REVIEW ARTICLE

CALVARIAN BONE GRAFT FOR PRE PROSTHETIC SURGERY

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ABSTRACT:
With 250 million edentulous people residing in Asia, Exact number of people with Edentulism in Nepal needs an extensive subject matter of study. Edentulism in long term may lead to functional and social problem which can becured, Rehabilitation can change the life style and function of the patients. With loss of tooth loss of bone starts which eventually leads to the atrophy of the jaw. Atrophy of the jaw is the major concern and a challenge for rehabilitation, requires a surgical procedure called pre-prosthetic surgery. Autologous bones are used as graft for reconstruction of the alveolar ridges for the preparation of complete denture or implant supported Prosthesis. Preprosthetic surgery in Nepal is not a new procedure for Maxillofacial Surgeons but lack documentation. Reconstruction of the resorbed ridges with calvarial bone graft is a challenging procedure, the advantages which calvarial bone tend to possess over other autologous bone grafts for reconstruction has opened up the new horizon, our counterparts from all over the world are doing it since long time with good results, now it is the time for us to explore, with team work and availability of Neuro Surgeons in many health centres the procedure to graft calvarial bone graft is no longer outreach from the Maxillofacial Surgeons of Nepal for the functional and esthetic rehabilitation of the patients.
Key words: CBG – Calvarial bone graft, autologous bone graft, complications, pre prosthetic surgery

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INTRODUCTION

250 million people are edentulous in Asia: 67% live in China and India, 10% live in Japan, 8 % live in Indonesia and 15% live in others.[1] No study has been conducted in the country to find the percentage of edentulous population,with around 27 million population [2] according to new census and falling among the category of 15% we can assume that there are more than million people in our country who may be edentulous. Edentulism is a social problem causing decreased efficiency in chewing (functional), difficulty in speech and esthetic problems due to lip going down and giving impression of early signs of old age.[3] If it is not taken care, may cause resorption of the alveolar bone leading to atrophy of the jaws.[4] Compromise in the function and esthetic along with atrophy often results in problems like insufficient retention of prosthesis, loss of soft tissue support and loss of facial vertical dimension. Such limitation can negatively affect the patient's quality of life and daily activities and at times may lead to pathologic fracture of the mandible. However with the introduction of endosseous implants and advancement in preprosthetic surgeries the functional and surgical outcomes in such patients have been improved in recent days.[5]

Reconstruction of the atrophic maxilla and mandible is a surgical challenge for any maxillofacial surgeon of which the two primary goals should be restoration of function and esthetics. Reconstruction of severe alveolar ridge defects necessities bone grafting procedures followed by subsequent rehabilitation with Dental implants, however the use of intraoral donor site is restricted because of limited availability of bone volume.[6] Autogenous bone remains the gold standard for alveolar grafting.[7] Multiple extra oral sources that can be used are Iliac crest, proximal tibia and calvarium. A maxillofacial surgeon should however be aware of the biologic basis of the free autogenous grafts for its successful transplantation. Cortical bone provides superior mechanical strength and can be incorporated with plate fixation to span interpositional defects.[8]

Autologous bone grafts are considered superior to grafts of allogenic or alloplastic origin because of their osteo inductive, osteoconductive and non-immunogenic characteristics.[9, 10]

An ideal bone graft for Maxillofacial reconstruction is which provides sufficient bone volume, is easy to harvest, lies in proximity to the recipient site, incorporates well into the recipient area, shows minimal resorption and is associated with minimal donor site morbidity.[11] It is utmost important to consider the amount of bone required for reconstruction while selecting the donor site. [11] Endochondral bone have higher tendency to resorption than membranous bone because membranous bone have greater osteoblastic and less osteoclastic activity.[12] Zins JE and colleague have implicated that due to its higher tensile strength resorption rates of Endochondral bone are as high as 60 to 80 % whereas resorption rates of the membranous bone ranges from 17 % to 20 %.[13] Implant survival rates with autologous bone grafts has worse results for iliac crest bone compared to the Calvarial bone or intraoral grafts.[19]

