criteria used in this study. PubMed/MEDLINE and Cochrane electronic databases were searched for articles published from 2000 to 2013.
The key outcome of inclusive research studies including the type of graft augmentation has been summarized (table-2).

<table>
<thead>
<tr>
<th>Researcher</th>
<th>Graft type for augmentation</th>
<th>Main Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cochrane⁴</td>
<td>Not specified</td>
<td>Sand blasted/acid etched titanium implants promote osseous contact than plasma sprayed.</td>
</tr>
<tr>
<td>Lazzara et al⁵</td>
<td>Not mentioned</td>
<td>Cumulative implant survival rate 99.8% at 10.5 months loading in non-complicated implants. Clinically investigation suggested that functional loading is possible at 2 months.</td>
</tr>
<tr>
<td>Khang et al⁶</td>
<td>Not specified</td>
<td>Cumulative success rate for post loading three year 96.8% (acid etched) and 84.8% (machined surface).</td>
</tr>
<tr>
<td>Wallace et al⁷</td>
<td>Autogenous allograft/direct</td>
<td>Survival rate of implant in augmented sinus ~92.6%.</td>
</tr>
<tr>
<td>Del et al⁸</td>
<td>Autogenous composite/non autogenous</td>
<td>Bone substitutes are successful for sinus augmentation.</td>
</tr>
<tr>
<td>Stach et al⁹</td>
<td>Not specified</td>
<td>Cumulative success rate (4 years) for machined implants 92.7% (dense bone) &amp; 88.2% (poor bone)</td>
</tr>
<tr>
<td>Peleg et al¹⁰</td>
<td>Not specified</td>
<td>Immediate implant insertion can be a likely choice for patients with 1-2mm of vertical residual bone height.</td>
</tr>
<tr>
<td>Winter et al¹¹</td>
<td>Not specified</td>
<td>In atrophic posterior maxilla, primary stability was achieved with tapered implants.</td>
</tr>
<tr>
<td>Peleg et al¹²</td>
<td>Not specified</td>
<td>Simultaneous implant placement favorable results.</td>
</tr>
<tr>
<td>Loza et al¹³</td>
<td>Autogenous</td>
<td>Less dense bone required large diameter implants.</td>
</tr>
<tr>
<td>Hallman et al¹⁴</td>
<td>Bovine HA and autogenous bone</td>
<td>Acceptable short term results and less resorption.</td>
</tr>
<tr>
<td>Engelke¹⁵</td>
<td>Particulate alloplastic bone (autogenous) and blood</td>
<td>Adequate bone height achieved.</td>
</tr>
<tr>
<td>McCarthy et al¹⁶</td>
<td>Autogenous</td>
<td>Sufficient bone volume achieved.</td>
</tr>
<tr>
<td>Philippart et al¹⁷</td>
<td>Autologous calvarial bone, human recombinant tissue factor, platelet plasma &amp; tetracycline</td>
<td>High bone regeneration capacity.</td>
</tr>
<tr>
<td>Rodriguez et al¹⁸</td>
<td>Deproteinized bovine bone + platelet rich plasma</td>
<td>Favorable results obtained.</td>
</tr>
<tr>
<td>Stricker et al¹⁹</td>
<td>Autogenous</td>
<td>Grafted bone showed good prognosis.</td>
</tr>
<tr>
<td>Bloomqvist et al²⁰</td>
<td>Iliac corticocancellous bone</td>
<td>Total implant survival rates report favorable.</td>
</tr>
<tr>
<td>Hirzeler et al²¹</td>
<td>Autogenous &amp; ePTFE membrane</td>
<td>98.8% survival rate.</td>
</tr>
<tr>
<td>Zimmer et al²²</td>
<td>Alloplastic</td>
<td>Good alternative</td>
</tr>
<tr>
<td>Block et al²³</td>
<td>Autogenous</td>
<td>Good on functional stability.</td>
</tr>
<tr>
<td>Daelemans et al²⁴</td>
<td>Autologous</td>
<td>Favorable results.</td>
</tr>
<tr>
<td>Block et al²⁵</td>
<td>Autogenous</td>
<td>Significant volume of bone for augmentation</td>
</tr>
<tr>
<td>Wallace et al²⁶</td>
<td>Organic bovine bone with/without autogenous bone.</td>
<td>Vital bone formation in sinus graft when a membrane is placed. Implant survival similar in both types</td>
</tr>
<tr>
<td>Karabuda et al²⁷</td>
<td>Autogenous</td>
<td>Overall survival rate 95.9%.</td>
</tr>
<tr>
<td>Fugazzotto²⁸</td>
<td>Autogenous/allograft/Gore-Tex membrane</td>
<td>Favorable response 97.5%.</td>
</tr>
<tr>
<td>Kaptein et al²⁹</td>
<td>Autogenous cancellous bone/HA</td>
<td>Cumulative success rate 82%.</td>
</tr>
<tr>
<td>Van et al³⁰</td>
<td>Autogenous</td>
<td>Favorable response.</td>
</tr>
<tr>
<td>Hatano et al³¹</td>
<td>Autogenous bone/xenograft mixture 2:1</td>
<td>Favorable response.</td>
</tr>
<tr>
<td>Schwarz et al³²</td>
<td>Resorbable membrane, collagen and inorganic bone mineral</td>
<td>The survival rate of implant placed under repaired membrane correlates inversely with size of perforation; less than 5mm showed good results.</td>
</tr>
<tr>
<td>Valentine et al³³</td>
<td>Porous bone minerals</td>
<td>Good osteoconductive properties.</td>
</tr>
<tr>
<td>Emmerich et al³⁴</td>
<td>Various</td>
<td>Elevation with osteotome; short term clinical success.</td>
</tr>
<tr>
<td>Leonards et al³⁵</td>
<td>Calcium sulphate</td>
<td>Suitable material for sinus augmentation.</td>
</tr>
<tr>
<td>Khoury et al³⁶</td>
<td>Autogenous</td>
<td>Best bone regeneration.</td>
</tr>
<tr>
<td>Lekholm et al³⁷</td>
<td>Inlay/onlay graft</td>
<td>Implant placement (23% failure). Inlay/onlay technique; 60% less favorable results.</td>
</tr>
<tr>
<td>Peleg et al³⁸</td>
<td>Autogenous</td>
<td>Favorable results.</td>
</tr>
<tr>
<td>Lovenzoni et al³⁹</td>
<td>Autogenous</td>
<td>Success rate of 92.7% for implants.</td>
</tr>
</tbody>
</table>
A number of researchers reported a high success rate for using either autogenous bone grafts or composite materials containing autogenous bone (Table 2). Use of alloplastic grafts also produced favorable results. Zinner et al described alloplastic grafts as a good alternative to autogenous bone grafts. Regarding the applications of inorganic biomaterials, bioactive materials based on calcium and phosphates have been used either alone or in combination with natural organic materials. Porous bone minerals showed great osteoinductive properties. Leonardis et al has reported calcium sulphate as a suitable material for sinus lift applications.

