Review Article

International Journal of Dental and Health Sciences
Volume 02,Issue 05

CLINICAL OUTCOMES OF THE MAXILLARY SINUS fIOOR AUGMENTATION USING DIFFERENT AUGMENTATION MATERIALS WITH SIMULTANEOUS IMPLANT PLACEMENT : A SYSTEMATIC REVIEW

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ABSTRACT:

Background: To date, there are still no clear cut guidelines for the maxillary sinus floor augmentation technique materials either by autogenous bone or bone substitutes or by platelet rich fibrin or by graftless augmentation with simultaneous implant placement .

Aim: The aim of the present review was to analyze the current literature in order to determine whether there are advantages of using autogenous bone (AB) over bone substitutes (BS) or platelet rich fibrin (PRF) in sinus floor augmentation or by graftles augmentation . The focused question was: is AB superior to BS or platelet rich fibrin (PRF) in sinus floor augmentation or by graftless maxillary sinus floor augmentation in partially dentate or edentulous patients in terms of implant survival, patient morbidity, sinusitis, graft loss, costs, and risk of disease transmission?

Materials and methods: The analysis was limited to titanium implants with modified surfaces placed in sites with 6mm of residual bone height and a lateral wall approach to the sinus. A literature search was performed for human studies focusing on sinus floor augmentation. Results: nine articles were included in the review. The highest level of evidence consisted of prospective cohort studies. A descriptive analysis of the constructed evidence tables indicated that the type of graft did not seem to be associated with the success of the procedure, its complications, or implant survival. Length of healing period, simultaneous implant placement or a staged approach or the height of the residual alveolar crest, sinusitis or graft loss did not modify the lack of effect of graft material on the outcomes. The studies documented that there was donor site morbidity present after the harvest of AB. When iliac crest bone was harvested this sometimes required hospitalization and surgery under general anesthesia. Moreover, bone harvest extended the operating time. The assessment of disease transmission by BS was not a topic of any of the included articles.

Discussion and Conclusion: The retrieved evidence provides a low level of support for selection of AB or a bone substitute or any other types of materials .Clear reasons could not be identified that should prompt the clinician to prefer AB or BS any other types of materials.

Keywords: autogenous bone, bone substitute, complication, implant survival, sinus floor augmentation, platelet rich fibrin, graft less

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INTRODUCTION:

Sinus floor augmentation is a technique based on the elevation of the sinus membrane from the floor of the maxillary sinus. Various graft materials have been used to fill the newly formed space. Autogenous bone(AB),allografts, xenografts,alloplastic materials, and mixtures of various materials have been proposed for this purpose (Wheeler 1997). AB is very popular for sinus floor augmentation, because it possesses osteoconductive, osteoinductive, and osteogenic properties (Galindo-Moreno et al. 2008).

Unfortunately, the harvest of AB requires donor site surgery and potentially increases patient morbidity (Nkenke et al. 2004). In this context, it is important to note that maxillary sinus floor augmentation is an elective procedure. In such kind of surgery, it should always be a priority to reduce patient morbidity to a minimum.

It has been clearly stated that donor site morbidity cannot be ignored when AB is used for maxillary sinus floor augmentation (Ku ¨bler et al. 1999; Raghoebar et al. 1999). Harvesting AB from intraoral sites can be associated with a number of problems like devitalization of anterior mandibular teeth by involvement of tooth apices, changes in facial esthetics, possible damage to mental and lower dental nerves, and increased risk of mandibular ramus fracture when intraoral donor sites are chosen (Galindo-Moreno et al. 2007). Bone harvest from extraoral sites may cause hemorrhage, instability of the sacro-iliac joint, hernia through the donor site, a dynamic ileus, or gait disturbances (Kalk et al. 1996). As a consequence, the use of AB for sinus floor augmentation has been questioned (Tadjoedin et al. 2002). Therefore, it was the aim of the present review to determine whether there are advantages in using AB over bone substitutes (BS) or (PRF) or by graftless technique for sinus floor augmentation. The question focused on was: what is the best material used in the lateral approach maxillary sinus floor augmentation with simultaneous implant placement .

MATERIALS AND METHODS

Search strategy

A systematic search strategy was used. In the initial phase of the review, a computerized literature search for human studies was performed (22-8-2015). There was no language restriction. In addition, a hand search was carried out. Moreover, the Cochrane Controlled Trials Register and The Cochrane Health Group Specialized Register were checked for publications on sinus floor augmentation. The full text of reviews was obtained from reviews on sinus floor augmentation published to date of (22-8-2015) Additional publications were identified from the reference lists of the retrieved articles.

