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ORIGINAL ARTICLE

Primary Gingivoperiosteplasty and its effect on Craniofacial Growth (Systematic review with clinical cases)

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Abstract

Background: ***Gingivoperiosteoplasty (GPP) is a surgical technique utilized with initial lip repair to aid orthodontic therapy and eliminate the need for subsequent bone grafting. It involves the primary repair of the alveolar bone.***

Aim and objectives: ***To assess the consequence of GPP for treating alveolar clefts on craniofacial growth in cases with unilateral cleft lip and palate.***

Patients and methods: ***This systematic review was conducted on eight articles with 185 individuals with unilateral cleft lip and/or palate who underwent primary gingivoperiosteoplasty. All studies reported the age of repair and evaluation, ranging from 2 to 9 years.***

Results: ***Passive molding plates were applied by Wood et al., the Latham device was used by Matic and Power, and nasoalveolar molding was used by Hsieh et al. and Wang et al. Sahel and Mullerova showed that maxilla relation to cranial base (SNA) was 75.7, mandibular relation to cranial base (SNB) was 73.5, maxillary mandibular relation (ANB) was 202, and maxillary length (A-PMP) was 44.9.***

Conclusion: ***The GPP procedure leads to poorer alveolar bone quality and a higher risk of Bergland type III. Early cleft repair may inhibit maxillary growth. Presurgical infant orthopedic (PSIO) treatment may affect alveolar bone and maxillary growth outcomes. Secondary alveolar bone grafting has better outcomes than primary GPP. However, nasoalveolar molding may generate similar success rates and alveolar height while being less invasive and having lower morbidity than primary GPP.***

Keywords: Gingivoperiosteplasty; Craniofacial Growth; Unilateral cleft lip; Nasoalveolar molding

1. Introduction

The disorder known as complete cleft lip and palate affects both the primary and secondary palates. This disorder presents from the nose to the sharp foramen, extending across the lip and involving deficits in the soft and demanding palates of the alveolar bone. The most common craniofacial congenital disability is orofacial clefting, which affects 1 in 750 live births.[1]

Individuals with cleft lip and palate can now have primary bone grafting, secondary bone grafting, or GPP as therapy options for closing their cleft alveolus.[2]

Most cleft centers now use secondary alveolar bone grafting as the primary technique for alveolar cleft repair. Nevertheless, issues arising from the area where the tissue is taken, the rate at which it is absorbed, and a delay in the timing for a subsequent grafting procedure led to the introduction of primary GPP.[3]

GPP offers a significant advantage in securely sealing accurately aligned segments using periosteal flaps. This, in turn, allows for the potential of bone regeneration in the cleft maxilla. This enhances the stability of the entire jaw and promotes more favorable anatomical conditions for the growth of the maxilla.[4]

Additional benefits of GPP include the sealing of the abnormal passage between organs, the establishment of a fully developed upper jaw structure in the early stages of growth, the facilitation of the proper alignment of permanent teeth as they emerge, the early correction of imbalances in the nasal base, and the prevention of significant harm to the area from which bone is taken during the grafting procedure.

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In GPP, a mucoperiosteal bridge develops over the alveolar fissure, which is linked to cleft lip and palate. Young individuals can undergo bone regeneration through the subperiosteal tunnel without bone grafting.[5,6]

The study's objective was to evaluate the influence of Growth Plate Preservation (GPP) on the development of the craniofacial region in persons with unilateral cleft lip and palate through the treatment of alveolar clefts.

2. Patients and methods

This systematic review was performed on eight articles, totaling 185 individuals with unilateral cleft lip and palate who underwent primary GPP. All studies reported the age of repair and evaluation, ranging from 2 to 9 years.

Type of study and participants: Systematic review and clinical cases. Only human subjects elective for Gingivoperiosteplasty.

The types of included studies are comparative cohort studies, recent clinical trials, cluster trials, and prospective and retrospective analyses.

Types of included interventions: Primary Gingivoperiosteplasty.

Types of outcome measures: Craniofacial Growth evaluations.

