ORIGINAL ARTICLE

Radiographic Assessment of Secondary Autogenous Bone Grafting in Alveolar Cleft Patient at Kirtipur Hospital

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ABSTRACT

Introduction: Alveolar bone graft is the procedure to fill the gap in the gum with bone so the teeth and jaw can grow normally. It is an integral part and most commonly performed procedure in cleft patients. The study is aimed to evaluate the outcomes of secondary alveolar bone grafting through bone fill at alveolar defect site using 2- dimensional radiographs.

Methods: We conducted a single center prospective cohort study at Kirtipur Hospital, Nepal from July 1st, 2025 to December 30th, 2025. Patients who underwent alveolar bone graft were evaluated for outcome of grafting through bone fill seen on intra oral radiographs using Kindelan score grading at 3-4 months post operatively. Outcomes were dichotomized as successful (Kindelan score 1–2) and failure (Kindelan score 3–4).

Results: We had a total of 16 cases with 6 males (37.5%) and 10 female (62.5%) patients who had a median age 15.5 years (IQR 11.5, 18). Radiographic success as defined by Kindelan score 1–2 was achieved in 12 cases (75.0%) and failure in 4 cases (25%) with no statistically significant association between sex and radiographic success ($p = 0.234$). There was good to excellent intra-observer agreement (ICC = 0.89 & 0.96 for observer 1 & 2) and excellent inter-observer reliability (ICC = 0.96).

Conclusion: Secondary autogenous alveolar bone grafting demonstrated favorable early radiographic outcomes, with 75% of patients achieving satisfactory bone fill at 3–4 months postoperatively. The Kindelan scoring system proved to be a reliable and reproducible method for radiographic evaluation

Keywords: Alveolar cleft, alveolar bone graft, kindelan score

INTRODUCTION

Alveolar bone graft (ABG) is an integral part and most commonly performed procedure in cleft patients.[1,2] It was first described by Boyne and Sands in 1972.[3] It is performed during mixed dentition when the roots of the canines have grown to 1/2 to 1/3 of their length.[4,5] The aim of ABG is to obtain anatomical continuity of alveolar process. It closes the oronasal fistula. It also provides bony support to the nasal alae and improves the symmetry of the nose.[4,6] There are various methods of radiographic evaluation of the success of alveolar bone grafting like Bergland, Chelsea and Kindelan. All three scales were found to be equally reproducible.[7,8] ABG is a crucial surgical procedure in cleft surgery. In an effort to help with realistic patient counseling, proper case selection & surgical planning for predictable long-term outcomes, this study aims to evaluate early radiographic outcomes using the Kindelan scoring system.

METHODS

This is a cohort study of non-syndromic cleft alveolus

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patients who underwent secondary autogenous alveolar bone grafting (ABG) at Kirtipur Hospital between 1st July 2025 to 30th December 2025. Ethical approval was obtained from the Institutional Review Committee (IRC No: 211-2025). Written informed consent was taken from the patients (if 18 years of age) or their guardians. Sample size was calculated to estimate the radiographic success proportion with 95% confidence, ±10% precision, anticipated success 85%, and finite population N = 15 (cases available in the 4 months window). The calculated sample was 12; allowing 10% for loss to follow-up, the final target was 14.

All consecutive, eligible patients undergoing secondary ABG during the study period were included. Syndromic patients and those undergoing re-bone grafting were excluded. Demographic data including age and sex were recorded preoperatively. All cases were operated by a single surgeon with autogenous cancellous bone graft harvested from the iliac crest. Graft site and donor site morbidity were evaluated on 2nd, 5th and 14th post operative days clinically and clinical data were recorded. Radiographic evaluation was performed 3 months postoperatively using standardized two-dimensional oblique occlusal intra-oral radiographs. Graft integration and bone volume were assessed using Kindelan scoring system (grades 1–4) which evaluates the percentage of bone fill.

Data were entered and analyzed using Microsoft Excel. Continuous variables were summarized as mean ± standard deviation (SD) or median with interquartile range as appropriate. Categorical variables were presented as frequencies and percentages. Association between sex and radiographic success was assessed using Fisher's exact test. A p-value <0.05 was considered statistically significant.