Search terms Keywords were((((((((((((platelet rich fibrin implants) OR platelet rich fibrin sinus) OR platelet rich fibrin sinus lift)) OR (((((autogenous bone) OR autogenous bone grafts) OR autogenous bone graft) OR autogenous bone grafting) OR autogenous bone graft dental implants)) OR (((allograft) OR bone allograft) OR allograft bone)) OR (((((alloplastic) OR alloplastic bone) OR alloplastic bone graft) OR alloplastic bone substitutes) OR alloplastic implant)) OR ((graftless) OR graftless sinus))) AND ((((((maxillary sinus augmentation) OR maxillary sinus elevation) OR maxillary sinus floor elevation) OR maxillary sinus lifting)) OR maxillary sinus lift))) AND (((((drntal implants) OR implants) OR implants) OR titanium implants) OR implants dental))) AND survival of implants were used.

Inclusion criteria The inclusion criteria for study selection were:

(i) clinical studies, (ii) lateral window approach to the sinus, (iii)use of root-form or cylindrical titanium implants with modified surfaces, (iv) studies with a follow-up interval of at least 6 months after simultaneous implant placement in the region of the sinus floor augmentation, (v) average residual height of pristine bone in the region of sinus floor augmentation of a maximum of 6mm, (vi) defined survival or success criteria for the implants placed in the region of the sinus floor augmentation, (vii) documentation of the implant survival rate after a defined period of time, and (viii) a sample size of at least 6 patients.

Exclusion criteria Publications dealing with invitro studies or preclinical (animal) studies were excluded.

Human studies not meeting all inclusion criteria were also excluded from the review: In addition, studies were excluded if

(i) additional augmentation procedures were carried out besides sinus floor augmentation, (ii) survival rates or success rates could not be distinguished for rough- and smooth-surfaced implants, (iii) they reported on the same patient cohort, and (iv) personal communication was included in the paper.

Selection of studies Titles derived from this broad search were independently screened by the three authors based on the inclusion criteria. Disagreements were resolved by discussion. Following this, abstracts of all titles agreed on by all authors were obtained and screened for meeting the inclusion criteria. If no abstract was available in the database, the abstract of the printed article was used. The selected articles were then obtained in full text. If the title and abstract did not provide sufficient information regarding the inclusion criteria, the full report was obtained as well. Again, disagreements were resolved by discussion. Finally, the selection based on inclusion and exclusion criteria was made for the full-text articles. For this purpose, Material and Methods and Results of these studies were screened. This step was again carried out independently by the authors.

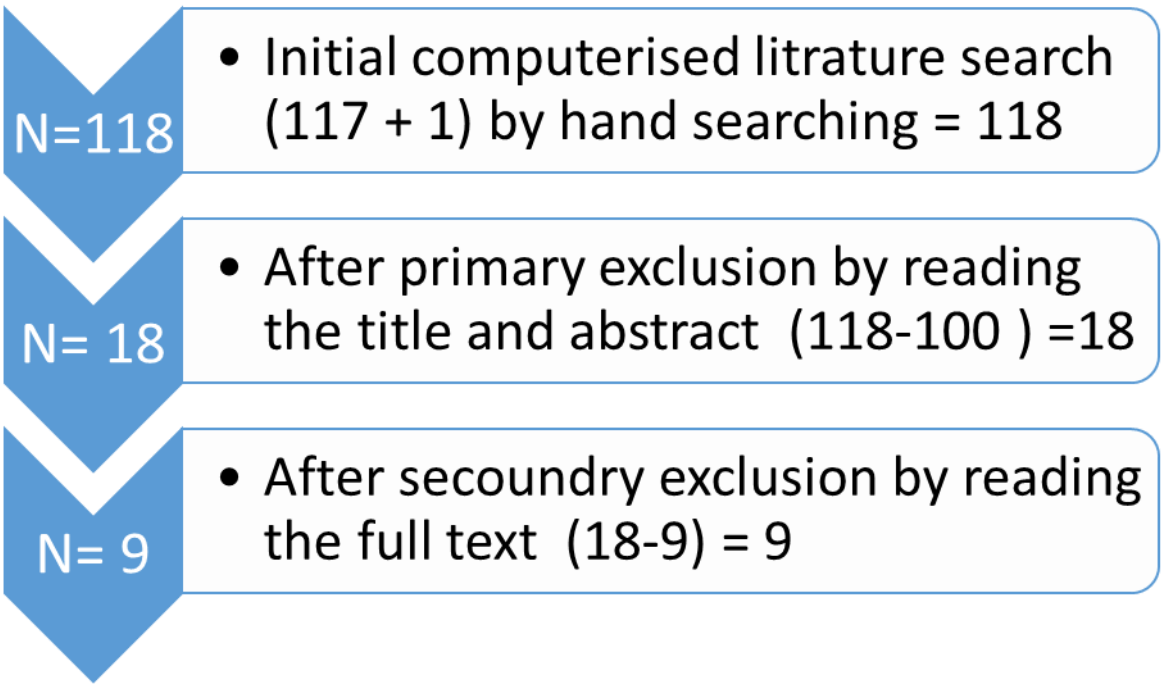
Disagreements were resolved by discussion (Diagram. 1).

