Scientific Research Publishing

Open Journal of Pediatrics, 2020, 10, 751-758
https://www.scirp.org/journal/ojped
ISSN Online: 2160-8776
ISSN Print: 2160-8741

Evaluation of Bone Regeneration in Single Stage Closure of Cleft Alveolus with Gingivoperiosteoplasty

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How to cite this paper: Kolari, V., Sequiera, J.P., Hasoon, U. and Sait, A.I. (2020) Evaluation of Bone Regeneration in Single Stage Closure of Cleft Alveolus with Gingivoperiosteoplasty. *Open Journal of Pediatrics*, **10**, 751-758.
https://doi.org/10.4236/ojped.2020.104076

Received: December 14, 2020
Accepted: December 27, 2020
Published: December 30, 2020

Abstract

Background: Cleft alveolus closure is a challenge for cleft surgeon for many decades. Secondary alveolar bone grafting (SABG) is the preferred technique using autologous cancellous ileac crest bone as the donor graft. Many alternative methods were tried over the years with no any promising results. Gingivoperiosteoplasty (GPP) is a good alternative surgical technique for bone regeneration in cleft alveolus with proper case selection criteria. **Aim:** Aim of the study was to evaluate the bone regeneration following closure of cleft alveolus with gingivoperiosteoplasty. **Method:** This study was carried out in the department of Oral and Maxillofacial Surgery, Yenepoya Dental College, Deralakatte, Mangalore, Karnataka, India, from March 2018 to July 2019. In this study, we have performed gingivoperiosteoplasty with palatoplasty and evaluated the amount of bone formation in the cleft alveolus using a series of intra oral periapical radiographs. Five patients who required surgical repair of unilateral cleft palate and alveolus were selected for the study. Clinical and radiographical assessment was done post operatively, after three and six months respectively for anatomical function and bone formation. **Results:** After completion of clinical studies on patients, the statistical analysis of the data obtained. Radiographs were analyzed for grey scale density by means of adobe photo shop using the MATLAB process by histogram comparison in three months and six months, showing denser grey scale pattern, indicating the new bone formation in the cleft alveolus surgical site, in all the 5 surgical cases. **Conclusion:** Gingivoperiosteoplasty (GPP) is a good alternative procedure to secondary alveolar bone grafting (SABG), so donor site morbidity can be avoided with reduced time and cost for the surgery. But a larger sample size and longer follow-up are necessary to understand the better reliability of this surgical technique. **Clinical Significance:** Gingivoperiosteoplasty in

cleft alveolus patients showed significant bone formation in 3 to 6 months postoperatively.

Keywords

Gingivoperiosteoplasty, Trabecular Pattern, Unilateral, Cleft Palate

1. Introduction

Alveolar repair has become a routine part of treatment protocols for patients with alveolar clefts. Its primary aim is to restore the function and structure of the maxillary arch at the cleft site. The two treatments most frequently used for alveolar repair are secondary alveolar bone grafting performed in patients with mixed dentition, and primary gingivoperiosteoplasty (GPP) performed in infancy [1]. Consequently, rehabilitation of the child born with a facial cleft must undergo multidisciplinary approach and be staged appropriately with the child's development, balancing the need for intervention against its effects on subsequent normal growth.

Multiple studies have been done on cleft lip and palate surgeries over the years. Since antiquity, many attempts have been carried out and various theories have been proposed to the process that leads to bone regeneration [2]. Three options currently exist to repair the cleft alveolus in patients with cleft lip and palate: primary bone grafting, secondary bone grafting and gingivoperiosteoplasty (GPP). Even though several methods exist to repair cleft lip and palat, no single method exists that is superior to any other [3].

Conventionally, 2 types for GPP procedure were reported: Skoog and Millard types. In Skoog's method, the lack of presurgical orthopedics (PSIOs) involved extensive subperiosteal maxillary dissection to close the alveolar cleft. However, the invention of PSIOs led to the development of less invasive GPP surgery (Millard-type GPP) [4].

