Evaluation of unilateral cleft lip and palate using anthropometry measurements post-alveolar bone grafting

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Abstract. Rehabilitation of patients with unilateral cleft lip and palate (UCLP) requires multiple steps and coordination of multidisciplinary sciences to produce optimal results. Alveolar bone-grafting (ABG) is an important procedure in the treatment of such patients because it influences the eruption of teeth and stabilizes the maxilla. To evaluate the effect and suitability of alveolar bone grafting procedure at Cleft Center Harapan Kita Maternal and Child Hospital on nasal deformity from anthropometry with photogrammetry and aesthetic proportional in patients with unilateral cleft lip and palate with UCLP. Patients with UCLP were evaluated post-ABG using anthropometry and photogrammetry to investigate the results anteriorly, laterally, and basally. Anthropometric measurements taken photogrammetrically used 14 points and 11 distance items. Evaluations were made of upper lip length, upper lip projection, and nostril sill elevation for both the cleft and non-cleft sides of patients’ faces. A t-test showed that the values for upper lip length and projection were significantly increased, and a correction test using a Fisher exam gave a value of 1. The ABG treatment protocol for patients with UCLP at the Cleft Lip and Palate Unit at Harapan Kita Maternal and Child Hospital is suitable to be performed; it aesthetically satisfies patients and their families.

1. Introduction

Treatment for patients with unilateral cleft lip and palate (UCLP) consists of several procedures that require the cooperation of multiple disciplines and continuous treatment to achieve optimal results. Alveolar bone grafting (ABG) is an important procedure for treating cleft lip and palate, introduced by Boyne and Sands in 1972 [1-3]. Studies have reported that the proper time to perform ABG varies based on teeth development patterns [2]. Jia et al. found that the proper time to perform ABG is between the ages of 9 to 11 years after considering maxillary canines that have not erupted and ensuring that the type of cleft is conducive to successful ABG procedures [4].

ABG affects the eruption of teeth and maxilla stability in patients with UCLP, although some reports state that such procedures has no significant effect on nasal morphology, symmetry, and nostril shape [2,5]. Nasal deformity caused by poorly treated defects during initial operations and defects that develop with growth cause problems for patients with cleft lip and palate. Because the results of the ABG procedure can affect patients psychologically, a proper and comprehensive examination post-ABG is needed, using direct measurements taken anthropometrically and indirect measurement taken photogrammetrically. Thus, this study provides data for successful ABG results for nasal deformities among patients with cleft lip and palates.

2. Materials and Methods

This study used a retrospective, cross-sectional design in which anthropometry and photogrammetry measurements were taken of patients to assess the clinical appearance of UCLP after ABG. The study took place at Harapan Kita Maternal and Child Hospital, Jakarta in the Cleft Lip and Palate Unit from
May 2014 to June 2014. The subjects were UCLP patients who underwent ABG, ranging from 9 to 11 years, and the procedures took place between 2007 and 2012. The inclusion criteria were non-syndromic, UCLP patients, patients that underwent ABG of the iliac bone between the ages of 9 and 11 years, patients that underwent pre-bone graft orthodontic treatments, patients born normally with minimum birth weights of 2,500 gram, and patients that had follow up visit 12 months post-ABG. The exclusion criteria were patients that did not come for follow up visit periodically and patients with scarring or dehiscence in the nasal area. The independent variable was nasal deformity, the dependent variable was bone grafting, and the controlled variables were the oral surgeon who performed procedures, the orthodontist who performed all pre-ABG orthodontic treatments, and the age of patients.

First, subject data were gathered from medical records from the Cleft Lip and Palate Unit for patients who underwent ABG from 2007 to 2012 between the ages of 9 to 11 years. Based on the data gathered, patients were chosen who met the inclusion criteria. Informed consent was provided by the subjects, and facial soft tissue measurements (i.e., anthropometry) were taken using photogrammetry. Photogrammetry was performed by positioning the subjects in a chair one meter from a blue background, asking subjects to relax their facial expressions, and ensuring that hair did not cover the right or left ears. Subjects looked straight ahead, with their chins parallel to the ground (i.e., Frankfurt horizontal). The photogrammetry measurements were taken by a camera positioned one meter away from the subjects, and subject profiles were taken in three directions: anterior, lateral, and basal. The measurements were repeated three times, and the results were based on landmarks recorded in table form. Then, measurements of nasal deformities were compared to the non-deformed side of each patient’s face. A reliability test was conducted using a t-test standard value (p < 0.05). Secondary data were analyzed by transforming data from photogrammetry measurements into a table, which was analyzed in SPSS 12.0 (Chicago, IL, USA).

