

Outcome of Secondary Alveolar Cleft Reconstruction by Iliac Crest Bone Graft

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ABSTRACT

Objective: To determine the outcome of iliac crest graft use in secondary alveolar reconstruction.

Study Design: Prospective observational study

Place and Duration of Study: Oral and Maxillofacial Surgery Department of Saidu Teaching Hospital, Saidu Sharif, Pakistan, from September, 2024 to April, 2025.

Methodology: A total of 65 patients with cleft lip and/or palate who underwent iliac crest bone grafting were studied. Patients were categorized based on Bergland scores at four months post-surgery, with successful reconstruction defined as a score ≤ 3 . Furthermore, to assess the cosmetic outcome, patients' satisfaction with their postsurgical looks was assessed as "Satisfied", "Neutral" and "Dissatisfied".

Results: The majority of patients were male 55 (84.6%), with 53 (81.5%) presenting with cleft lip and palate and 56 (86.2%) unilateral cases. The mean Bergland score was 2.01 ± 0.92 , with 62 (95%) achieving satisfactory graft outcomes. Complications were infrequent, with infection 3 (4.6%), resorption 5 (7.7%), and suture dehiscence 2 (3.1%). Patient satisfaction and post-surgical complications were significantly associated with graft success ($p < 0.001$).

Conclusion: Iliac crest bone grafting for secondary alveolar cleft reconstruction yields high success rates, supporting both functional integration and cosmetic satisfaction. Careful patient selection and postoperative monitoring are critical for optimizing outcomes.

Keywords: Alveolar cleft reconstruction, Cleft lip, Cleft palate, Iliac crest bone graft.

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INTRODUCTION

Among the prevalent craniofacial anomalies is the oral cleft: occurring in as many as 1 in 700 births with 1.6 times higher involvement of males.¹ Both the variants: cleft lip and palate eventually require the coverage of the deficient alveolar bone.² This is done by bone grafting; which can be performed at various dentition development period. Primary grafting is done during deciduous stage; whereas secondary bone grafting is done at time of mixed dentition stage.^{3,4} At present, secondary alveolar grafting is the choice. Cancellous bone is a better bone source because of osteo-conduction and osteo-induction properties: it not only incorporates but also responds to the physiologic and functional demand of arch expansion and tooth movement.⁵ The Bergland's criteria is a simple, practical and reproducible method of alveolar grafting outcome assessment. The criteria evaluates occlusional level of interdental bone and compares it to the normal side.⁶⁻⁸

The objective of this study was to determine the

outcome of iliac crest graft in secondary alveolar reconstruction. This will help establish and document the efficacy of iliac bone graft in secondary alveolar cleft. Efficacy of bone graft in alveolar cleft reconstruction has not been studied in our center. Consequently, this study will fill the gap in knowledge of the pathology and its reconstruction; hence will help doctors in our community to develop best practice guidelines regarding management of the disease based on locally generated data.

METHODOLOGY

This prospective observational study was conducted at the Oral and Maxillofacial surgery department, Saidu Teaching Hospital, Saidu Sharif. The study period extended from 1st September, 2024 to 30th April, 2025. By using WHO sample size calculator a sample size of 65 was determined; using 95% confidence interval, 5.3% margin of error and taking 95% successful incorporation with Bergland's score of 3 or less.⁹

Inclusion Criteria: Patients of both genders and aged 6–13 years with early/late mixed dentition who underwent iliac crest graft reconstruction of secondary alveolar defect. Secondary alveolar cleft reconstruction

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is bone grafting done at time of mixed dentition stage i-e 6 to 13 years of age.

Exclusion Criteria: Patients who had history of immunodeficiency like diabetes, leukemia or lymphoma or those with insufficient volume of iliac bone quantified by absence of 5 cm or more bone at iliac crest of either side as per a AP pelvis X-ray were excluded. Similarly those lost to follow-up were not included.

