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Original Research

Prospective Analysis of Secondary Alveolar Bone Grafting in Cleft Lip and Palate Patients

M Gokul Chandra Reddy[1], V Ramesh Babu[2], V Eswar Rao[3], J Jaya Chaitanya[4], S Allareddy[5], C Charan Kumar Reddy[6]

Contributors:

[1]Professor & Head, Department of Oral & Maxillofacial Surgery, CKS Theja Institute of Dental Sciences & Research, Tirupati, Andhra Pradesh, India; [2]Associate Professor, Department of Oral & Maxillofacial Surgery, CKS Theja Institute of Dental Sciences & Research, Tirupati, Andhra Pradesh, India; [3]Sr. Lecturer, Department of Oral & Maxillofacial Surgery, CKS Theja Institute of Dental Sciences & Research, Tirupati, Andhra Pradesh, India; [4]Reader, Department of Oral & Maxillofacial Surgery, Narayana CKS Theja Institute of Dental Sciences & Research, Tirupati, Andhra Pradesh , India; [5]Senior Lecturer, Department of Oral & Maxillofacial Surgery, Narayana Dental College Nellore, Andhra Pradesh, India, [6]Post Graduate, Department of Oral & Maxillofacial Surgery, CKS Theja Institute of Dental Sciences & Research, Tirupati, Andhra Pradesh , India.

Correspondence:

Dr. Reddy MG. Department of Oral & Maxillofacial Surgery, CKS Theja Institute of Dental Sciences & Research, Chadalawada Nagar, Renigunta Road, Tirupati - 517 506, Andhra Pradesh, India. Phone: +91-9440137172. Email: gokoolnlr@yahoo.co.in

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Abstract:

Background: To assess the success of the uptake of bone graft in cleft alveolus of the cleft lip and palate patients, quantitatively through computed tomography (CT) scan 6 months postoperative. To assess the successful eruption of permanent lateral incisor or canine in the bone grafted area.

Materials and Methods: The children age group of 9-21 years with unilateral cleft lip and palate came to the hospital, needing secondary alveolar bone grafting. A detailed history and clinical examination of the patient was taken. A 3D CT scan was taken and the volume of the cleft was measured pre-operatively. After ambulatory period, 3D CT scan of the alveolar cleft region was taken and volume of the bone grafted was measured and patient was discharged from the hospital. After 6 months, patient was recalled and again 3D CT scan was taken and the volume of remaining bone was measured.

Results: The mean volume of the defect pre-operatively is 0.80 cm^3 with a standard deviation of 0.36 cm^3 with minimum volume of the defect 0.44 cm^3 and maximum volume of the defect 1.60 cm^3. The mean volume of the bone post-operative immediately after grafting is 1.01 cm^3 with a standard deviation of 0.52 cm^3 with minimum of bone volume is 0.48 cm^3 and maximum of 2.06 cm^3. The mean volume of the bone after 6 months after bone grafting is 0.54 cm^3 with a standard deviation of 0.33 cm^3, minimum bone volume of 0.22 cm^3 and maximum bone volume of 1.42 cm^3.

Conclusion: The CT scan is a valuable radiographic imaging modality to assess and follow the clinical outcome of secondary alveolar bone grafting.

Key Words: Alveolar bone grafting, cleft, computed tomography, Volume

Introduction

Reconstruction of alveolar cleft with bony tissue started at early 1900 in the late 1950's and early 1960's primary alveolar bone grafting was the treatment of choice. The term primary means operation is done during the first 2 years of life. Secondary alveolar bone grafting is done before the eruption of the canine.[1]

Primary alveolar cleft grafting has become increasingly unpopular because of adverse effects on growth, though there are the advocates of the procedure who have reported normal growth. Secondary alveolar bone grafting has become a well-established procedure since the original work of Boyne and Sands in 1972. Bergland *et al.* published a large series of patient who had undergone alveolar cleft grafts with considerable success. Secondary alveolar bone grafting is ideally done between 9 and 11 years before the eruption of the maxillary canine to allow the canine to erupt to the grafted site.

The alveolar bone graft is an essential step in the overall management of a patient with cleft lip and palate. Objectives of alveolar bone grafting include.