Data extraction : Three reviewers independently extracted the data using data extraction tables. Any dis-agreements were resolved by double-checking the original data and by discussion. From the selected papers, data were extracted on author(s), year of publication, study design, total number of patients, inclusion and exclusion criteria, follow-up period, patients lost to follow-up, healing period, simultaneous implant placement or staged approach, height of residual alveolar crest, sinus mucosa perforation, operating time, sinusitis, graft loss, patient morbidity, disease transmission, and costs. All abbreviations used in the text are given in Table 1.

Table 1 : list of abreviations :

AB	Autogenous bone
BS	Bone substitutes
PRF	Platelet Rich Fibrin
FDBA	Freezed dried bone allograft
DFDBA	Demerelaised freezed dried bone allograft
NS	Not specified
CJD	Creutzfeldt–Jakob disease
vCJD	The new variant CJD
BSE	Bovine spongiform encephalopathy
VB	Venous blood
BMP	Bone morphogenic proteins

Diagram 1: Flow chart



Initial computerized search after removal of duplicates	**N= 117**
Hand searching (one article)	**N= 118**
After Primary exclusion (-100)	**N=18**
After secondary exclusion (-9)	**N=9**

RESULTS:

Study characteristics by the electronic literature search, 117 titles were identified and one article was added by hand searching . nine original articles fulfilled the inclusion criteria (Diag. 1). The studies with the highest level of evidence were prospective cohort studies (Table 2). Exclusion of studies The reasons for excluding studies after the full text was obtained were two stages non simultaneous implant placement with sinus floor augmentation (9 articles), case report (one article), technique of sinus floor augmentation not assigned (one article) .(Diag. 1).

Included studies

Nine articles were selected for inclusion in the review. They are presented in Tables 2–8. Nine studies reported inclusion and exclusion criteria for their patients. Most often, patients with a history of sinusitis, immune system disorders, and uncontrolled systemic diseases were excluded. While most of the studies excluded smokers (Table 3). Patients lost to follow-up were documented (Table 4). The approach to the sinus through the lateral antral wall was either performed by a trap door technique or by the preparation of an access hole by removal of the buccal bone plate (Table 4). In some studies, the approach was not reported in detail. In the included studies, groups with sinus floor augmentation and simultaneous implant placement and groups with a staged approach were excluded. In these studies, the decision on the use of one or the other technique was based on the height of the residual crestal bone beyond the sinus to ensure the implant primary stability .

List of excluded articles

Title	Authors	Reasons of exclusion
Volume changes of autogenous bone after sinus lifting and grafting procedures: A 6-year computerized tomographic follow-up	(Carolina Sbordone etal .2013)	Case report study (one case)
RehabilitationoftheEdentulousPosterior Maxilla After Sinus Floor Elevation Using Deproteinized Bovine Bone: A 9-Year Clinical Study	(Rita Oliveira etal .2012)	Two stages implant placement (not simultaneous)
Comparative Study of Alveolar Bone Height and Implant Survival Rate Between Autogenous Bone Mixed with Platelet Rich Plasma Versus Venous Blood for Maxillary Sinus Lift Augmentation Procedure	(Namineni Kiran Kumar, etal. 2015)	Two stages implant placement after 4-6 months (not simultaneous)
Radiographic comparison of different	Froum SJ, etal 2014)	The technique of sinus floor

concentrations of recombinant human bone morphogenetic protein with allogenic bone compared with the use of 100% mineralized cancellous bone allograft in maxillary sinus grafting.		augmentation was not assigned (crestal or lateral approach)
Maxillary sinus floor elevation surgery with BioOss® mixed with a bone marrow concentrate or autogenous bone: test of principle on implant survival and clinical performance.	Rickert D , etal. 2013	Staged implant placement after 3-4 months (not simultaneous)
Atrophic maxillary floor augmentation by mineralized human bone allograft in sinuses of different size: an histologic and histomorphometric analysis	(Carlo Maria Soardi , etal.2010)	Two stages implant placement after 6-9 months (not simultaneous)
Histologic and histomorphometric evaluation of a synthetic bone substitute for maxillary sinus grafting in humans	(Mauro Tosta , etal. 2011)	Two stages implant placement after 9 months (not simultaneous)