The sampling was started after obtaining ethical approval from institutional review board of the aforementioned hospital (ref no: t3-/F/ZB/D2ct: dated: 26th August, 2024). Non-probability convenient sampling technique was used to assess a total of 65 cases of cleft lip or cleft palate that presented to that out-patient clinic of aforementioned hospital. Assessment of each case started with taking an informed consent from the patients' parents. During the consenting process the parents were informed about the purpose, benefits and risks involved in the study. All these cases were thoroughly assessed in terms of history and clinical examination. Required data including demographic characteristics including name, age, gender, weight, type of cleft, address, hospital/ward number and contact number were entered into a preformed proforma. The patients were managed for the illness as per the hospital guidelines. The procedure of grafting was performed under general anesthesia. Alveolar ridge site was opened, then floor of the defect was prepared to receive particulate graft. After this, the graft was taken from iliac crest. It was prepared to get a particulate material and then was placed on the previously prepared floor; followed by closure with 4-0 vicryl. At 4 months postoperatively patients were assessed and rated as per the Bergland's criteria.^{10,11} (Figure). Bergland' score of 3 or less, at 4-month follow-up was considered as successful reconstruction. Whereas, Bergland score of four on 4-month follow-up was considered unsuccessful. Bergland score is a four-point scale used to compare the interdental height of the grafted bone with normal/unaffected side on X-ray and is categorized as: Grade-I: Bone septum of approximate normal height, up to the cemento-enamel junction, Grade-II: Septum height at least 3/4 of normal height, Grade-III: Septum height less than 3/4 of the normal height, Grade-IV: No continuous bony bridge across the cleft, which is failure.^{12,13}

All the data collected from the study group was entered into Statistical Package for Social Sciences (SPSS) version 23. Categorical variables, including

gender, type of cleft, Bergland's score, and outcome were presented in terms of frequencies and percentages, whereas quantitative variables, including age and weight were presented in terms of measures of central tendencies: mean and standard deviation. Data was stratified according to age, gender, weight, and type of cleft to see the effect modification. Post-stratification chi-square was applied. All p -value $\leq$.05 was considered significant.

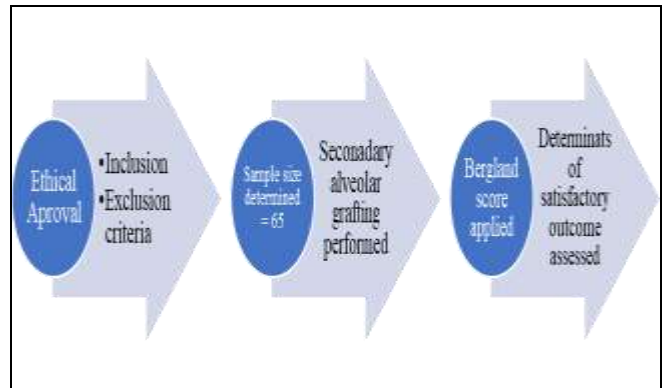


Figure: Patient Flow Diagram

RESULTS

The study included 65 individuals, predominantly male: 55(84.6%). The majority of patients were male 55(84.6%), with 53(81.5%) presenting with cleft lip and palate and 56(86.2%) unilateral cases. The majority 49(75.4%) had non-erupted canines. Complications were infrequent, with infection 3(4.6%), resorption 5(7.7%), and suture dehiscence 2(3.1%). Shapiro Wilk analysis was performed to confirm normal distribution of the date. The mean age of participants was 8.91 years ($\pm$ 2.18), and the mean Bergland score was 2.01 ($\pm$ 0.92) (Table-I).