3. Results and Discussion

3.1 Results

The study was held in the Cleft Lip and Palate Unit at RSAB from May to June 2014. Some patients had already undergone an ABG procedure at a mean age of 11 years. Nasal deformities were evaluated using photogrammetry measurements with points and lines used as landmarks based on anthropometry, introduced by Farkas [6]. The information gathered during interviews with patients and their parents revealed that only one subject still had water come out of their nose, resulting in periodic visits to the Nose, Ear, and Throat Clinic. Subject distribution was based on gender, which was almost equal and included seven males (58.3%) and five females (41.7%). Distribution based on diagnosis showed an almost equal distribution, with seven patients (58.3%) having right UCLP and five (41.7%) patients having left UCLP. Among male subjects, four had right UCLP, and three had left UCLP. Among female subjects, three had right UCLP and two had left UCLP.

Table 1. Subject frequency distribution of gender and bone graft type.

| Bone graft type | Male | Female | Total |
|-----------------|------|--------|-------|
| Successful      | 6    | 5      | 11    |
| Unsuccessful    | 1    | 0      | 1     |
| Total           | 7    | 5      | 12    |

Table 1 shows that of the 12 patients, the procedure for one male subject was unsuccessful. The remaining 11 subjects underwent successful bone grafts with nearly equal gender distribution: six of these subjects were male and five were female. These 11 subjects did not have any complaints and were satisfied with their treatment.
Table 2. Subject frequency distribution of diagnosis and bone graft type

| Bone graft type | Diagnosis | Right UCLP | Left UCLP | Total |
|-----------------|-----------|------------|-----------|-------|
|                 | Successful| 6          | 5         | 11    |
|                 | Unsuccessful| 1         | 0         | 1     |
| **Total**       |           | 7          | 5         | 12    |

Distribution of bone graft type based on subject diagnosis is shown in Table 2. Bone grafting was successful in six subjects with right UCLP and five subjects with left UCLP. It was not successful in one subject with right UCLP. Anthropometry measurements taken photogrammetrically from each subject included data for upper lip length, upper lip projection, and nostril sill elevation. From these data, values for nasal deformity post-ABG were compared to photogrammetric results of each subject’s non-cleft side. Upper lip length was considered the distance from the nasal base to the upper lip base, for which the mean value among males was 22–24 mm and among females was 20–22 mm. These measurements were taken at landmark points L1, L2, L3, and L4, and landmark distance comparisons were done using L5/R. Upper lip projection was used to determine how prominent the

![Upper Lip length](image1)

**Figure 1.** Comparison of photogrammetric anthropometry of the non-cleft side and cleft side of patient faces to evaluate upper lip length

![Upper Lip Projection](image2)

**Figure 2.** Comparison of photogrammetric anthropometry of the non-cleft and cleft sides of patient faces to evaluate upper lip projection

upper lip was on subjects’ faces by comparing landmark distance using point S5/R. Nostril sill elevation was measured based on landmark distances for points S1, S2, S3, and S4 from the frontal and lateral directions. It increases the accuracy of photogrammetry measurements taken post-ABG.
Photogrammetry measurements (Figure 1) were used to compare deformity values for upper lip length. The values increased in all subjects, regardless of the success of the bone grafts. Landmark distances in bars L4c/R and L5c/R were significant (p < 0.05). Deformity evaluations of upper lip projection (Figure 2) show that this varies by subject, but the results from subjects with successful bone grafts were lower than for the unsuccessful bone graft. For nostril sill elevation (Figure 3), there was no significant difference in the values for each landmark distance in all subjects. To gather consistent and unbiased results, a correction test was performed using Fisher’s exact test, which is suitable for small sample sizes. An SPSS statistical analysis of a t-test was used to gathered results from deformity measurements at each landmark, there were significant differences for landmark distances S1 and S3 (p < 0.05). For other landmark distances, there was no significant difference from either the non-cleft or cleft sides.