Online search of Google, Pubmed, Web of Science and Scopus, for literature of Gingivoperiosteoplasty (GPP) with radiographical assessment post opertatively using adobe photoshop MATLAB process by histogram comparison, resulted in no data available, and hence it was assumed as no such study was done previously.

In this study, we have adopted gingivoperiosteoplasty (GPP) performed with palatoplasty in five selected patients to evaluate the amount of bone regeneration in the cleft alveolus using a series of intra oral periapical radiographs.

2. Materials and Methods

2.1. Study Design

This study was carried out in the department of Oral and Maxillofacial Surgery, Yenepoya Dental College, Deralakatte, Mangalore, Karnataka, India, from March 2018 to July 2019. Ethics committee approval obtained from Yenepoya Univer-

sity Ethics committee and informed consent from patients care takers were obtained.

2.2. Inclusion and Exclusion Criteria

Five patients who required surgical repair of unilateral cleft palate and alveolus were selected for the study. Radiographical and clinical assessment was done post operatively, after 3 and 6 months respectively for anatomical function and bone formation. ASA (American Society of Anesthesiologists) Grade I patients and Children of either sex were considered for the study with the age group 6 months to 8 years. Medically compromised patients were excluded from the study.

2.3. Surgical Procedure

The surgical procedure is carried out under general anesthesia. Incisions were made bilaterally within the alveolar cleft margin; these may extend along the alveolar ridge up to 1 cm as needed for exposure. On the cleft side, the incision was directed up toward the lateral piriform aperture, and on the non-cleft side, it was directed toward the nasal spine. These incisions were joined with incisions carried posteriorly along the palatal cleft margins as part of the palatoplasty. Anteriorly, they were joined at the apex of the alveolar cleft within the labial vestibule. This is typically the underside of the nasal sill where the repair of the lip ended superiorly and posteriorly. 3 - 0 vicryl (Polyglycolic acid based resorbable material) was used for the closure of all flaps. The nasal sill was then closed continuously with the vomer flap and lateral shelf nasal mucosa to comprise the nasal layer of alveolus and palate repair.

Oral surface was then closed directly in continuity with the rest of the palatoplasty. The mucosa of the labial vestibule and the vestibular surface of the alveolus were then closed.

Patients were admitted for 5 - 6 days postoperatively. IV Antibiotics and analgesics were prescribed. Patients were recalled after 3rd and 6th months interval following surgery. Intra Oral Periapical Radiographs were taken on 3rd and 6th months postoperatively. The radiographs were analyzed with adobe photo shop. The bone density was calculated using MATLAB process by histogram comparison (**Figures 1-5**).

Figure 1. Preoperative image of cleft palate and cleft alveolus.

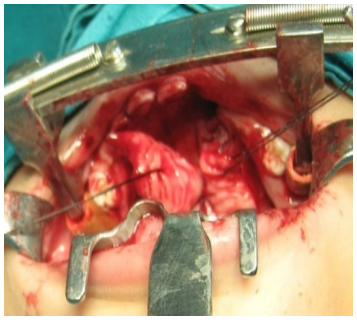

Figure 2. Elevation of the flaps.

Figure 3. Closure of Cleft palate and cleft alveolus following Gingivoperioplasty.

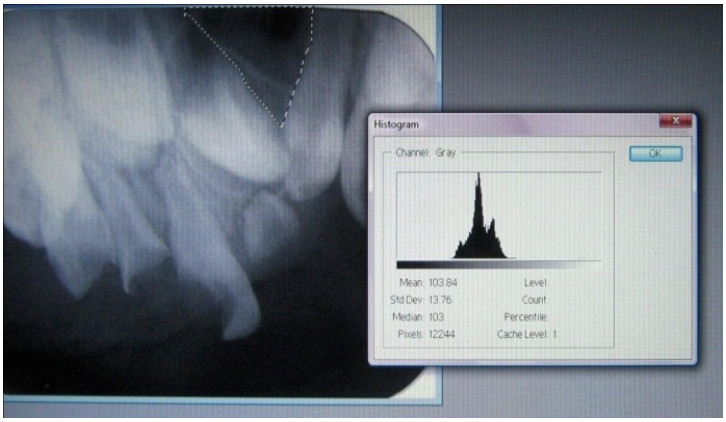

Figure 4. Radiographic (IOPAR) image of three months postoperative.