1. Stabilization of maxillary arch width and minimizing relapse
2. Providing continuity to the maxillary arch and establishment of alveolar bone contour
3. Closure of oroantral fistula
4. Bony support for teeth adjacent to the cleft
5. Providing bone matrix for erupting teeth in the line of cleft
6. Improved speech
7. Restoring facial symmetry and providing alar base and lip support
8. Improved oral hygiene
9. Promoting periodontal health with keratinized gingival
10. Stabilization of dental prosthesis
11. Minimizing growth disturbances.[2,3]

Traditionally the reported ways of evaluation of the alveolar bone graft in patients with cleft lip and palate has been occlusal, periapical, and panoramic radiograph. The principle of evaluating the success of bone graft on two-dimensional

image is that there is a significant correlation between the weight of the bone calculated from the two-dimensional dental radiographs and the total amount of the resorption. However, conventional radiographs had many limiting factors such as enlargement and distortion, superimposition of adjacent structures, limited number of identifiable landmarks, and difficulty in a position. More recently computed tomography (CT) scans have been used to evaluate the outcome of the secondary alveolar bone grafts. With the use of CT scan, the previously mentioned problems can be avoided. The major drawbacks to the use of the CT scan are the cost, increased radiation exposure, patient inconvenience, and accessibility.[4]

The purpose of this prospective study was to radiographically evaluate the quantity and quality of secondary alveolar bone grafts from the anterior iliac crest to maxillary alveolar clefts in cleft lip and patients using CT.

Materials and Methods

This research proposal received prior approval from Ethical Committee and patients were assessed and treatment was planned. 10 patients were selected randomly for this purpose with unilateral clefts with in the age of 9-11 years of age. A detailed history and clinical examination of the patient was taken. A 3D CT scan was taken and the volume of the cleft was measured pre-operatively (Figure 1) and necessary laboratory examination which were conducted namely hemogram, serological evaluation for HIV, hepatitis B virus, hepatitis C virus, biochemical estimation for blood glucose, blood urea, serum creatinine, and serum electrolytes. A medical assessment of the patient by physician and anesthesiologist was also done.

A written informs consent was obtained from the patient explaining about the procedure before the patient was shifted to the operation theater. Preparation of the face, private parts was done one before surgery. 0.2% chlorhexidine mouthwash every 6 h and 5% povidone-iodine head wash given and draping in a sterile gown before shifting to the operative room. All the patients were operated under general anesthesia with naso endochondral intubation following standard sterilization protocols where in extraoral and intraoral preparation was done with 5% solution of povidone-iodine and draping of the patient was done with sterile drapes exposing the required surgical field only.

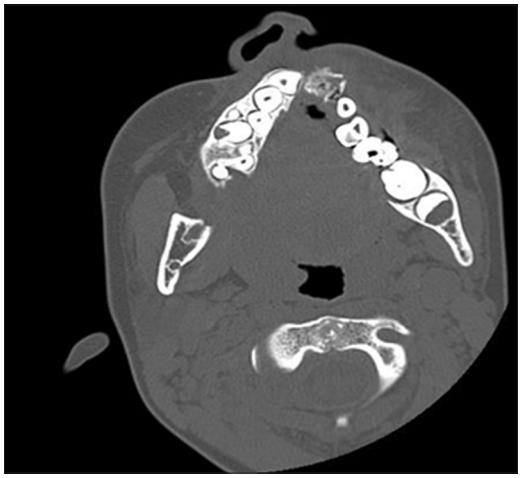

Figure 1: Pre-operative.

Surgical technique

The cleft area was widely exposed through incisions along the gingival border. Posteriorly, the incision was extended to the first molar where it is angled up into the sulcus. To provide sufficient mobility of the flap, which is going to cover the graft, it is necessary to cut through the periosteum at the base of the flap. Anteriorly, incision was extended along the gingival border to the center of the cleft side central incisor. Vertical incision was made along the edges of the cleft. On the palatal side, mucoperiosteal flaps were raised along the edges of the cleft. A wide exposure of the cleft area was achieved with these incisions. During the exposure of the cleft, every effort was made to avoid traumatizing the thin bone lamella that covers the dental roots adjacent to the cleft. Nasal floor was reconstructed, if necessary and pushed upward. On palatal side, the mucoperiosteal flaps were sutured together with everting mattress sutures. This left a well-defined cavity, whose walls are periosteum and denuded bone. The iliac cancellous bone graft was taken and placed over the cleft area and finally closed with 4-0 vicryl.