Table-I: Descriptive Statistics of the Study Patients (n=65)

Variables		n (%)
Gender	Male	55(84.6%)
	Female	10(15.4%)
Pathology	Cleft Lip Involving Alveolar Ridge (CL)	12(18.5%)
	Cleft lip and palate (CLP)	53(81.5%)
Cleft laterality	Unilateral	56(86.2%)
	Bilateral	9(13.8%)
Canine state	Non-erupted	49(75.4%)
	Erupted	16(24.6%)
Complications	None	55(84.6%)
	Infection	3(4.6%)
	Resorption	5(7.7%)
	Suture dehiscence	2(3.1%)
Age (years)	Mean $\pm$ SD	8.91 $\pm$ 2.18
Bergland score	Mean $\pm$ SD	2.01 $\pm$ 0.92

Table-II presents the distribution of Bergland score outcomes using two pie charts. The first chart shows that 95% of cases had satisfactory and only 5% had unsatisfactory results. The second chart further breaks down the satisfactory outcomes: 37% had Bergland score 1, 29% had Bergland score 2, and 29% had Bergland score 3. Table-III is showing the distribution of patient satisfaction level with the cosmetic results. It categorizes responses into Satisfied, Neutral, and Dissatisfied, with blue representing Satisfied (the largest portion), orange for Neutral, and gray for Dissatisfied (the smallest portion).

Table-II: Distribution of Final Bergland Score (n=65)

Distribution of Final Bergland Score	Outcome (Bergland Score)
4 (unsatisfactory)	3(4.6%)
3 (satisfactory)	19(29.2%)
2 (satisfactory)	19(29.2%)
1 (Satisfactory)	24(37.0%)

Table III: Distribution of Patient Satisfaction with regards to Cosmetic Results (Subjective outcome) (n=65)

Distribution of patient satisfaction	n(%)
Satisfied	42(64.6%)
Neutral	17(26.2%)
Dissatisfied	6(9.2%)

Table-IV presents the association between different variables and Bergland outcome classifications (Satisfactory vs. Unsatisfactory), analyzed using chi-square tests. Gender, Cleft Type, Cleft Laterality, and Canine Eruption showed no significant associations with Bergland outcome (p -values > 0.05).

Table-IV: Association of the Studied Variables with the final outcome as per Bergland Score (n=65)

Variables	Bergland Outcome		p-value
	Satisfactory (n=62)	Unsatisfactory (n=3)	
Gender			
Male	53(85.5%)	2(66.7%)	0.399
Female	9(14.5%)	1(33.3%)	
Cleft type			
Cleft lip	11(17.7%)	1(33.3%)	0.464
Cleft lip and Palate	51(82.3%)	2(66.7%)	
Cleft laterality			
Unilateral	54(87.1%)	2(66.7%)	0.365
Bilateral	8(12.9%)	1(33.3%)	
Canine	48(77.4%);	1(3.33%);	0.147
MNnerupted : erupted)	1422.6%)	2(66.7%)	
Patient satisfaction			
Satisfied	42(66.7%)	0(0.0%)	<0.001
Neutral	17(27.4%)	0(0.0%)	
Dissatisfied	3(4.8%)	3(100.0%)	
Complications			
None	55(88.7%)	0(0.0%)	<0.001
Infection :	3(4.8%)	0(0.0%)	
Resorption :	2(3.2%)	3(100.0%)	
Dehiscence	2(3.2%)	0(0.0%)	

Patient Satisfaction demonstrated a significant correlation ($p < 0.001$), with dissatisfaction being more common among cases rated unsatisfactory as per Bergland score analysis. Complications exhibited a strong significant association ($p < 0.001$), as resorption and infections appeared only in Bergland's unsatisfactory cases. Overall, patient satisfaction and post-surgical complications were statistically linked to Bergland outcomes, while other factors showed no clear impact.

