SYSTEMATIC REVIEW

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

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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 from1990-2013.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 density[1-3].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 yechnique. Later on, various methods were discovered in the precision of the sinus grafting techniques[1-6]. 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, xenografts and alloplastic grafts have been used for bone substitution to make implantation more predictable and successful clinically[5,7-9]. 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 implants[10].

Radiographic techniques including cone beam tomography is frequently used for anatomic assessment of orodental tissues[11-13]. 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[14]

Type	Criteria
I	Dense bone that delivers great cortical anchorage; limited vascularity
II	Delivers better cortical anchorage for primary stability and better vascularity
III	Soft bone texture
IV	Least successful soft bone texture

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[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.

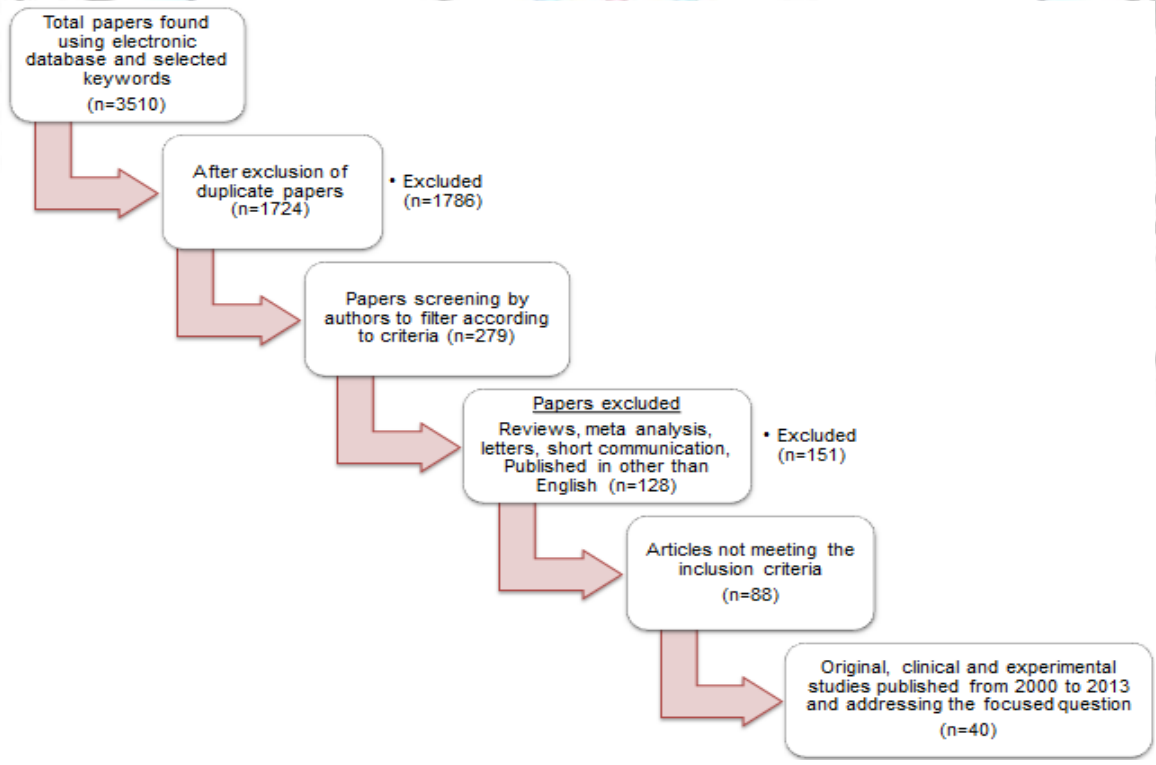

Figure 1: Article screening criteria used in this study. PubMed/MEDLINE and Cochrane electronic databases were searched for articles published from 2000 to 2013.

The key outcome of inclusive research studies including the type of graft augmentation has been summarized (table-2).