Iliac bone grafts are popular and widely used for augmentation procedures but in literature iliac bone grafts for alveolar ridge reconstruction are associated with higher bone resorption rates than that of calvaria.[14] Lizuka and colleagues reported a marginal bone resorption of Calvarial Bone Graft of less than 0.5 mm in 12 of 13 patients after a mean observation period of 19.6 months.[15] For iliac bone grafts on contrary, a total bone volume reduction of 47 - 49.5 % is reported using CT scans after a half a year.[16] Bone harvesting from iliac crest is associated with higher morbidity and complications. Arrington and Colleagues[17] analysed complications of iliac crest bone harvesting and categorized into minor and major complications, the minor complications were superficial infections, superficial seromas, and minor hematomas. Among the major complications reported were herniation of abdominal contents through massive bone grafts donor sites, vascular injuries, deep infections at the donor site, neurological injuries, deep hematoma formation requiring surgical intervention, and iliac wing fractures. Furthermore pain and walking difficulties are described, which are generally slight and transitory. Marx and Morales[18] reported a nearly 20 percent incidence of wound complications following bone harvest from anterior iliac crest, unable to walk at all for a mean of 4 days post operatively and 15 percent had not achieved normal gait 2 months post operatively. The combined use of iliac crest onlay grafts in combination with endosseous implants is generally used for dental rehabilitation of the patients, but frequently results in resorption of approximately 25 % of the grafted bone during the first 6 month period.[20]

Why Calvarial Bone?

The calvarium is composed of two parallel layers of cortical bone separated by a thin layer of cancellous bone. The skull reaches 75% of its thickness by the age of 5 years and adult thickness by 17 years.The mean thickness of the adult skull ranges from 6.80 mm to 7.72mm but can also deviate 3mm and 12 mm.[21] The thickest and safest area for outer table graft harvesting is central 8 x 10 cm region of the parietal bone. Graft taken below the temporal line puts the dura at greater risk owing to the lack of diploic differentiation.[22] Autogenous split calvarial graft is mesenchymal and has the potential for revascularization and consolidation which makes it a popular choice for reconstruction especially in preprosthetic surgery.[23]

The autogenous Calvarial bone (CBG) were described as osteocutaneous vascularized flaps in 1890.[24] In the 1970's Smith and Abramson [25] and Tessier [26] popularized the use of free outer table CBGs, without Intracranial approach that extended their use to all facial defects. In the 1980's it was suggested that Calvarial membranous bone was superior to Endochondral bone as bone graft material for head and neck surgery.[27] Calvarial bone embryonal derivation (membranous) compactness and wider availability when compared with other extra oral sites makes it preferred choice in preprosthetic surgery.[28] Cranial bone has excellent mechanical strength due to its larger cortical component. Calvarial donor site causes less discomfort to the patient compared with rib or iliac crest.[8]

Procedures

There are different procedures for harvesting the graft, procedure outlined by Christian metes et all is described below.[5]

Donor site – Skull Radiographs to determine the thickness and density of parietal bone, non-dominant hemishphere –right handed patient right side is preferred. The length of the incision depends on the quantity of bone needed and good visibility on the donor site. Mark the midline, a distance of atleast 3cm from the median line to avoid the contact with the superior sagittal sinus.[29] Split Calvarial bone grafts from outer cortex, desired dimensions of the graft block outlined with round burs under constant irrigation. The bur should reach the cancellous bone, indicated by bleeding, but should not penetrate the inner side of the cortical bone, preventing contact to the meninges. The block grafts than segmented in smaller grafts

to facilitate harvesting and are removed using curved chisels. Donor site the cranial defect is closed with Bicalcium Phosphate cement or Tri calcium Phosphate cement. Inner layer closed by continuous suture with vicryl and outer layer stapled or sutured with silk.