DISCUSSION

This study provides valuable insights into the determinants of surgical success in cleft lip and palate cases, primarily assessed through the Bergland classification. The predominantly male cohort (84.6%) and the high prevalence of unilateral clefts (86.2%) align with established epidemiological trends, reinforcing prior observations regarding gender and laterality distributions. Tomar *et al.*, assessed uptake of iliac crest done as secondary alveolar graft and found out that 95% of the grafts got successfully incorporated with Bergland's score of 3 or less.¹⁴ Among the local data are the findings of Lahooti and co-workers. They observed a Bergland score of 3 or less in 94% of the cases.¹⁵ The Bergland score outcomes indicate overwhelmingly satisfactory results, with 95% of cases classified as successful. This suggests that alveolar bone grafting procedures are effective in achieving bone continuity in most cases. The detailed breakdown of satisfactory results into Bergland scores 1, 2, and 3 reflects variability in the degree of success, yet all fall within acceptable graft integration standards. Similar results were reported by Tomar *et al* in their study. Among their study sample, 95% showed successful integration of the graft with scores of 1,2 and 3 noted in 30%, 55%, and 10% of the cases, respectively.¹⁴ Similar were the findings of Lahooti RA and co-workers. They inferred that Bergland score of 3 or less was observed in 94% of the cases.¹⁵ Thus, excellent graft consolidation was observed across the table. This can be attributed to the high-quality cancellous bone housed in iliac crest which served as a graft source in these studied cases. However, a study by Ko *et al.* using CBCT-based volumetric analysis found that while Bergland scores were satisfactory in over 80% of cases.¹⁶ Actual bone fill percentages varied significantly between orthodontically aligned and non-aligned groups (69.85% vs. 51.45%, $p = 0.0495$), suggesting that presurgical orthodontic preparation may influence volumetric outcomes even

when Bergland scores appear similar.¹⁶ This highlights a limitation of the Bergland system in capturing three-dimensional bone quality. Patient satisfaction exhibited a strong statistical correlation with Bergland scores ($p < 0.001$). Unsatisfactory Bergland classifications were associated with higher rates of dissatisfaction, emphasizing the link between objective surgical outcomes and subjective patient perceptions. The figures summarized in the table 2 further underscores this trend, as most patients expressed positive cosmetic satisfaction, while fewer reported dissatisfaction or neutral opinions. This highlights that patients generally equate Bergland success with favorable aesthetic results.

While complications were rare, their role in Bergland classification was significant ($p < 0.001$). Infections and resorption were exclusively observed in cases with unsatisfactory scores, suggesting that post-surgical complications substantially hinder bone graft success. A research conducted by Khalil and co-workers, also assessed the postoperative complications in alveolar graft cases. In their study population, 10% of cases suffered from graft infection and resorption each; while another 5% experienced suture dehiscence.¹ This finding reinforces the necessity of rigorous postoperative monitoring and preventive strategies to minimize adverse effects and optimize treatment outcomes. Comparatively, a meta-analysis by Kim et al. highlighted that the use of barrier membranes and advanced graft materials significantly reduced complication rates and improved bone regeneration, suggesting that surgical technique and biomaterial choice may be as critical as anatomical factors in determining outcomes.¹⁷

Interestingly, gender, cleft type, cleft laterality, and canine eruption failed to show significant correlations with Bergland classifications ($p > 0.05$). This suggests that inherent anatomical differences and tooth eruption status do not directly impact bone graft success. Instead, procedural factors, postoperative care, and individual healing responses appear to be more critical determinants. This finding challenges traditional assumptions about cleft morphology influencing surgical outcomes and directs attention toward modifiable clinical interventions. This aligns with findings from Oberoi *et al.*, who demonstrated that presurgical orthodontic alignment did not negatively affect root coverage or graft success, reinforcing the idea that surgical timing and technique may outweigh anatomical variations in influencing outcomes.¹⁸

LIMITATIONS OF STUDY

Among the limitations of this study were a limited sample size; predominant male cases and a relatively shorter follow-up. However, the uniformity of the surgical grafting technique in this uni-centric study helps lower technical bias. To make more solid inferences a multi-centric study of larger population and longer postoperative follow-up is welcomed.

CONCLUSION

Iliac crest usage for secondary alveolar grafting is associated with high Bergland score and leads to good patient satisfaction in postoperative period. Post-operative complications such as infection pose a risk to the graft and may ultimately result in reduced bone grafting consolidation and suboptimal outcomes.

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Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

KR & SB: Data acquisition, data analysis, critical review, approval of the final version to be published.

IA & TU: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

MTK & YR: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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