3.2 Discussion
This study evaluated nasal deformity in UCLP patients after ABG at the Cleft Lip and Palate Unit at RSAB in Kita Jakarta using anthropometric and photogrammetric measurements. Photogrammetry measurements were taken by measuring landmark points on the ears, eyes, nose, and lips of the subjects. Clinical photos of the subjects were taken from three different directions: anterior, lateral, and basal. Anterior landmarks included L1, L2, and L3; lateral landmarks included L4, L5, S4, and S5; and basal landmarks included S1, S2, and S3. The results of post-ABG for all subjects were successful, except for one subject.

The evaluation of ABG was based on patient interviews. Most subjects were satisfied with the results of the operation. The mean subject age at the time of operation was 11 years, and the Cleft Lip and Palate Unit followed standard procedures based on age criteria for bone graft operations. This is consistent with Jia et al. who reported that the best age for ABG is from 9 to 11 years old, which takes into consideration maxillary canines that have not erupted and the influence of the type of cleft on the procedures success [4].

Statistical tests provided deformity values for upper lip length, upper lip projection, and nostril sill elevation, which showed no significant differences for all subjects. This contrasts with a previous study in which nostril sill elevation increased after bone grafting [6]. No studies have evaluated upper lip length due to tissue expansion [5]. ABG can close defects in the palate that cause increasing volumes of alveolar and widen the upper lip.

To evaluate alterations, photogrammetry was used to measure landmark distance points on subject faces, based on anthropometry guidelines [7]. These measurements are advantageous because they can be taken indirectly and are most accurate when taken by an experienced operator. The study hypothesis was that ABG treatments are similar for patients with cleft lip and palates with nasal
deformities between the ages of 9 and 11 years old. The standard procedures performed at the Cleft Lip and Palate Unit at RSAB in Kita Jakarta on 12 subjects showed this hypothesis to be true. By performing ABG at 11 years of age, the severity of deformity is not significantly different (Figure 1) because the statistical results showed significant differences only for landmark distances L4c/R and L5c/R, which correlate to upper lip length and height, respectively. Figures 2 and 3 show no significant differences among all subjects. Collins et al. evaluated the results of ABG in 115 patients at Great Ormond Street from January 1982 to January 1989 and concluded that bone grafting in subjects less than 12 years old provides good results with a 2% failure rate, which manifests as conditions such as internal resorption or apical resorption in the canines [8]. Most of the subjects in the current study underwent bone grafting at age 11 years, and the final results were excellent for all patients except one.

Photogrammetric measurements shows proportionally aesthetic final results with lower values in patients with UCLP after bone grafting with autogenous iliac crest. Figure 1 shows upper lip length, Figure 2 shows upper lip projection, and Figure 3 shows nostril sill elevation, and based on these results, deformity values are lower on the cleft side compared to the non-cleft side. Indirect anthropometry measurements, such as photogrammetry, have the advantages of allowing direct comparison and a simple method for taking measurements because of the remote nature of data acquisition, with no contact with the measured object and with high accuracy [9].

The limitation of the current study was the small sample size due to complications resulting from the inclusion criteria for subjects and subjects choosing not to participate because of trauma or moving to another country. A larger sample size would allow for more comprehensive descriptions of nasal deformities in patients with UCLP.

4. Conclusion

Similarity among ABG procedures in patients with UCLP and in measurements of nasal deformities taken anthropometrically using photogrammetry revealed low values. Additionally, this similarity showed proportional aesthetics among patients. Age 11 was found to be a suitable age to perform ABG with excellent results for patients and their families. Further research of a larger sample size would provide more varied and accurate results and more comprehensive descriptions of the results of standard procedures for bone grafting in the long-term to increase the satisfaction of patients and their families.

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