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Clinical Performance of Different Bone Substitutes in Direct and Indirect Sinus Lift Procedures for Implant Placement: A Review

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Abstract
Lack of appropriate bone height along the maxillary sinus presents major difficulties when implants are positioned in the edentulous maxillary jaw. Bone augmentation methods have been suggested for re-creating sufficient bone height and volume necessary for dental implant sites. The purpose of this review was to determine the clinical performance of implant placement by using different bone substitutes.
Key-words: Autograft; Allograft; Xenograft; Alloplast; DBBM, GTAM.

Introduction

Pyramidal cavities inside the splanchnocranium over the posterior maxillary arch are known as maxillary sinuses that differ in measurements from individual to individual.[1]In case of severe bone deficiency at the floor of maxillary sinus may cause rupture of sinus membrane which is a common complication in the posterior maxilla while implant placement when the length of the selected implant is more than available bone height. Sinus membrane rupture is the most common reported reason forimplant failure, to overcome issues related to bone deficiencies numerous sinus augmentation techniques have been proposed in the literature.[2,3]These augmentation techniques are used for reconstruction of the bone and to raise the bone height, even this procedure may affect the Schneiderian membrane.[4]

Besides, the amount of bone is also influenced by the degree of resorption of the alveolar ridge and pneumatisation of the maxillary sinus, which also restricts the implant placement in the posterior edentulous maxilla.Implant measurements of 10 mm in length and 4 mm in diameter have been stated to be a pre-requirement for long-term survival in a vulnerable situation like posterior maxilla. Therefore, strategies for maxillary sinus elevation have been developed to increase and improve bone quality.A sinus lift can be performed in two ways: A lateral window technique (direct) and an osteotome sinus floor elevation technique (indirect) associated with placing bone graft material to increase the height of the available bone.[5]The most popular bone grafting materials for new bone generation are autogenous bone grafts with the disadvantages of time-consuming, high morbidity, the need to bereplaced, and insufficient quantity of bone.[6]In order to find a good alternative to autografts, many bone substitutes have been attempted, but even the best of bone substitutes is only osteoconductive(e.g. hydroxyapatite, allografts, xenografts, and alloplastic materials). These materials are ideal for sinus augmentation processes as they are available in the requisite quantity and retain the original volume throughout the replacement process.[7,8]

Various Grafting materials used for sinus lifting are:

- No graft (coagulum)
- Autograft
- Membrane (non-resorbable or resorbable)
- Growth factor
- Allograft
- Xenograft
- Alloplast
- Combinations of any of above

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1. Coagulum:
Numerous studies have encouraged sinus bone formation by raising the membrane without using grafting material. Lundgren et al., (2004)[9] observed a new bone formation inside the compartment formed by the sinus membrane elevation. Similarly, Thor et al., (2007)[10]observed average 6.51 mm gain of bone at the sinus floor after 1 year follow up and another study by Winter et al., (2002)[11] observed average 9.12 mm osseointegration after the follow up of almost 2 years.

2. Autograft
Autografts are extracted from the patient himself, because the donor and the recipient are the same entity, having no antigenic properties. It also strengthens the prognosis for maxillary sinus floor elevation. Although bone-substitute materials were considered as a replacement for autografts there were no reported data claiming lower success rate in sinuses augmented with bone-substitute materials alone versus autogenous bone.[1]Llambes et al., (2007)[12] observed 94% success rate after using the autograft and while used in combination with micro titanium mesh or bilayered collagen membrane showed about 90% bone regeneration respectively.[13,14]

3. Membrane
Whether a resorbable or non-resorbable membrane is used to cover the region of the defect seems to make no difference.[15]The use of a membrane, however, will increase the augmentated volume compared to when no membrane is used.[16]When using a non-resorbable membrane alone, autogenous particulate, or dried bovine bone mineral(DBBM) to cover dehiscence-type defects and fenestration-type defects, comparable results were obtained with regard to implant survival and amount of defect filling. Jovanovic et al., (1992)[17] placedpolytetrafluoroethylene (e-PTFE)membrane over the exposed implant sites and observed highly significant bone formation around the dental implant and similar results were observed by Lorenzoni et al.,[18] in 1999, they also mentioned that the newly formed bone was able to withstand the functional loading. By using Gore-Tex Augmentation Material (GTAM) success rate of new bone formation was observed around 85%.[19] Park et al., (2007)[16] observed significantly greater bone gain with bovine collagen membrane (BME) and acellular dermal matrix (ADM) when it was compared to no membrane group. Similar results were observed by Parodi et al., [20] in 1998 who used bioresorbable collagen membranes in his study. Resorbable membrane showed significant bone formation even without complete flap closure[21] and better results shown if used with bone grafts and fillers like organic bovine bone mineral (DBBM)[22,23]

4. Growth factor
Autogenous platelets rich plasma (PRP) and plasma rich in growth factor (PRGF) got popularity around 90s in various field of dentistry to improve the guided tissue regeneration.[24]Although there is lack of evidence related to use of PRP and PRGF alone as sinus augmentation, Anitua et al., (2016)[25] successfully stabilized the small sized implant by using PRGF augmentation. PRP and PRGF are mostly used in combination with autogenous bone that improve the rate of healing[26] only it's neither beneficial for implant survival or implant stability compared to use of only autogenous graft.[27]

5. Allograft
In order to remove antigenic properties, allografts processed because the donor and the recipient are different individuals of the same species, but once used for implants, excellent results were seen. When mineralized freeze-dried bone allograft (FBDA) used in combination with a titanium-reinforced expanded polytetrafluoroethylene (TR e-PTFE) barrier produce a predictable amount of bone.[28]There was no difficulty in achieving initial stabilization and parallelism in hydroxyapatite-coated dental implants with demineralized freeze-dried bone allograft and no clinical proof of crestal bone loss around the implants.[29]

6. Xenograft-
Xenografts are obtained from different species to humans. In dehiscence-type defects and fenestration-type defects, the best-reported augmentation protocols are DBBM coated with a membrane, particulatedautograft

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with or without a resorbable membrane, and a nonresorbable membrane alone. The best-known grafting procedure in horizontal ridge augmentations involves an intraorally harvested autogenous bone block alone or in combination with DBBM and with or without barrier membrane coverage.[30]The success rate of implant used with DBBM was around 95%. [31, 32]

7. Alloplast

It is synthetic bone graft substitutes prepared to replicate the natural bone tissue like hydroxyapatite crystals. By using nano-crystalline hydroxyapatite (ncHA) bone substitution material for implant placement Strietzel et al., (2007)[33]observed no signs and symptoms of inflammation. Similar results were found by Mangano et al., (2003)[34] by using porous hydroxyapatite (HA) and it promoted bone regeneration.

Conclusion

Various forms of bone defects found around maxillary sinus are dehiscence, fenestration, bone defect in the lateral and vertical dimension and inadequate bone height towards the sinus floor. Vertical dimension increases were predominantly carried out using autogenous bone grafts, either as intraorally harvested blocks or as particles assisted by a space-keeping system. Coagulum, particulate autograft, and DBBM are the best-known sinus grafting products using the trans alveolar method.

The following grafting procedures well-documented for maxillary sinus floor elevations using the lateral window technique: coagulum (in combination with immediate implant placement), autogenous particulate alone or in combination with DBBM or demineralized freeze-dried bone allograft(DFDBA), DBBM alone or in combination with DFDBA, and alloplastic HA alone. Coagulum, particulate autograft, and DBBM are the best-known sinus grafts for the trans alveolar approach.

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