Table 2: Reviewed studies with basic research outcome

Researcher	Graft type for augmentation	Main Outcome
Cochrane[1]	Not specified	Sand blasted/acid etched titanium implants promote osseous contact than plasma sprayed.
Lazzara et al[2]	Not mentioned	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.
Khang et al[3]	Not specified	Cumulative success rate for post loading three year 96.8% (acid etched) and 84.8% (machined surface).
Wallace et al[4]	Autogenous allograft/ direct	Survival rate of implant in augmented sinus ~92.6%.
Del et al[5]	Autogenous composite/ non autogenous	Bone substitutes are successful for sinus augmentation.
Stach et al[6]	Not specified	Cumulative success rate (4 years) for machined implants 92.7% (dense bone) & 88.2% (poor bone)
Peleg et al[15]	Not specified	Immediate implant insertion can be a likely choice for patients with 1-2mm of vertical residual bone height.
Winter et al[16]	Not specified	In atrophic posterior maxilla, primary stability was achieved with tapered implants.
Peleg et al[17]	Not specified	Simultaneous implant placement favorable results.
Lozada et al[18]	Autogenous	Less dense bone required large diameter implants.
Hallman et al[19]	Bovine HA and autogenous bone	Acceptable short term results and less resorption.
Engelke[20]	Particulate alloplastic bone (autogenous) and blood	Adequate bone height achieved.
McCarthy et al[21]	Autogenous	Sufficient bone volume achieved.
Philippart et al[22]	Autologous calvarial bone, human recombinant tissue factor, platelet plasma & tetracycline.	High bone regeneration capacity.
Rodriguez et al[23]	Deproteinated bovine bone + platelet rich plasma	Favorable results obtained.
Stricker et al[24]	Autogenous	Grafted bone showed good prognosis.
Bloomqvist et al[25]	Iliac corticocancellous bone	Total implant survival rates report favorable.
Hurzeler et al[26]	Autogenous & ePTFE membrane	98.8% survival rate.
Zinner et al[27]	Alloplastic	Good alternative
Block et al[28]	Autogenous	Good on functional stability.
Daelemans et al[29]	Autologous	Favorable results.
Block et al[30]	Autogenous	Significant volume of bone for augmentation
Wallace et al[31]	Organic bovine bone with/without autogenous bone.	Vital bone formation in sinus graft when a membrane is placed. Implant survival similar in both types
Karabuda et al[32]	Autogenous	Overall survival rate 95.9%.
Fugazzotto[33]	Autogenous/allograft/Gore-Tex membrane	Favorable response 97.5%.
Kaptein et al[34]	Autogenous cancellous bone/HA	Cumulative success rate 82%.
Van et al[35]	Autogenous	Favorable response.
Hatano et al[36]	Autogenous bone/xenograft mixture 2:1	Favorable response.
Schwarz et al[37]	Resorbable membrane, collagen and inorganic bone mineral	The survival rate of implant placed under repaired membrane correlates inversely with size of perforation; less than 5mm showed good results.
Valentine et al[38]	Porous bone minerals	Good osteoconductive properties.
Emmerich et al[39]	Various	Elevation with osteotome; short term clinical success.
Leonardis et al[40]	Calcium sulphate	Suitable material for sinus augmentation.
Khoury et al[41]	Autogenous	Best bone regeneration.
Lekholm et al[14]	Inlay/onlay graft	Implant placement (23%failure). Inlay/onlay technique; 60% less favorable results.
Peleg et al[42]	Autogenous	Favorable results.
Lovenzoni et al[43]	Autogenous	Success rate of 92.7% for implants.

Pal et al[44]	Autogenous	Significant gain in bone height; mean 8.5mm,
Butz et al[45]	Alloplastic	Favorable success rate.
Guers et al[46]	Autogenous	Good response.
Kahnberg et al[47]	Autogenous	Favorable results.

A number of researchers[4,5,18-21,24-26] 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[27,45]. Zinner et al[27] 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 osteoconductive properties[38]. Leonardis et al[40] 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 toosteoinductiveand osteoconductive potential [1-6,15,16]. Various alternative materials havealso 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[17-24].

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[17-24]. 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 ($p<0.05$) contrast to machined ($p>0.05$). 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[1-5].Direct implant placement is usually a recommended protocol in such cases[25-31]. 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[32-39].This included significant results ($p<0.05$) using lateral swing door technique, osteotome sinus elevation. Clinically, these techniques provided a significant amount of bone height for implant placement. A recent study by Pal et al[44] 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[14,40-47].

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[36].Advanced graft materials such as platelet rich plasma, xenograft mixture with autogenous and deproteinated 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 ($p>0.05$). A significant failures with inlay/onlay graft ($p<0.05$) upon three year interval has been reported[14].Membranes (absorbable and non-absorbable) found no significant effects ($p<0.05$) in relation to osseointegration[37]. 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 osseointegrationin case of perforation 5mm or less. The repaired sinus with graft and ePTFE membranes[26] 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[48]. 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, deprotonated bovine, platelet rich plasma) are being used in combination with autogenous graft sand providing promising basal support forimplant 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.

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