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Alveolar Bone Defect and Secondary Bone Grafting Outcome in Cleft Lip/Palate Patients

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Abstract: *Background:* Current evidence on factors influencing the outcome of Secondary Alveolar Bone Grafting (SABG) in cleft lip/palate patients is ambiguous and further deliberations are required to provide solid proof on prognostic criteria. *Objectives:* The objectives of this study were to determine the changes brought about by SABG in cleft depth and alveolar bone support of teeth in the vicinity of the cleft and to elucidate their prognostic value in surgical outcomes. *Materials & methods:* A prospective study was designed for 17 consecutive cleft lip and palate patients who underwent secondary alveolar bone grafting with anterior iliac crest graft at the AIMS Cleft Lip and Palate Clinic, Amrita Institute of Medical Sciences, Kochi. Maxillary occlusal radiographs taken at two time periods (T1- preoperative within 1month, T2-post-operative, after 6 months) were assessed for medial and lateral bone support of the teeth adjacent to cleft as well as for reduction in alveolar notching. The changes between the two were statistically analyzed using paired t-test and correlation computed with Pearson correlation coefficient. *Results:* Statistically and clinically significant improvements were achieved by the SABG procedure in terms of bone support and cleft depth. Pre surgical medial alveolar bone support and medial alveolar crest defect were found to have a positive impact on post surgical values. *Conclusion:* Significant increase in bone support achieved for cleft adjacent teeth and elimination/reduction of alveolar notching proves the beneficial role of SABG in cleft management protocol.

Keywords: Cleft Lip & Palate, Alveolar Bone Grafting, Anterior Iliac Crest Graft, SABG Outcome, Graft Take

1. Introduction

Face being the identity of an individual ranks high in his/her persona. Abnormalities in facial development can have detrimental impacts on the aesthetic, functional and emotional well-being of the person. Cleft lip and cleft palate, caused by abnormal facial development during gestation[1] are the most common congenital malformations of the head and neck.[2] In addition to the evident anatomic deformity, it has multiple functional consequences, affecting the child's ability to eat, speak, hear and breathe.

The rehabilitation of a child born with a facial cleft presents an exceptional challenge to the medical community. It involves a multidisciplinary approach and needs to be staged appropriately as the child grows, balancing the need for intervention against effects on subsequent growth.[1]The osseous closure of the alveolar cleft, which is required for the formation of a regular upper dental arch, has now become an integral part of comprehensive cleft lip and palate management. Secondary Alveolar Bone Grafting (SABG) as a procedure for repair of the alveolar cleft was introduced by Boyne and Sands in 1972.[3] Bone grafting during the transitional dentition often obviates the need for prosthetic habilitation of the anterior dentition by providing an osseous structure into which the canines and, in some instances, the lateral incisors can erupt. It can also facilitate orthodontic movement of teeth into cleft site. Other benefits of SABG include[4] increased bone support for teeth adjacent to the cleft site, elimination of oronasal fistulae, improved facial symmetry, alar base support, and nasolabial contour as well as improved status of oral hygiene by separating the nasal cavity from the oral cavity.

Driven by these advantages, SABG during mixed dentition period before permanent canine eruption coupled with orthodontic treatment has gained acceptance over the years and has become a standardized care plan for cleft patients.

Most cleft management teams assess the SABG outcomes based on subjective clinical and radiographic evaluation, with potential risk of bias leading to erroneous inferences. Fruitful efforts to devise more objective assessment methods started with the work of Bergland et al [5] in 1986 and depended on the height of interalveolar septum after graft placement. Other investigators like Long et al[6], Enemark et al[7], Witherow et al[8], Van der Meij et al[9], Lee et al[10] and Aurouze et al[4] have described different methods to evaluate graft take based on radiographs, computed tomography (CT) and cone beam CT (CBCT). These studies reveal that in spite of the popularity and the well established procedures which have been shown to lead to successful grafting, not all alveolar bone grafts are successful. Even in the successful series of SABG, graft take ratios displayed wide variations.

Despite the efforts made to unveil the pre surgical determinants of SABG success; the current knowledge in the arena is still incomplete and inadequate. More investigations are required to trace out the factors that influence the end results of alveolar bone grafting to arrive at more definitive conclusions. This study sought to determine the changes in cleft depth and alveolar bone support of teeth in the vicinity of the cleft and to elucidate their prognostic value in SABG outcomes.