Table 2 . Study design and basic patient data

The author	Design of study	No. patients	No. Sinuses	Age (years)	Mean of age	Residual bone height
Kunal Jodia etal.2013	NS	12	13	20-50		More than 5mm
Naoki Hatano etal.2003	NS	191			55.9(+-9.7)	4-6mm
Gavriel Chaushu etal.2009	NS	28		24-65	54(+-9)	4-5mm
Maurizio silvestri etal. 2013	RCCT	37	42	35-68		2-5MM
Fabio L. Borges etal. 2011	RCCT	17	17*2 Split mouth	Ns	57.9	More than 3mm
Tassos irinakis etal.2011	Retrospective	49	27 + 22	Ns	Ns	More than 3mm
Wang Peng etal.2013	NS	24	29	Ns	Ns	1.9-6.6
Young-Kyun Kim etal.,2014	NS	30	25	Ns	Ns	Less than 5mm
Nobutaka Tajima etal.,2013	Ns	6	9	53-82	67.8	1.9-6mm (4.3+-1)mm

(Table 5). No differences were detectable for implant survival rates for the different graft materials that were associated by simultaneous implant placement. A wide variety of sources for AB were used. AB from the chin, the mandibular ramus, the calvarium, and the iliac crest was included .Donor site morbidity was specified in the studies (Marchetti et al. 2007). Harvesting of bone from the iliac crest led to donor site morbidity within the first two postoperative weeks (Marchetti et al. 2007). Donor site infections were found after harvest of mandibular ramus grafts. Hematomas, penetration into the cranial cavity, and minimal patches of alopecia were found after harvest of calvarial bone (Iturriaga & Ruiz 2004). The length of the healing periods did not seem to influence implant survival in dependence of the graft material used. The implant survival rate was not influenced by the use of AB alone or BS or PRF or graftless sinus floor augmentation.

None of the studies examined whether systemic diseases or other risk factors had an influence on implant survival in

dependence of the different graft materials used. The resorption of the graft material over time was documented in some of the studies (Hallman & Nordin 2004; Kim et al. 2009). Graft resorption did not seem to influence implant survival in dependence of the graft material used. None of the studies that used allogenic or xenogenic material was designed to report on the transmission of infectious diseases. Cases of disease transmission were not documented in any of the studies. The aspect of cost was not explicitly treated in any of the studies. However, it was reported that bone harvesting led to an extension of operating time of up to 15min, when intraoral donor sites were chosen (Peleg et al. 2004). Moreover, it was mentioned that surgery was carried out under general anesthesia when iliac crest bone was harvested and that patients were hospitalized up to 5 days after this procedure (Marchetti et al. 2007).

DISCUSSION:

Sinus floor augmentation is one of the most reliable procedures in preprosthetic surgery. A number of systematic reviews and meta- analyses have been performed on this topic (Table 9). These reviews have shown that titanium implants without modified surfaces performed significantly worse than implants with modified surfaces when placed following sinus floor augmentation. Therefore, implants without modified surfaces were excluded from the present review. Based on this major change compared with the previous reviews, the aim to determine whether there are advantages in using AB compared with BS , PRF and grafless sinus floor augmentation. The question focused on was: is AB superior to BS or PRF or by graftles sinus floor augmentation in partially dentate or edentulous patients in terms of implant survival, patient morbidity, sinusitis, graft loss, costs, and risk of disease transmission? A major concern with the use of AB is donor site morbidity (Nkenke et al. 2001, 2002, 2004).