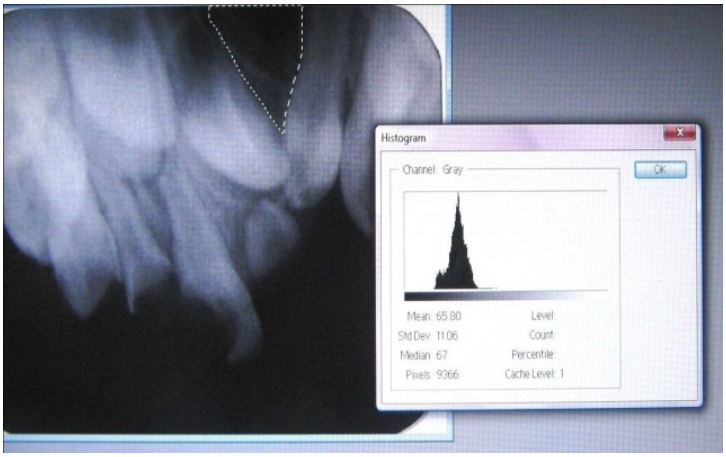

Figure 5. Radiographic image of six months postoperatively.

3. Results

Following completion of clinical study on patients, the data from all the patients were taken for statistical studies. Among the five patients there were three females and two males. The age ranged from 18 months to 6.5 years, with a mean age of 3.2 years.

Radiographical Assessment

Radiographic assessment at 3rd month and 6th month showed trabeculae formation in the alveolar cleft area using the MATLAB process by histogram comparison with the preoperative values. The cleft area appeared more radio-opaque in the radiographs taken on 3rd month and slightly less radio-opaque on 6thmonth post operatively. These radiographs were analyzed for grey scale density by means of adobe photo shop. The average grey scale value at 3 months shows 78.32 with a standard deviation of 23.34, and the average grey scale value at 6 months shows 57.78 with a standard deviation of 8.91. Wilcoxon's Sign rank test showed *P* value of 0.68. Even though the follow up period is not enough to come to a conclusion the grey scale values shows definite bone formation (Table 1 and Table 2).

4. Discussion

Three methods currently exist to repair the cleft alveolus in patients with cleft lip and palate; primary bone grafting, secondary bone grafting, and gingivoperiosteoplasty. Gingivoperiosteoplasty (GPP), or "boneless bone grafting" was introduced by Tord Skoog at the University of Uppsala, Sweden, in 1965, Skooghypothesized that periosteal continuity established during the initial procedures was responsible for the spontaneous bone regeneration [3].

Clefts of alveolar bone can be repaired by 2 different methods: alveolar bonegrafting or GPP. Each of the 2 methods can be referred to as primary or secondary based on the timing of the procedure relative to lip surgery. Conventionally,

Table 1. Gray scale bone density (Hounsfield units).

SL. NO	Pre-operative	3rd month	6th month
1	46.23 HU	103.29 HU	67.22 HU
2	32.88 HU	63.97 HU	59.92 HU
3	24.17 HU	53.66 HU	45.76 HU
4	39.28 HU	92.34 HU	58.25 HU
5	26.38 HU	59.61 HU	42.34 HU

Table 2. Mean value.

	Mean	Standard Deviation	Z	*P*
3 months	78.3150 HU	23.33880	−1.826	0.068
6 months	57.7875 HU	8.91430		

a primary GPP or primary alveolar bone grafting is performed at the stage of lip repair or soon after, when the patient is less than 2.5 years old. Secondary GPP or secondary grafting commonly refers to surgical alveolar reconstruction (by soft tissue bridging or alveolar bone, respectively) performed post lip repair (between 2.5 and 10 years) [4].