2. Objectives

1 To assess the change in cleft depth and alveolar bone support of teeth adjacent to cleft site brought about by secondary alveolar bone grafting (SABG) in cleft patients.
2 To find out the relationship between cleft depth/ alveolar bone support and SABG outcome.

3. Materials and Methods

Consecutive cleft lip and palate patients who underwent secondary alveolar bone grafting using anterior iliac crest graft at Amrita cleft lip and palate clinic between January 2011 and June 2012 were prospectively studied. Both bilateral and unilateral cleft cases were included. Adjunct orthodontic treatment was an essential requisite for inclusion. Syndromic cleft patients and those with systemic illnesses like diabetes were excluded to decrease the heterogeneity of the sample.

Pre-surgical maxillary occlusal radiograph taken within 1 month and post-operative occlusal radiograph taken at least 6 months after surgery were used for analysis. Unlike the routine occlusal X-rays, these radiographs were taken in such a way that central ray passes perpendicular to the cleft. Radiographs of each cleft site, pre and post-surgical, were scanned and digitized with a transparent film scanner and amount of alveolar bone support for teeth mesial and distal to the cleft was determined.

Measurements included depth of the cleft and bone support for teeth mesial and distal to cleft. Surgical outcome was assessed on the basis of post-operative values of bone support and alveolar notching (cleft depth). Measurements of the bony architecture used in this study were previously described by Aurouze et al. (2000)[4]. Eleven reference points were digitized on each radiograph. (Figure 1)

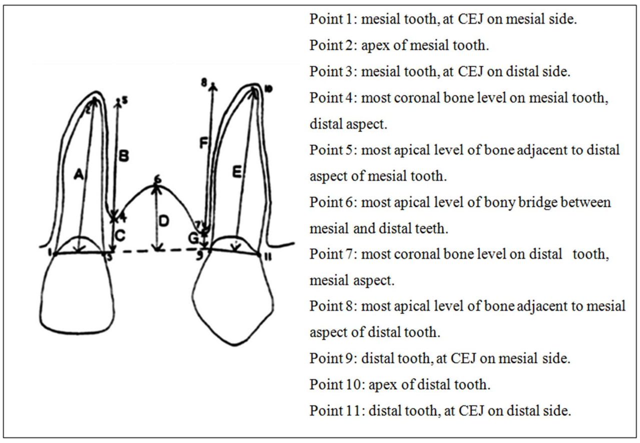

Figure 1. *Reference points drawn on occlusal radiograph: Schematic representation (From Aurouze et al. 2000).*

Microsoft Paint application was used to mark the reference points. (Figure 2a, c)Two examiners who were dental surgeons independently marked the points and they were blinded to the treatment phase of the patient and other clinical details. In cases where divergence of assessment occurred, the point location was decided by reevaluation and discussion.

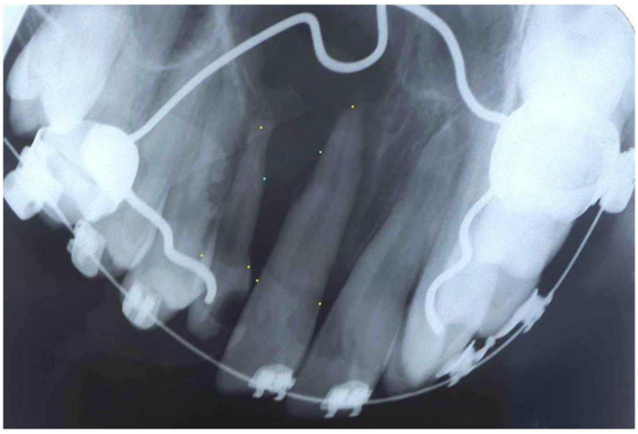

Figure 2a. *Reference points marked on Pre operative Occlusal radiographs using Microsoft Paint application. (Point 6 cannot be located as the cleft extends beyond the apex of the tooth ie D>A) Point 1: mesial tooth, at CEJ on mesial side. Point 2: apex of mesial tooth. Point 3: mesial tooth, at CEJ on distal side. Point 4: most coronal bone level on mesial tooth, distal aspect. Point 6: most apical level of bony bridge between mesial and distal teeth. Point 7: most coronal bone level on distal tooth, mesial aspect. Point 9: distal tooth, at CEJ on mesial side. Point 10: apex of distal tooth. Point 11: distal tooth, at CEJ on distal side.*