Harvesting technique cancellous bone is harvested from the anterior iliac crest, while the patient is in the supine position. Prophylactic antibiotics were given intravenously on induction of anesthesia. A marking pen was used to mark the iliac crest and the anterior iliac spine was located. The area of the incision was infiltrated with local anesthesia with adrenaline (1:2,00,000). The incision was made parallel and approximately 1 cm inferior to the prominence of the iliac crest to ensure that the resulting sacr did not lie directly over the crest. The aim was to harvest bone from where the ilium was thickest, namely between the iliac tubercle and the anterior superior iliac spine. The immediate vicinity of the anterior iliac spine was avoided to prevent damage to the lateral femoral cutaneous nerve and the main growth center of the bone. Gentle blunt dissection is continued down through the subcutaneous tissue to the insertion of the oblique fascia on the crest. The fascia and the underlying periosteum were sharply incised, exposing a segment of the iliac crest. The bone was harvested between the anterior superior iliac spine and the iliac tubercle. Here the ilium was at its greatest width, facilitating cancellous bone harvesting.

A laterally based osteoplastic trapdoor flap was outlined with a scalpel, making anterior and posterior stop cuts which were joined with a crestal sagittal cut, with a small osteotome. A 10 mm osteotome was used to elevate the medial aspect

of the cap; the osteotome was directed laterally to minimize the risk of peritoneal penetration, reflection or dissection of the muscle medially was kept to a minimum medially, and the muscle and periosteum were left intact on the lateral aspect of the iliac crest. The flap was hinged laterally, the outermost layer of the cancellous bone was discarded because of the presence of chondrocytes and the cancellous bone was harvested with a hand gauge and spoon curettes. Before closure thorough irrigation was performed and meticulous hemostasis was obtained. The osteoplastic flap was replaced and secured with 3-0 resorbable suture. A two layer closure was performed to approximate the fascia and subcutaneous tissues. A few millimeters xylocaine with 1:2,00,000 adrenaline was infiltrated under the fascia and a final layer of suture was done to approximate skin and pressure dressing given.

After ambulatory period, 3D CT scan of the alveolar cleft region was taken and volume of the bone grafted was measured and patient was discharged from the hospital (Figure 2). After 6 months patient was recalled and again 3D CT scan was taken and the volume of remaining bone was measured (Figure 3).

Figure 2: Post-operative.

Figure 3: Post-operative (6 months).

In our study, the CT scans are taken pre-operatively to measure the volume of the defect by assessing through the area of the defect and thickness of the slice to the number of slices.

$$V = [A_1 \times T] + [A_2 \times T] + \ldots\ldots + [A_n \times T]$$

Where V = volume, A = area and T = thickness of the axial CT slice; n =number of slices.[4]

Particular note was taken to assess (1) Evidence of bony bridging, (2) status of the canine tooth, and (3) the quality of bone after 6 months.

Results

Patients undergoing the alveolar bone grafting with mean age of 10 with minimum of 8 years and maximum of 12 years, Table 1 shows the data of the patients undergoing alveolar bone grafting and volume of the defect and volume of the bone immediately after grafting and after 6 months.

Table 2 shows the statistical data with mean and standard deviation of volume defects of bone preoperatively and postoperatively.

Asymp.sig suggests P value

There is a significant association between the bone defect volume and volume of bone immediately after grafting in Table 3.

Table 1: Volume of the defect and remaining bone volume after 6 months.

Patient age/sex	Volume of defect pre-operatively	Volume of bone immediately after grafting	Volume of the bone post-operatively 6 months
8	0.54 cm^3	2.06 cm^3	1.42 cm^3
11	1.6 cm^3	1.67 cm^3	0.22 cm^3
12	1.24 cm^3	1.39 cm^3	0.69 cm^3
8	0.64 cm^3	0.69 cm^3	0.47 cm^3
9	0.44 cm^3	0.48 cm^3	0.29 cm^3
10	0.92 cm^3	0.98 cm^3	0.59 cm^3
8	0.49 cm^3	0.54 cm^3	0.29 cm^3
9	0.67 cm^3	0.74 cm^3	0.48 cm^3
10	0.71 cm^3	0.74 cm^3	0.47 cm^3
12	0.80 cm^3	0.84 cm^3	0.54 cm^3

Table 2: Descriptive statistics.