It seems that donor site morbidity can be a major reason to question the use of AB. On the other hand, allografts and xenografts used as alternatives to autografts have a potential for disease transmission (Cordioli et al. 2001). Infectious particles (prions) cause Creutzfeldt–Jakob disease (CJD) in humans and bovine spongiform encephalopathy (BSE) in cattle. Therefore, the use of xenogenic material for medical products and devices poses the question: to what degree such material can be considered free of prions and what are the risks of transmission of the disease to humans. Cases have been reported of iatrogenic transmission of CJD from humans to humans through the use of human-derived medicinal products (Brown et al. 1992). While the appearance of the new variant CJD (vCJD) appears to be caused through consumption of infectious bovine food, none of the vCJD patients had a history of surgery and the use of xenografts (Will et al. 1996). Allografts also pose the risk of transmission of other infectious diseases, such as acquired immunodeficiency syndrome. However, it

has been stated that adequate material processing including freezing, demineralization, and lyophilization can decrease the risk of infection transmission to minimum (Gomes et al. 2008). It seems that the risk for transmission of these diseases by BS is minimal. Cases have been reported of iatrogenic transmission of CJD from humans to humans through the use of human-derived medicinal products (Brown et al. 1992). While the appearance of the new variant CJD (vCJD) appears to be caused through consumption of infectious bovine food, none of the vCJD patients had a history of surgery and the use of xenografts (Will et al. 1996). Allografts also pose the risk of transmission of other infectious diseases, such as acquired immunodeficiency syndrome. However, it has been stated that adequate material processing including freezing, demineralization, and lyophilization can decrease the risk of infection transmission to minimum (Gomes et al. 2008). It has been stated that perforation of the sinus membrane does not compromise the osseointegration process or the survival of dental implants placed in anaugmented maxillary sinus (Karabuda et al. 2006). A correlation between sinus membrane perforation and extended post- operative sinusitis or implant loss could not be found (Kaptein et al. 1998). The present review reveals that the advent of sinusitis, partial or total graft loss is independent of the graft material. Using AB will not protect patients from developing sinusitis or graft loss. Resorption of graft material and subsequent repneumatization have been mentioned as reasons to choose non-resorbable or slowly resorbable BS in sinus floor augmentation. However, the data of the present review do not reveal that resorption of the graft material has an influence on implant survival (Hallman & Nordin 2004; Kim et al. 2009). The aspect of resorption does not seem to be of concern that should prompt the clinician to prefer or abandon AB. The height of the residual alveolar ridge was the basis for the decision of a staged approach or implant placement simultaneous with sinus floor augmentation in some studies. As the thresholds for one or the other procedure were chosen arbitrarily and had no scientific basis, the implant survival was comparable for the different graft materials used. The aspects of height of the residual alveolar crest and simultaneous or delayed implant placement did not seem to contribute to the decision of whether AB should be preferred in sinus floor augmentation or not. However, it has to be kept in mind that simultaneous implant placement is less invasive than a staged approach, more cost-effective, and more time efficient (Becktor et al. 2008). However, this is true for every graft material used. The healing periods elapsed after the different sinus floor augmentation procedures were also chosen arbitrarily in the different studies. Longer healing periods did not increase implant survival in a relevant way. Implant survival seemed not to be influenced by the healing periods of the different graft materials. The length of the healing period of the

graft material could not be identified as a reason to prefer AB over BS or PRF or graftles technique. The aspect of costs cannot be ignored in sinus floor augmentation procedures. Harvesting AB increases the operating time (Peleg et al. 2004). Especially, in case of extraoral donor sites, surgery is performed under general anesthesia (Ruiz 2004). In some studies the patients even had to be hospitalized (Marchetti et al. 2007). These different aspects lead to an increase in costs. It has to be assumed that the money spent on increased operating time, general anesthesia , and hospitalization will exceed the expenses for BS by far. Consequently, costs may not be a reason to prefer AB. However, detailed incremental cost-effectiveness analyses are needed to clarify this aspect. From the present review, it is impossible to decide whether general diseases, smoking, or other risk factors have an influence on the implant survival rate depending on the graft material used.

Presently, it is not possible to decide whether the use of zytokines, growth factors, and BMPs will change the characteristics of AB or BS is way that one or the other material should be preferred as far as implant survival is concerned. All in all, the current literature provides only a low level of evidence as far as the decision-making between the use of AB ,BS,PRF or without graft is concerned. To date, studies are missing that are dedicated to the clarification of the influence of residual bone height, simultaneous or delayed implant placement, sinusitis, and graft resorption on implant survival in dependence of the graft material used. The aspects of donor site morbidity, disease transmission, and costs have also not been treated adequately.