The following linear measurements were then recorded:

A: Anatomic root length of tooth medial to cleft in mm

B: Distal alveolar bone height of tooth medial to cleft in mm

C: Distal alveolar crest location of tooth medial to cleft in mm

D: The perpendicular distance from highest point of notch to CEJ midline in mm

E: Anatomic root length of tooth lateral to cleft in mm

F: Mesial alveolar bone height of tooth lateral to cleft in mm

G: Mesial alveolar crest location of tooth distal to cleft in mm

Computer application CorelDraw suite 15 was used to make the linear measurements with the precision of three decimal points. (See Figure2 b, d)

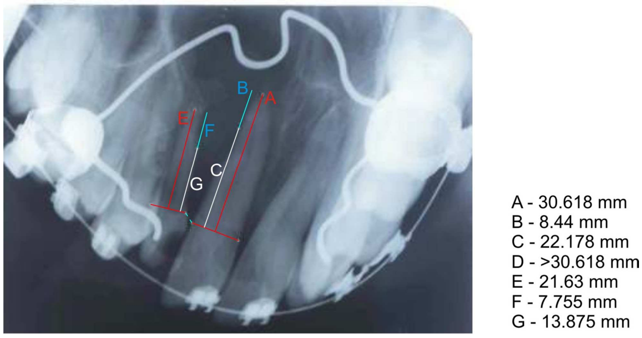

Figure 2b. *Linear measurements recorded on Pre operative Occlusal radiographs using CorelDraw suite 15.*

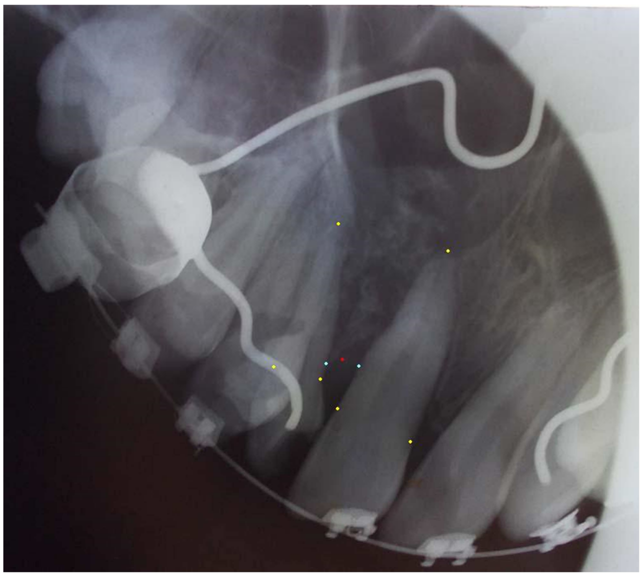

Figure 2c. *Reference points marked on Post operative Occlusal radiographs using Microsoft Paint application Point1: mesial tooth, at CEJ on mesial side. Point 2: apex of mesial tooth. Point 3: mesial tooth, at CEJ on distal side. Point 4: most coronal bone level on mesial tooth, distal aspect. Point 6: most apical level of bony bridge between mesial and distal teeth. Point 7: most coronal bone level on distal tooth, mesial aspect. Point 9: distal tooth, at CEJ on mesial side. Point 10: apex of distal tooth. Point 11: distal tooth, at CEJ on distal side.*

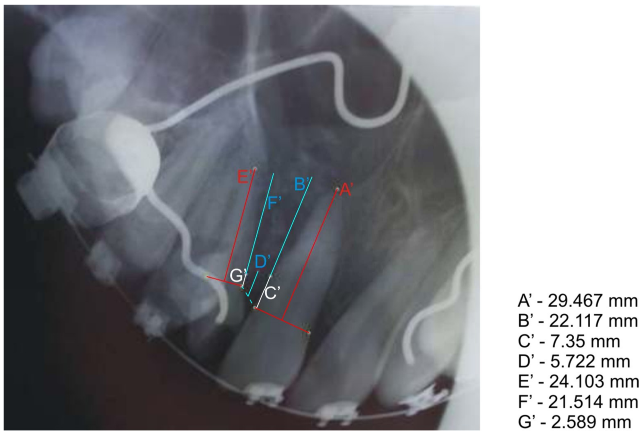

Figure 2d. *Linear measurements recorded on Post operative Occlusal radiographs using CorelDraw suite 15.*