**Discussion**

There are various techniques for sinus augmentation such as lateral window, crestal approach, summers osteotomy, bone aided augmentation. The most popular technique for sinus lift is found to be lateral window with autogenous corticocancellous grafts. Autogenous bone grafts have always been considered the most effective standardized grafting material due to osteoinductive and osteoconductive potential. Various alternative materials have also been used in this context, however compromising the osteoinductive potential. The property of biomaterials in providing graft maturation and effective provision to the endosseous implants is the most significant element believed for the success of sinus graft augmentation procedures.

Implants placed in grafts composed of a combination of autogenous bone and synthetic materials found to have better survival rates than implants placed using the autogenous graft only. Such response is probably due to its high resorption values. The reviewed studies explained that a majority of implants had textured surface followed by machined surface. Textured surface implants have shown significant results contrast to machined, No association was observed in context to bone graft materials. This might refer to the adequate results with rough surfaced implants in immunological risk patients or those who have insufficient bone this seems regardless in bone with adequate height and density. Direct implant placement is usually a recommended protocol in such cases. Primary implant stability and graft is related to adequate bone height. Delayed implant placement is not recommended for badly destructed alveolar ridge with no proper implant base.

Implant surgical procedures are found to have a profound effect on implant placement. This included significant results using lateral swing door technique, osteome bone elevation. Clinically, these techniques provided a significant amount of bone height for implant placement. A recent study by Pal et al explained that the increase in bone height found to be significantly greater with lateral antrostomy than in indirect method by crestal approach. This might be beneficial when more than 6mm bone height present and increase required up to 4mm. In case of advanced bone loss, a direct method using lateral antrostomy is beneficial. Implant survival comparison showed no significant differences.

Reviewed studies (Table 2) showed different types of graft materials amongst which autogenous iliac crest corticocancellous were the commonest one. A combination of autogenous and xenograft have been used because of better success predictability in relation to less bone resorption postoperatively. Advanced graft materials such as platelet rich plasma, xenograft mixture with autogenous and deproteinized bovine have showed promising results when used in conjuncture with autogenous graft. These graft types provided stabilized bone base for immediate implant placement following sinus augmentation. These graft materials also assessed for cross antibody reaction and resorption, and later found to be insignificant in this regard. A significant failures with inlay/onlay graft upon three year interval has been reported. Membranes (absorbable and non-absorbable) found no significant effects in relation to osseointegration. Although the mean values showed good results with absorbable however no statistically significant effects.

Short term data explicitly suggested that implant placement after sinus augmentation is found to be a stable procedure however; a large number of longitudinal data is required.

Considering the complications of such procedures, sinus perforation was found to be the most frequent however not affecting the osseointegration in case of perforation 5mm or less. The repaired sinuses with graft and ePTFE membranes is also found to have significant good prognosis in this regard, however long term prognosis is required to be assessed. Sinus infection can affect the osseointegration potentially. None of the included studies reported the sinus infection postoperatively following the sinus augmentation. Natural silk based materials have been reviewed recently for bone grafting and
regeneration. From biomaterials prospective, there is an intense need of new materials for these applications. The limitations of clinical studies included inadequate sample size, lack of integrated systemized similar approaches and variability in data collection. All accounts towards the specific need of more rational case control and randomized clinical trials. This approach can further encompass the various human physiologically mediated conditions required to be discussed. There is also found to have constant need of long term follow-up related to implant stability.

Conclusion

Predictability of sinus augmentation is substantially based upon factors that need further understanding. This comprehensively explained statistically significant results using rough surfaced implant compared to the smooth surface. The most commonly used graft material is autogenous corticocancellous iliac crest. New graft materials (such as xenografts, deproteinated bovine, platelet rich plasma) are being used in combination with autogenous graft sand providing promising basal support for implant insertion. Success rate improves remarkably with immediate implant placement in a good quality basal bone support. However, immediate implant placement is not recommended if site is lacking a good quality bone support.

References


International Dental Journal of Student’s Research, April - June 2015;3(2):66-71