Figure 1: Lateral Skull radiography

Figure 2: Incision 3 cm away from the midline

Figure 3: Preparing the graft

Figure 4: Blocking graft

Figure 5: After removal of graft and shaping

Figure 6: Closing the donor sire with cement

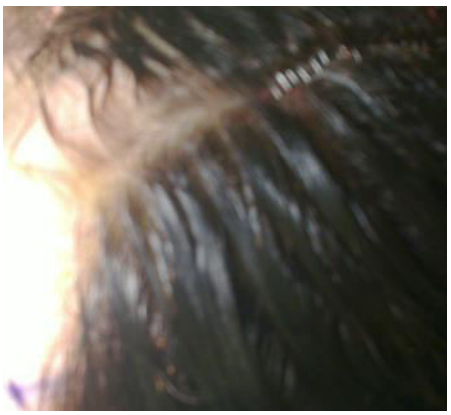

Figure 7: Closing the soft tissue with 2 layers

Advantages and Disadvantages of Calvarial bone graft

The main advantage of Calvarial bone graft is good integration, absence of pain and no visible scar. The skull is well known donor site, but majority of authors use only the outer table of the Calvarial bone, limit of this surgery is thin Calvarial bone less than 5mm, because the risk of dural or cerebral wound is accentuated [30]. Calvarial bone grafts are not indicated if there is extensive sagittal mis-relationship between maxilla and mandible, Extensive vertical misrelationship between maxilla and mandible, patient with thin calvaria and when the defect to be restored is resulting from oral cancer treatment [5].

Complications and how they can be reduced

Calvarial bone graft does not cause serious complications such as dural lacerations, requiring neurosurgical or suspension sutures, subdural hematoma, leak of CSF and brain damage are scare [31]. A multicentre study reported only three cases of temporary neurologic complications in 12,672 cranial bone graft harvesting [32]. Jackson et al reported 265 cranial bone grafts with a 5.6 % incidence of complications, with non-involving neurologic disturbances [33]. Kline and Wolfe reported among 12,672 cranial bone grafts 21 dural lacerations, 7 brain lacerations and 3 sagittal sinus lacerations in cases of thin calvaria.[34]

Tessier et al presented 2 cases out of 10,550[35, 36] the occurrence of infection, systemic prescription of antibiotics may be reason for low cases; strong vascular supply of scalp may be the other reason.

Scalp hematoma requiring drainage is the most frequent immediate complication. Tessier et al[35, 36]reported 12 cases in their series of 10,550. Emerick et al[37]observed this complication in 4%, bleeding has 2 origins, it comes from a section of subcutaneous vessels, partly to the sampling site (diploe, pacchionian granulation) and due to very limited use of electrocoagulation to avoid destruction of hair follicles. However a large infiltration of cold serum with epinephrine significantly reduces the scalp bleeding. Continuous suture improves the subcutaneous hemostasis.

Emerick et al[37] found the extrusion of biomaterials in the harvesting site in 1 % where the methylacrylate was used, so they recommended the use of 40 % B tricalcium phosphate and 60 % hydroxyapatite, which is found to be osteoconductive and ultimately good in osteointegration. Depression of the donor site can be prevented by reconstruction by means of biomaterials. Osteoconductive biomaterials eventually leading to osteointegration are indicated.[38] Scalp residual dysesthesia seems to be frequent complications of coronal incision (15.4 %) of cases in the series of Xia et al [39]. It is supposed to be related to the lesion of the supratrochlear or supraorbital nerve branches in the posterior one. These 3 nerves have a para sagittal way. Thus incision should not begin until at least 2cm from the hair implantation line.[35, 36] Alopecia is amongst the late complications described relatively frequently in the literature, with the significant aesthetic sequel complaint of the patient. Xia et al[39] has 8 % in his series. First the scalp incision itself causes damage to the hair follicles. Burm and Oh [40] described an incision with an angle of 30 degrees to the follicles which preserves the deeper parts of them and decreases the number of hairs that grow back in the scar. Second, tension of the suture increases the width of the scar. The major factor for the cause of alopecia is believed to be due to extensive electrocoagulation of the incision wound. Papay et al [41] showed that incision made with a scalpel gives significantly smaller scar widths than that done with electrocoagulation (5.8 mm against 3.5 mm), they came to the conclusion that direct overheat or diffusion would cause irreversible damage to the hair follicles.

CONCLUSION

Donovan and colleagues showed higher satisfaction and minimal to no postoperative discomfort following bone harvesting from the outer table of the calvaria and bone augmentation in the maxilla or mandible[2]. However harvesting and shaping cranial bone require surgical special expertise and there is potential morbidity. Although calvaria graft provides an optimal bone quality and quantity it is difficult to be accepted by patients[43] so the patient education is an important factor especially in context of our country. Presence of neuro surgeon around the hospital premise is must and important medico legal requisite every maxillofacial surgeons should respect before undertaking cranial bone graft.

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