Meta analysis by Tong et al. 1998 showed that Implant survival was 90 % for autogenous bone (484 implants in 130 patients followed for 6–60 months), 94 % for the combination of hydroxyapatite (HA) and autogenous bone (363 implants in 104 patients followed for 18 months), 98 % for the combination of demineralized freeze-dried bone (DFDB) and HA (215 implants in 50 patients followed for 7–60 months), and 87 % for HA alone (30 implants in 11 patients followed for 18 months) (Tong et al. 1998). No difference in measure of success such as plaque index, gingival index, pocket depth and implant stability were noted in various studies using different augmentation procedures such as with bovine hydroxyl-apatite mixed with fibrin glue (Hallman M, Nordin T , 2004), anorganic bovine bone (Valentini P, Abensus DJ 2003) and autogenous bone graft (Stricker A, Voss PJ, Gutwald R, Schramm A, Schmelzeisen R ., 2003).

The overall height of bone graft decreased during the first 2–3 years after augmentation. Thereafter, only minor changes occurred. However, graft height up to 96 months after augmentation was higher than that observed preoperatively. These findings suggest that implant loading promotes osteogenesis over the long term (Nystro ¨m et al. 1993; Keller et al. 1994). Implant loading may exert a

stabilizing effect on the maintenance of bone graft height, consistent with the findings of Listrom & Symington (1988). The absence of implant loss after about 3 years may be associated with the stability of sinus-graft height.

Good long-term results can be achieved using a 2:1 autogenous bone/xenograft mixture for maxillary sinus floor augmentation with simultaneous placement of implants. Overall, graft height decreased during the first 2–3 years after augmentation, but subsequent changes were minimal. The results suggest that long-term stability of sinus-graft height represents an important factor for implant success.(Naoki etal.,2004)

A block of cancellous freeze-dried allograft may be used as a grafting material for sinus floor augmentations and for the initial stabilization of dental implants when placed during this procedure . Its main advantage is its ability to provide initial stability for the implant and the grafting material, without the need for autogenous bone harvesting, even in the presence of membrane perforation. (Gavriel, 2009) that autogenous bone mixed with platelet rich plasma (PRP) or venous bone (VB)produces similar long term clinical results with autologous bone mixed with VB having slight advantage. Even though there are studies which are providing evidence that the use of autologous PRP does accelerate soft and hard tissue healing in at least limited number of applications further controlled clinical studies with larger sample sizes are needed to evaluate the influence of different parameters on treatment outcome. In addition, defined clinical protocols in combination with long term clinical documentation are needed to identify the clinical benefits for the use of VB in combination with autogenous bone grafts for maxillary sinus augmentation procedures. (Namineni Kiran , etal. 2015)

Simultaneous sinus membrane elevation and implant placement, with or without bone graft, reach a comparable bone gain and implant survival at 6-month follow-up. The sinuses, in a split-mouth design, were assigned to two groups: a control group consisting of 17 sinuses, which received simultaneous sinus membrane elevation, autogenous bone graft, and implant placement; and a test group consisting of 17 sinuses, which received simultaneous sinus membrane elevation and implant placement without graft material . The results demonstrates a high survival rate for simultaneous implant placement in both groups. The success rate ranged between 96.4% and 100%, similar to previous reports (Borges etal., 2011)

The bone resorption rate after single autogenous bone graft was significantly higher compared to the autogenous bone combined with Bio-Oss. The resorption rate of maxillary sinus bone graft in the one-stage surgery group was significant higher than that in the two-stage surgery group. The resorption rate of maxillary sinus bone graft in the higher residual bone height group (>4 mm) was significant higher than that in the residual bone

height group (<4 mm). There was no significant correlation with the resorption rate of maxillary sinus bone graft among patients' age, implant size, implant placement region, local infection, and surgical complication. During an average monitoring period of 2.7 years, the success rate and survival rate of the implant were 92.2% and 100%, respectively. The results suggest that maxillary sinus floor elevation with autogenous bone graft through the lateral window approach technique is feasible and safe, and that the elevation of maxillary sinus floor is predictable in implant rehabilitation for patients with reduced vertical bone height in the posterior maxillary region.(Wang Peng , etal. 2013)