For analytical purposes, outcomes were dichotomized as successful (Kindelan score 1–2) and failure (Kindelan score 3–4). Radiographs pre-operatively and at 3 months post-operatively, without patient identity, were selected for scoring. Two reviewers, who were not the operating surgeon, independently evaluated the measurements on 2 separate occasions, 1 week apart. The mean score for each observer was calculated and the final score was obtained by averaging the means of both observers. To assess reliability, intra-observer and inter-observer agreement were evaluated using the intraclass correlation coefficient (ICC).

RESULTS

A total of 17 non-syndromic patients who underwent secondary autogenous alveolar bone grafting were initially evaluated and consented for study inclusion. One participant was lost to follow up (due to geographic and personal barriers), which left a final cohort of 16 patients who were evaluated radiographically at 3 months postoperatively. The total number of males were 6 (37.5%) and females were 10 (62.5%). Median age recorded at time of ABG was 15.5 years (IQR 11.5, 18). Fourteen cases were unilateral (87.5%) with 13 left sided (92.85%) and 1 right sided (7.15 %) complete cleft lip, alveolus and palate and 2 (12.5 %) were bilateral cases. Three of them (18.75) had orthodontic treatment for teeth alignment before ABG.

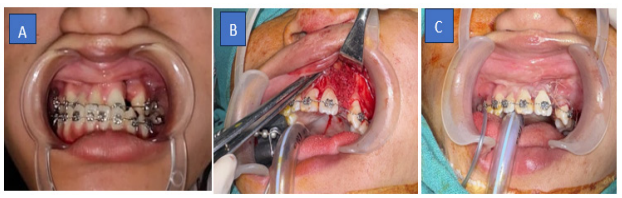

Figure 1: (A) Left alveolar cleft (B) Autogenous cancellous iliac graft at alveolar defect (C) Closure of defect after bone grating

All demographic variables are presented in Table I.

Table 1: Demographic and clinical characteristics of patients

Demographic Variable	Number	Percentage
Male	6	37.5%
Female	10	62.5%
Age (median, IQR)	15.5 years (11.5,18)	
Diagnosis Side		
Right	1	6.25%
Left	13	81.25%
Bilateral	2	12.50%
Distance to Hospital (median, IQR)	185 Kms (45, 272)	

The median time for post-operative radiograph for scoring was 3.35 months (IQR 3.07, 3.85). The median

Kindelan score was 2 (IQR 2, 2). Scores were ranged from 1 to 4. Radiographic success as defined by Kindelan score 1–2 was achieved in 12 cases (75.0%) and failure in 4 cases (25%).

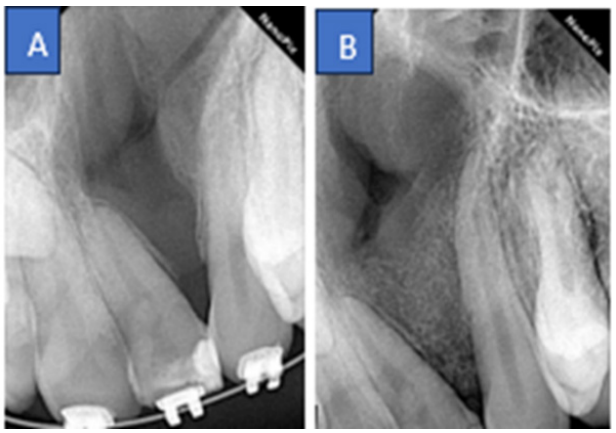

Figure 2: (A) Pre-operative radiograph showing defect (B) 4.25 months post operative radiograph showing good bone fill

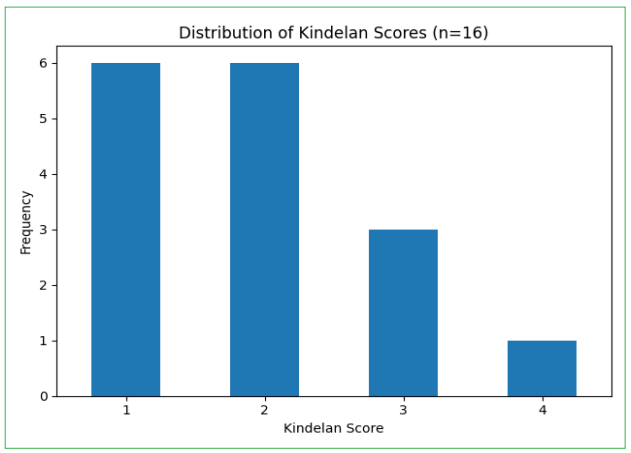

Figure 3: Distribution of Kindelan Scores

A Fisher's exact test showed no statistically significant association between sex and radiographic success (p = 0.234).