In order to avoid the potential distortion factors of elongation and foreshortening, all the absolute measures were converted to ratio measurements using the various measures of alveolar bone height (Variables B, C, D, F & G as in Figure1) as the numerator and the root length of the cleft adjacent teeth as the denominator (Variables A & E).The study parameters thus devised were

a) Medial alveolar bone support – B/A (Pre Op), B`/A` (Post Op)
b) Medial alveolar crest defect – C/A (Pre Op), C`/A` (Post Op)
c) Lateral alveolar bone support – F/E (Pre Op), F`/E` (Post Op)
d) Lateral alveolar crest defect – G/E (Pre Op), G`/E` (Post Op)
e) Cleft Depth – D/A (Pre Op), D`/A` (Post Op)

All variables measured were cleft characteristics that were expressed as a function of the total number of clefts, not the total number of patients. Ideal value for medial and lateral alveolar bone support (B/A & F/E) would be 1, ie alveolar bone fully extending to cemento - enamel junction and the least possible value could be 0, i.e. no alveolar bone support from apex to CEJ. For cleft depth (D/A) and medial and lateral alveolar crestal defects, ideal value would be 0, ie no alveolar notching and no crestal bone defects. If alveolar notching extended, till the root apex of cleft adjacent tooth or beyond, the cleft depth (D/A) was taken as 1 for calculations. The cleft graft was considered a failure when no additional bone support was obtained on either teeth adjacent to the cleft and alveolar notching extended up to or beyond the apex of neighboring teeth.

The statistical analysis was designed to satisfy the declared objectives. To test the statistical significance of the difference in mean values of the parameters before and after surgery, paired t test was applied. Pearson`s correlation coefficient was computed to study the correlation between pre surgical values of cleft depth/alveolar bone support and surgical outcomes.

4. Results

The study population included 17 cleft sites from thirteen consecutive cleft lip and palate patients. Out of thirteen patients, 9 had unilateral cleft lip and palate and 4 had bilateral cleft lip and palate. The bilateral cases underwent grafting of both sides in the same surgical procedure. All cleft grafts were done by the same surgeon with ample experience. Pre-surgical expansion of the maxillary arch was done prior to grafting in very narrow clefts to facilitate graft placement and subsequent suturing. The age of patients at the time of surgery ranged from 11 years to 20 years. Graft was harvested from anterior iliac crest for all patients.

The absolute values of linear measurements recorded from the pre-operative and post-operative radiographs are given in Table 1.

Table 1. *Absolute values of linear measurements.*

cleft	A	A`	B	B`	C	C`	D	D`	E	E`	F	F`	G	G`
1	24.369	27.53	13.119	24.282	11.250	3.248	-	3.275	20.242	25.589	18.888	24.277	1.354	1.312
2	27.684	17.856	9.156	16.537	18.528	1.319	-	2.563	16.355	10.608	7.043	8.401	9.312	2.207
3	15.069	17.245	10.763	14.001	4.306	3.244	-	0.766	27.908	25.738	26.439	25.114	1.469	0.624
4	48.313	16.915	35.7	12.833	12.613	4.082	-	3.423	24.883	18.273	19.603	16.157	5.28	2.116
5	26.727	21.245	5.868	20.069	20.859	1.176	-	3.988	25.79	17.596	23.38	13.86	2.41	3.736
6	23.652	27.381	15.737	20.791	7.915	6.59	-	5.226	34.355	20.4	15.089	19.814	19,266	0.586
7	30.618	29.467	8.44	22.117	22.178	7.35	-	5.722	21.63	24.103	7.755	21.514	13.875	2.589
8	19.236	18.347	11.869	17.748	7.367	0.599	-	0	18.605	15.024	15.164	13.41	3.441	1.614
9. R	17.699	16.222	9.788	14.044	7.911	2.178	-	2.042	20.975	22.041	20.02	20.57	0.955	1.471
L	19.202	17.132	15.165	15.888	4.307	1.244	-	3.758	21.644	21.756	15.304	21.396	6.34	0.36
10.R	21.562	8.035	16.314	7.412	5.248	0.623	-	0	29.243	15.431	23.984	14.345	5.259	1.086
L	23.33	11.07	20.878	11.07	2.452	0	-	0	23.16	16.494	17.129	14.857	6.031	1.637
11, R	24.338	28.319	0	11.352	24.338	16.967	-	13.118	37.11	34.483	3.092	33.535	34.018	0.948
L	20.416	22.515	3.994	12.14	16.422	10.375	-	5.801	25.58	30.388	13.812	29.7	11.768	0.688
12	29.788	25.003	27.631	21.697	2.157	3.306	-	7.978	39.4	40.383	31.03	37.005	8.37	3.378
13. R	17.364	12.067	16.392	11.784	0.972	0.283	-	3.04	15.197	17.103	13.974	16.67	1.223	0.433
L	17.161	12.768	15.665	11.762	1.496	1.006	-	3.444	22.51	21.059	17.525	19.841	4.985	1.218