Bone materials weremixed and used, and they were divided in ttwo groups, containing autogenous bones and without autogenous bones.In the group containing autogenous bones(46 implants),the bone harvested from the maxillary tuberosity or the mandible symphysis was mixed with allogeneic bones such as Regenaform (Exactech,Gainesville,FL, USA) or xenogeneic bones such as Bio-Oss(Geistlich Pharma AG,Wolhusen, Switzerland)and grafted. In the group without autogenous bones (30implants), allogeneic bones such as Regenaform were mixed with xenogeneic bones such as BioOss and grafted.An evaluation of cases at an average of 47.6 months after maxillary sinus bone graft and implant placement showed that the average resorption volume of maxillary bone graft materials was 3.15±2.95 mm.Significant differences according tothe bone graft procedure or materials were not observed. Complications that occurred during maxillary sinus bone graft such as perforation did not mediate thedecisive effects on the resorption of grafted bones or the prognosis. (Young – Kyum kim etal.2014)

Platelet-rich fibrin is an autologous and inexpensive material, which can be considered as an optimized blood clot. Sinus floor augmentation with simultaneous implant placement using platelet-rich fibrin as the sole filling material is a secure and reliable option that promotes natural bone regeneration. (Tajima 2013).

CONCLUSIONS:

-The available evidence neither supports nor refutes the superiority of AB over other graft materials for sinus augmentation with regard to implant survival but regarding the operative and post operative complications the AB was more than other grafts at the recipient site.

- Good long-term results can be achieved using a 2:1 autogenous bone/xenograft mixture for maxillary sinus floor augmentation with simultaneous placement of implants.

- A block of cancellous freeze-dried allograft may be used as a grafting material for sinus floor augmentations and for the initial stabilization of dental implants when placed during this

procedure. Its main advantage is its ability to provide initial stability for the implant and the grafting material, without the need for autogenous bone harvesting, even in the presence of membrane perforation.

- Sinus floor augmentation with simultaneous implant placement using platelet-rich fibrin as the sole filling material is a secure and reliable option that promotes natural bone regeneration .

- Maxillary sinus floor augmentation using xenografts is predictable technique with good results and minimal postoperative complications .

- Simultaneous sinus membrane elevation and implant placement, with or without bone graft, reach a comparable bone gain and high implant survival rate.

- Implant survival may be confounded by factors other than the graft material used for sinus floor augmentation.

Table 3: Exclusion characters

The authors	Smokers	Systemic disease	Sinus pathology	Others
Kunal Jodia etal.2013	Yes	Yes	Yes	Ns
Naoki Hatano etal.2003	Ns	Yes	Ns	Ns
Gavriel Chaushu etal.2009	Yes	Ns	Ns	No drug history
Maurizio silvestri etal. 2013	Yes	Yes	Yes	Ns
Fabio L. Borges etal. 2011	Yes	Yes	Yes	Ns
Tassos irinakis etal.2011	Yes	Yes	Yes	Ns
Wang Peng etal.2013	Ns	Yes	Yes	Ns
Young-Kyun Kim etal.,2014	Ns	Yes	Ns	Ns
Nobutaka Tajima etal.,2013	Ns	Yes	Yes	Ns

Table 4: characters of surgical procedures:

The authors	Simultaneous /Staged implant placement	Antibiotic use	Surgical approach (lateral approach)	Membrane use	Follow up (month)
Kunal Jodia etal.2013	Simultaneous	Pre &postoperative 625mg Augmentin (T.I.D) 0.2% Chlorhexidine gluconate mw	Round – elliptical shape using round burr	Resorbable collagen	6-18-30
Naoki Hatano etal.2003	Simultaneous	Ns	Modified cauld well lauc	Ns	Ns
Gavriel	Simultaneous	Pre	Trapezoid –	Resorbabale	Ns

Chaushu etal.2009		&postoperative 500mg Amoxicillin (T.I.D) 0.2% Chlorhexidine gluconate mouthwash	oval Kent & block 9mm height ,15mm width by round burr	collagen (orapharma – bionet-biogide)	
Maurizio silvestri etal. 2013	Simultaneous	Pre &postoperative 500mg Amoxicillin (T.I.D)	Boyne & James Round burr or piezo electric	Collagen (eulution Teenoss or biogide)	Ns
Fabio L. Borges etal. 2011	Simultaneous	postoperative 875mg Amoxicillin (T.I.D) 125mg Sulbactam 0.2% Chlorhexidine gluconate mouthwash	Window 15mm *10mm , bone block used new floor of sinus by round burr	Polypropylene	6
Tassos irinakis etal.2011	Simultaneous	postoperative 875mg Amoxicillin (T.I.D) 125mg clavulate 0.2% Chlorhexidine gluconate mouthwash	Window by piezo	Collagen 15 *20 mm Neomembrane (test) Newmed or biomend (contro)	12-24
Wang Peng etal.2013	17sinus simultaneous , 47 sinus staged	Yes	Trapdoor , new floor by round burr	Ns	24-68
Young-Kyun Kim etal.,2014	Simultaneous	Ns	Window by round burr	collagen	47.6 (+- 11.2)
Nobutaka Tajima etal.,2013	Simultaneous	Postoperative 250 mg amoxicillin tid	Window by piezo	Ns	6