Surgical correction of cleft lip and palate remains a solitary problem, principally because the fundamental surgical problem is not clearly conceptualized. This failure to diagnose the problem precisely is attributable to the fact that the relevant anatomy is complex, poorly understood, and frequently erroneously described. Even though several methods exist to repair cleft lip and palate no single method exists that is superior to any other [5].

Maintaining the integrity of the periosteum is essential during primary gingivoperiosteoplasty. The closer the bones, the more likely that enough bone will form in the cleft alveolus to eliminate the need for later secondary alveolar bone grafting [1].

Concerns about the effects of wide subperiosteal dissection on maxillary growth and the often-tenuous nature of large flaps required to close the alveolar cleft led to descriptions of free periosteal grafts, most often from the tibia [6] [7].

Improved surgical and dental collaboration within cleft centers led to the widespread use of presurgical orthopedics and made direct gingivoperiosteoplasty possible for clefts previously, too wide for such a maneuver. Millard in particular was a strong proponent of this regimen as narrower clefts allowed for smaller flaps, less dissection, and less chance for maxillary growth restriction [8].

The techniques of periosteal grafting produce variable but often acceptable results [6] [9] [10]. In infants and children, the high osteogenic potential of periosteum in maxillofacial skeleton is well documented [11] [12] and success relies heavily on integrity and vascularity of the periosteal envelope. Periosteum consists of two layers. An outer fibrous layer and an inner osteogenic layer, adjacent to the bone and containing pre-osteoblasts and osteoblasts [13] [14].

In our study we selected five patients of unilateral complete cleft lip and palate who underwent gingivoperiosteoplasty (GPP) with palatoplasty. Two patients who had very wide clefts had to undergo pre surgical orthodontics for 3 – 4 months which helped in bringing the alveolar segments close to each other. We didn't find much difficulty in approximating the periosteum from either side in any of our cases. Since we have done functional cheiloraphy 6 months earlier to palatoplasty the sphincteric action of orbicularis-oris also helped in bringing alveolar segments closer. Wound dehiscence and infection have been attributed for the failure of GPP earlier. These complications were mainly due to absence of a tension free and water tight closure leading to wound contamination. In all our cases we were able to achieve a tension free water tight closure, by mobilizing the mucoperiosteum adequately. Lateral releasing incisions were given which helped in approximating the periosteum both labially and palatally. The pre surgicalorthopaedics in two patients helped in reducing alveolar gap, which also helped in uneventful healing in the post-operative period.

Presently little information is found in the literature concerning the optimal-timing of gingivoperiosteoplasty within the cleft treatment protocol. The early stabilization of the maxillary arch prevents subsequent medial arch collapse inevitable in the untreated cleft palate. Bone formation was evaluated at intervals of three and six months by means of intra oral periapical radiographs, which was analysed for grey scale density using adobe photo shop. In addition, qualitative functional analysis was done by analysing wound healing, lip height and white roll matching which were found satisfactory.

Limitations of this study are the sample size and the follow-up time. A larger group of sample size will give better assessment of the results and longer follow-up will give a clear picture of long-term benefits of this technique over the conventional technique.

5. Conclusion

In this study cleft alveolus was surgically repaired by GPP to promote the formation of bone in the cleft area in order to reduce the need for a secondary bone grafting. This study clearly indicated the periosteum has the potential for bone regeneration especially in young individuals. The sequential increase in the bone density in the post-operative radiographs between 3 and 6 months highlights the innate bone induction capability within the periosteum. Moreover, the procedure of GPP is simple, cost effective and has demonstrated good results. The present study was done with a follow up of 3 months and 6 months for evaluation of bone regeneration, only by primary closure without the use of any bone adjuncts.

Conflicts of Interest

The authors declare that they have no competing interests.

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