Post operative complications were seen in two cases (12.5%). One patient (6.3%) showed opening of flap near 2-3 mm at grafted site, which healed by itself with oral hygiene measures. Another patient developed a donor site seroma noticed on 5th post operative day which was managed conservatively. There was a complete graft loss in 1 patient (6.3%) corresponding to a Kindelan score 4. Observer reliability analysis demonstrated good to excellent intra-observer agreement (for observer 1, ICC = 0.89 and for observer 2, ICC = 0.96) and excellent inter-observer reliability (ICC = 0.96).

DISCUSSION

This study demonstrated favorable early radiographic outcomes following secondary autogenous alveolar bone grafting (ABG), with a success rate of 75% at 3–4 months postoperatively. Similar favorable outcomes have been reported in previous studies evaluating secondary ABG using standardized radiographic scoring systems.[3,5,9] The median Kindelan score of 2 (IQR 2, 2) indicates that most patients achieved satisfactory alveolar bone fill, reflecting adequate graft integration during the early postoperative period.

Radiographic evaluation remains fundamental in assessing graft integration. Although Computed Tomography (CT) appears to give a better assessment than intraoral radiographs, studies have shown acceptable correlation between them for bone estimates.[9] Two-dimensional (2D) radiographs are widely used in clinical practice due to its practicality and lower radiation exposure. 2D radiographs provide a cost-effective and accessible method for routine postoperative assessment.[2,4] The Kindelan scores that use 2D radiograph have noted good reliability.[10,11] Furthermore, it provides a simple and reproducible tool for assessing alveolar bone graft.

The observed success rate of 75% in this study is comparable with previously reported outcomes in the secondary ABG literature. Variations in reported success rates across studies may be attributed to differences in patient age at grafting, cleft morphology, surgical technique, graft handling, and orthodontic timing.[5,6] Careful patient selection and optimal surgical timing are recognized determinants of favorable outcomes. Furthermore, long-term studies have emphasized the importance of graft integration in facilitating canine eruption and arch continuity, which are essential for functional and aesthetic rehabilitation.[12,13]

No statistically significant association was observed between sex and graft success. Graft success depends more on timing of grafting, cleft morphology, surgical technique and orthodontic management rather than demographic variables alone.[5,6]

One patient in study developed a donor-site seroma that resolved with conservative management, and another patient had complete graft loss. These complications are consistent with previously reported morbidity associated with autogenous iliac crest bone grafting. Careful surgical technique, meticulous soft tissue closure and postoperative monitoring remain essential to minimize these risks.

The study shows strong intra-observer (ICC = 0.89 and 0.96) and excellent inter-observer reliability (ICC = 0.96), which confirms the reproducibility of the Kindelan scoring system. Comparable reliability findings have been reported in previous studies evaluating radiographic grading systems for alveolar bone graft assessment.[8,11] The high reliability values in this study further strengthen the validity of the radiographic findings.

Prospective studies assessing clinical parameters alongside radiographic grading may also provide a more comprehensive understanding of functional outcomes. Although early radiographic success was favorable in the majority of cases, continued follow-up is necessary to evaluate long-term stability. The limitations of this study include the relatively small sample size and short follow-up. Future studies incorporating larger cohorts and volumetric imaging may provide further insight into graft maturation and stability.

CONCLUSION

Secondary autogenous alveolar bone grafting demonstrated favorable early radiographic outcomes, with 75% of patients achieving satisfactory bone fill at 3–4 months postoperatively. Two-dimensional radiographic assessment remains a practical, accessible and clinically valuable tool for monitoring early graft success in patients with cleft alveolus. The Kindelan scoring system proved to be a reliable and reproducible method for radiographic evaluation

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