Table 5 : Healing time

The authors	Healing
Kunal Jodia etal.2013	6 months after extraction , 6 months after implants Follow up 6-18-30 months
Naoki Hatano etal.2003	Ns
Gavriel Chaushu etal.2009	Mean 27 months (11-46 months)

Maurizio silvestri etal. 2013	After 6 months of healing , loading 2 months after uncovering the implants
Fabio L. Borges etal. 2011	6 months
Tassos irinakis etal.2011	12 months after functional loading
Wang Peng etal.2013	2.7 years
Young-Kyun Kim etal.,2014	3 years
Nobutaka Tajima etal.,2013	6 months

Table 6 : Grafting materials, implant type

The authors	Grafting	Implants
Kunal Jodia etal.2013	Novabone (bioactive glass putty)	EZ double thread
Naoki Hatano etal.2003	Autogenous + Biooss (2:1)	Nobelbiocare
Gavriel Chaushu etal.2009	FDBA	MSI (35) Bioment(29) Zimmer (8)
Maurizio silvestri etal. 2013	Bovine particulate (control) porcine particulate (test)	SPI Contact , thommen
Fabio L. Borges etal. 2011	Autogenous bone (symphysis/ramus) milled	Conus ,INP, Brazil screw shape
Tassos irinakis etal.2011	Allograft control : particulate (mineross , biohorizon) Test : injectable (Dynablast)	Nobel biocare
Wang Peng etal.2013	Autogenous (ramus – iliac crest) Vrs Composite (autogenous + xenograft Biooss)	Biohorizons external implant RBT
Young-Kyun Kim etal.,2014	Autogenous mixed with allogenic (Regenafom)or xenograft (Biooss) Vrs allogenic or xenograft	3-i (15) , Biohorizons (5) , Implantium (19) , US2 (7) , SS2 (4) , GS2 (6) ,XIVE (10) , AVANA (6)
Nobutaka Tajima etal.,2013	PRF	Noble biocare

Table 7 : Complications

The authors	Sinus perforation	Postoperative sinusitis	Graft loss	Other
Kunal Jodia etal.2013	One patient	Ns	Ns	Ns
Naoki Hatano etal.2003	Ns	Ns	Ns	Ns
Gavriel Chaushu etal.2009	6 cases (21.4%)	Ns	Ns	Ns
Maurizio silvestri etal. 2013	Ns	Ns	Residual bovine =16, residual porcine =13.5	Ns
Fabio L. Borges etal. 2011	1 more than 5mm , 2 more than 2mm	Ns	Ns	2 fistulas ,suppuration in both groups
Tassos irinakis etal.2011	2 small (control)	Ns	Ns	Ns
Wang Peng etal.2013	10	5	Ns	Ns
Young-Kyun Kim etal.,2014	12	Ns	Ns	Infection =2 Fail = 4
Nobutaka Tajima etal.,2013	No	Ns	Ns	Ns

Table 8 : Results

The authors	Implant survival rate	Graft height reduction	Bone height
Kunal Jodia etal.2013	100 %	0.3mm -0.7mm (18 months) 0.2-0.3mm (30 months)	0-6 months 4.8 6-18 months -0.5 18-30 months -0.5 0-30 months -3.8
Naoki Hatano etal.2003	94.2 % 21 of 216	Grafted sinus height / original sinus height mean = 2.3+1.5	
Gavriel Chaushu etal.2009	94.4 %	Ns	12.3mm
Maurizio silvestri etal. 2013	96.3% (3 implants)	Ns	Ns
Fabio L. Borges etal. 2011	96.4% graftless group 100% autogenous group	Ns	8.3 +- 2.6 autogenous 7.9 +- 3.6 graftless
Tassos irinakis etal.2011	100%	Ns	Ns
Wang Peng etal.2013	100%	23.1 % autogenous after 6m 18.9% both after 6m	Ns
Young-Kyun Kim etal.,2014	94.7%	3.4mm+-2.9 autogenous 2.7mm+-2.8 without	Ns
Nobutaka Tajima etal.,2013	100%	Ns	Gain 7.5mm

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