The study parameters i.e. ratio measurements computed from the absolute values are given in Table 2.

Table 2. *Values of parameters (n=17).*

B/A	B`/A`	C/A	C`/A`	D/A*	D`/A`	F/E	F`/E`	G/E	G`/E`
0.538	0.882	0.462	0.117	1	0.118	0.933	0.948	0.066	0.051
0.331	0.926	0.669	0.074	1	0.144	0.431	0.792	0.569	0.208
0.714	0.812	0.286	0.188	1	0.044	0.947	0.976	0.053	0.024
0	0.401	1	0.599	1	0.463	0.083	0.973	0.917	0.027
0.196	0.539	0.804	0.461	1	0.258	0.54	0.977	0.46	0.023
0.928	0.868	0.072	0.132	1	0.319	0.788	0.916	0.212	0.084
0.739	0.759	0.261	0.241	1	0.202	0.788	0.884	0.212	0.116
0.22	0.944	0.78	0.055	1	0.188	0.907	0.788	0.093	0.212
0.757	0.922	0.243	0.078	1	0	0.82	0.93	0.18	0.07
0.895	1	0.105	0	1	0	0.74	0.901	0.26	0.099
0.665	0.759	0.335	0.241	1	0.191	0.439	0.971	0.561	0.029
0.276	0.751	0.724	0.249	1	0.194	0.359	0.893	0.641	0.107
0.617	0.967	0.383	0.033	1	0	0.815	0.893	0.185	0.107
0.553	0.866	0.447	0.134	1	0.126	0.954	0.933	0.046	0.067
0.79	0.927	0.21	0.073	1	0.219	0.707	0.983	0.293	0.017
0.944	0.977	0.056	0.023	1	0.252	0.92	0.975	0.08	0.025
0.913	0.921	0.087	0.079	1	0.27	0.779	0.942	0.221	0.058

* D/A taken as 1 for calculations, in cases where cleft extended beyond root apex (i.e D >A).

4.1. Changes in Bone Morphology

In all the cases, pre-operative margins of the cleft extended beyond medial root apex and D/A was taken as 1 for calculation. Post-operatively, none of the clefts in the study showed cleft depth equal to or more than 1.There was substantial improvement in both medial and lateral alveolar bone support.

Results obtained with paired t test showed *statistically significant* differences in all the study parameters brought about by SABG as evident from Table 3.

4.2. Medial Alveolar Bone Support (B/A)

The mean of distal bone support for the mesial tooth adjacent to the cleft pre-surgically was found to be 0.593; the mean of bone support after the surgery was 0.837. This difference was found to be statistically significant (p=0.00).

4.3. Lateral Alveolar Bone Support (F/E)

Alveolar bone support on mesial aspect of tooth lateral to the cleft had a mean value of 0.703 before SABG and 0.922

after with the difference being found to be statistically significant (p=0.003).

4.4. Medial Alveolar Crest Defect (C/A)

Pre surgical medial crestal loss accounted for a mean of 0.407 whereas the post surgical mean was 0.163. The difference had statistical significance (p=0.00).

4.5. Lateral Alveolar Crest Defect (G/E)

This parameter had a mean pre SABG value of 0.297 and the matching post SABG value was 0.078. This difference also was statistically significant (p=0.003).

4.6. Cleft Depth (D/A)

Alveolar notching of the cleft had the same value of 1 for all patients before grafting as their clefts extended to or beyond the root apex. But after grafting, the mean value dropped to 0.176. Again this difference was found to be statistically significant (p=0.00).