Volume of bone	*N*	Mean	SD	Minimum	Maximum
Volume of defect pre-operative (cm^3)	10	0.8050	0.36388	0.44	1.60
Volume of bone post-operative after grafting (cm^3)	10	1.0130	0.52305	0.48	2.06
Volume of bone post-operative after 6 months (cm^3)	10	0.5460	0.33991	0.22	1.42

SD: Standard deviation

Table 3: Test statistics.[a]

Tests	Volume of bone after grafting cm^3- volume of defect pre-operative cm^3	Volume of bone after 6 months cm^3 - volume of defect pre-operative cm^3	Volume of bone after 6 months cm^3 - volume of bone after grafting cm^3
Z	−2.809[b]	−1.886[c]	−2.803[c]
Asymp. Sig. (2-tailed)	0.005	0.059	0.005

[a]Wilcoxon signed ranks test; [b]Based on negative ranks; [c]Based on positive ranks

There is a significant association between the volume of bone immediately after grafting and 6 months after grafting suggestive of graft guiding in eruption process.

Discussion

The treatment of patients with clefts of the lip and alveolus and palate is a multimodal therapeutic concept. Primary osteoplasty at the time of the initial repair of the lip or shortly afterward as described by Schuchardt was common treatment for reconstruction of alveolar cleft defects before 1970s.[1]

Gingivoperiosteoplasty has been proposed as an alternative to the primary bone grafting until secondary autogenous bone grafting. Alveolar bone graft is an essential step in the overall management of patient with cleft lip and palate. Restoration of cleft alveolar ridge is done by autogenous bone to fill the remaining alveolar cleft.

The procedure is classified as early secondary alveolar bone grafting when done between 2 and 5 years; intermediate secondary alveolar bone grafting when done between 6 and 15 years; late secondary alveolar bone grafting or tertiary if done from adolescence onwards (Macardo and Vig).[3]

Although timing of the surgical repair is still controversial that primary alveolar bone grafting that is within 2 years inhibit forward growth of maxilla, Boyne and Sands introduced the idea of the particulate corticocancellous bone grafting for alveolar clefts.

A bone graft is defined as any implanted material that promotes bone healing, whether alone or in combination with other material, tissue that is transplanted and expected to become a part of the host.

Types and tissue sources

Autografts

Autogenous bone grafting involves utilizing bone obtained from the same individual receiving the graft.

Isografts

Grafts that are transferred between two genetically matched subjects, identical twins in humans are isografts.

Allografts

Allografts are the grafts transferred between two genetically unmatched subjects.

Heterogenous graft

Heterogenous graft is bone harvested from another species.

Xenografts

Xenografts bone substitutes has its origin from other than humans such as bovine.

Alloplastic grafts

Alloplastic grafts may be made from hydroxylapatite, a naturally occurring mineral that is also the main mineral component of bone. They may be made from bioactive glass.[5,6]

Rosenstein *et al.* and Dado *et al.* compared three dimensional calculations from CT scans with the two-dimensional calculations from standard radiographs. Both groups found and overestimate of up to 21% or underestimates up to 18% with conventional radiographic imaging.

Van der Meij *et al.* did a 1-year post-operative study taking CT scans pre-operatively and 1-year post-operatively. They compared the corresponding slices and found that a mean bone loss of 30% in the group with unilateral clefts whereas in the group with bilateral clefts only 45% of the initial bone graft remained.

Honma and Kobayashi also compared CT scans taken before and after the operation. They reported a significant bone loss after the 3rd-month post-operatively. The common point of agreement between these studies is that the amount of bone loss was significantly higher than that shown by conventional two-dimensional imaging.[7]

Summary and Conclusion

Complex methods of bone graft analysis have been proposed. These methods attempt to map segmentally the height, thickness and position of the adjacent to the roots of the cleft tooth. In our study, CT scan analysis was carried out to evaluate the volume of the cleft and graft volume after 6 months. The results showed that the amount of bone resorption is significant statistically and to confirm this large sample is necessary as our study has a sample of 10 only which is not enough. Only disadvantage of this study is multiple exposures of the patient to radiation.

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