4.7. Influence of Bone Support On Surgical Results

To determine whether the pre surgical values of cleft depth/alveolar bone support has an impact on surgical outcomes, Pearson's correlation coefficient was computed for all the five variables, namely Medial alveolar bone support (B/A), Medial alveolar crest defect (C/A), Lateral alveolar bone support (F/E), Lateral alveolar crest defect (G/E) & Cleft Depth (D/A).Statistically significant correlation was observed for the first two variables, viz. medial alveolar bone support (B/A) and medial alveolar crest defect (C/A) with P value 0.004 for both (Table 4). For the variable cleft depth (D/A), correlation cannot be computed because pre operative values for the variable was constant, 1 in all cases.

Table 3. *Descriptive statistics for bone morphology ratios.*

Variable	Phase	Mean	Std deviation	P value
Medial alveolar bone support (B/A)	Pre Op	0.593	0.291	0.000
	Post Op	0.837	0.16	
Medial alveolar crest defect (C/A)	Pre Op	0.407	0.291	0.000
	Post Op	0.163	0.16	
Lateral alveolar bone support (F/E)	Pre Op	0.703	0.248	0.003
	Post Op	0.922	0.06	
Lateral alveolar crest defect (G/E)	Pre Op	0.297	0.248	0.003
	Post Op	0.078	0.06	
Cleft Depth (D/A)	Pre Op	1.000	0.000	0.000
	Post Op	0.176	0.124	

Table 4. *Bivariate correlations for study variables.*

Variable	Correlation	Pvalue
Medial alveolar bone support (B/A)	0.655	0.004
Medial alveolar crest defect (C/A)	0.654	0.004
Lateral alveolar bone support (F/E)	-0.030	0.908
Lateral alveolar crest defect (G/E)	-0.029	0.912
Cleft Depth (D/A)	Cannot be computed	

Table 5. *Comparison with popular studies in the literature.*

Variable	Phase	Current study	Aurouze et al	Long et al
Medial alveolar bone support (B/A)	Pre Op	0.59	0.75	0.72
	Post Op	0.84	0.88	
Medial alveolar crest defect (C/A)	Pre Op	0.41	0.22	0.24
	Post Op	0.16	0.10	
Lateral alv bone support (F/E)	Pre Op	0.70	0.84	0.86
	Post Op	0.92	0.93	
Lateral alv crest defect (G/E)	Pre Op	0.3	0.15	0.14
	Post Op	0.08	0.60	
Cleft Depth (D/A)	Pre Op	1 (all cases)	1 (94% cases)	0.32
	Post Op	0.18	0.12	

5. Discussion

Cleft lip and palate causes considerable morbidity to affected children and imposes a substantial financial risk for families. Treatment of these children involves a team of interdisciplinary specialists and spans several years with multiple surgeries.

For better results, cleft management teams around the globe have described specific protocol designs for treatment. Alveolar bone grafting of the cleft maxilla is an important part of the rehabilitation of patients with clefts of the lip and palate[11]. Though controversies exist, SABG is the most widely accepted approach[12]. A major concern following SABG is the risk of resorption of the grafted bone transplant[11]. It is mandatory to assess the graft take before proceeding with further treatments. Quantifying bone graft outcomes allows the clinician to reflect on the bone grafting protocol rendered and helps to apply statistics that provide the data necessary to make evidence-based decisions regarding the treatment protocols used, and their improvisation[13].

Different imaging modalities including radiographs[4, 5, 7, 8, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26], USG[27], CT[9, 11, 28, 29, 30] and CBCT[31] have been utilized to appraise the success of grafting with varying advantages. We adopted dental occlusal radiograph as the assessment tool for evaluating the outcome of SABG considering its easy availability, accessibility and affordability as well as avoidance of potential radiation hazards[31, 32]. The changes in alveolar bone support and cleft notching after alveolar grafting were assessed using standardized serial radiographs.

The results presented indicates the success of cleft grafting in increasing the alveolar bone support of teeth in the vicinity of cleft as well as cleft depth reduction. Statistically significant differences in all the study parameters before and after SABG, confirms the benefits of this surgical procedure.

Medial alveolar bone support (B/A) of 0.84 obtained in this study post surgically is comparable to the means obtained by Long etal, 0.72 and Auroze et al, 0.88. Other values for comparison are given in table 5. Preoperatively, depth of cleft extended beyond apex in all our subjects. This was 94% in the Aurouze sample. However none of these 5 parameters had statistically significant differences in that study.

Analysis of post-operative bony contour adjacent to cleft showed that lateral alveolar bone support was consistently higher (with a mean value of 0.92 for this study, 0.93 for Aurouze et al and 0.86 for Long et al) than medial alveolar bone support (with a mean value of 0.84 for this study, 0.88 for Aurouze et al and 0.72 for Long et al) in all these studies. Long et al attributed this difference to the eruption of the mesial tooth into an unfavorable position prior to the alveolar bone grafting surgery[4]. As a corollary, alveolar crest defect was more on medial part than on lateral part with concurrence for these studies.

31% of our patients (4 in 13) had supernumerary teeth, which is higher than the mean value (16.05%) quoted by Lopez LD *et al.* (1991)[33]. 3 patients had single supernumerary tooth and a bilateral case had one on each side. Lateral incisor was missing in 3 out of 13 patients, matching with dental anomaly data for cleft group[34].

Conforming to the evidence in the existing literature that left sided clefts are more than right sided clefts [35], 67% (6 out of 9) of our UCLP patients had cleft on left side and 33% on right side. The ratio of 2:1 for left side to right side in UCLP found in this study is conforming to the ratio obtained by Dewinter *et al*(2003) and Akcam MO *et al*(2010)[36].

Patients with alveolar clefts have a significantly higher risk for canine impaction compared with patients without clefts[36], was substantiated by the fact two of our patients had impacted canines. In a UCLP male patient both upper permanent canines were impacted and left upper canine was impacted for a girl with UCLP. These impacted teeth were removed for both these patients.

None of our patients had serious complications following SABG. One UCLP case had some graft extrusion postoperatively. However graft take was good on long term. Another BCLP patient had mild graft exposure in the post operative period on left side which was trimmed to bleed. Eventually, it healed well, and the canine erupted through the graft. Another BCLP patient had fever with increased CRP in the immediate post operative period and was managed with antipyretics.

Most of the similar studies in the literature utilized categorical variables. As we used continuous variables and ratio measurements, nonparametric tests could be applied. This improves the statistical information made available by the data.

Statistically and clinically significant differences were achieved in all alveolar bone contour parameters. The good success rate may be attributed to the experience of the surgeon, strict asepsis and sterilization, meticulous technique and excellent supportive care given by motivated caregivers mostly parents.

During the course of this investigation, some limitations were noted. These include the small sample size, use of 2D images for outcome analysis and non inclusion of cleft width as an additional parameter. One of the reference points in this study is root apex of tooth in the vicinity of the cleft which serves as the denominator for more than one variable studied. If the cleft adjacent tooth roots are not fully developed, it may be difficult to apply the stated measurement methods. Incidentally our sample did not have cleft adjacent teeth with incomplete root formation though some of them were unerupted at the time of SABG. But it is quite possible for any random case to have developing roots.

In our opinion, the presented method gives a fair idea about the amount of bone available for planning further therapy after SABG. Advanced imaging modalities like CT/CBCT, allows more precise determination of the exact amount of bone resorption in all three dimensions. However, the actual significance of such an accurate measurement of bone in the cleft site is questionable. As is well known, the most important factor in success is the achievement of bony continuity bridging the cleft alveolus with adequate bone present to facilitate survival of teeth, their orthodontic movement and a functional and aesthetic arch alignment.[11]

6. Conclusion

With the evolution of newer practices and novel techniques in cleft lip and palate management, appropriate tools to validate their utility and scales to assess their success are needed. Numerous research studies have tried to objectively assess the outcomes with the hope that this knowledge would eventually result in improved care and prognosis for individuals with these conditions.

The intention of this study was to quantify the enhancement brought about by SABG in terms of alveolar bone support of cleft adjacent teeth and reduction in alveolar notching. The current study with statistically and clinically relevant endpoints in terms of success enabled us to acquire insights into the characteristics and pre-surgical determinants of SABG success. Better bone graft take as evidenced by the thorough improvement in medial and lateral alveolar bone support of teeth near cleft and worthwhile reduction in cleft depth reinforces the rationale of SABG in indicated cases of cleft maxilla. Also, in concurrence with other researchers, we could identify that preoperative medial alveolar bone support has a positive correlation with SABG success. Critically analyzing the weaknesses of this initial short duration study, we advocate further research works on SABG outcome analysis with larger sample size and long term follow up which should have substantial contributions to cleft management community.

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