Selection criteria for studies: Inclusion criteria: Studies with English language and publication at any time and up to date.

Inclusion criteria for clinical cases: Age: from 3-9 months, sex: both sexes are included, primary unilateral cleft lip and palate, bone gap from 1-3 mm, non-collapsed alveolar cleft and non-syndromic patient

Exclusion criteria: Languages other than English, duplicates, and non-clinical outcome studies.

Exclusion criteria for clinical cases: Age: below three and above nine months, bilateral cleft lip and palate, previously operated cases, bone gap above 3 mm, collapsed alveolar cleft, and syndromic patients.

Ethical considerations: As approved by a committee of Al-Azhar University.

Search strategy for study identification: The search was performed using PubMed, PLOS, or Clarivate deSsil-supocS without limitations on location or publication genres. We utilized various research engines, notably EKB, to procure articles from the previous year.

Study procedure: The research started by searching articles via the Mesh (("Gingivoperiosteoplasty" OR "Gingivoplasty") AND ("Alveolar Process/surgery" OR "Craniofacial Growth" OR "Maxillofacial Development" OR "Tooth Movement Techniques" OR "Tooth Movement" OR "Bone Development" OR "Orthodontics" OR "Periodontal Surgical Procedures")) Then, the process includes searching for articles that meet the specified inclusion criteria and eliminating papers that meet the exclusion requirements. The supervisors thoroughly reviewed these publications to ensure the identification of the proper data source. Subsequently, I collaborated with the statistical supervisor to input the data into R-based software for meta-analysis and began the investigation.

Statistical considerations: The systematic review management system aggregated the findings from the studies and conducted a thorough assessment to see if they satisfied the inclusion criteria. A PRISMA flowchart was created using the search results and the criteria for determining which studies to include and exclude. To analyze potential bias in each study, we gathered relevant data using the Cochrane collaboration tool to assess the risk of bias after consolidating the data gathered from the chosen studies. The relative risk was calculated for each of the expected outcome metrics of interest.

Applying prior consideration involved papers reached eight papers.

Data Extraction:

The data extraction process was carried out methodically by two separate reviewers, adhering to the criteria outlined by PRISMA. Summary measures were aggregated in a systematic review. Data input and processing were done using a standardized Excel spreadsheet while the reviewers extracted the data from the included studies. The extracted data consisted of details regarding the critical aspects of the included studies, the initial characteristics of the examined populations, and the outcomes of the studies. The data extracted from the provided papers by each reviewer was analyzed separately, and any discrepancies were resolved through discussion.

Dealing with Missing Data:

The missing standard deviation of the mean change from baseline was calculated using either the standard error or the 95 percent confidence interval (CI) based on Dziura et al.,7

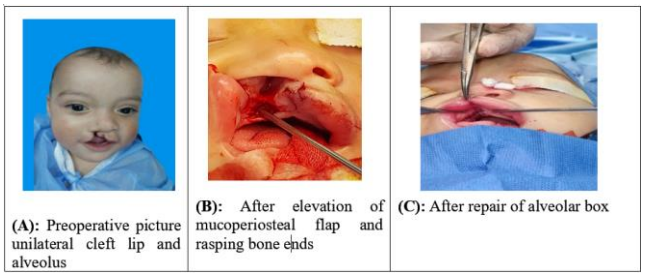
Direct Meta-analysis:

The study synthesized continuous outcomes using inverse variance to calculate MD or SMD. The relative risk (RR) was calculated by combining dichotomous outcomes utilizing the Mantel-Haenszel technique. Due to clinical and methodological variability, the research utilized random effects. The statistical analysis used either Review Manager (RevMan) 5.3 or Open Meta-analyst for Windows.

Evidence of publication bias: The funnel plot test was utilized during the investigation. A PRISMA flowchart was created using the search results and the inclusion/exclusion criteria. Data was gathered using the Cochrane collaboration tool to assess the probability of bias in each trial.

The relative risk for each planned outcome measure was calculated and compared after aggregating the data from the desired search studies.

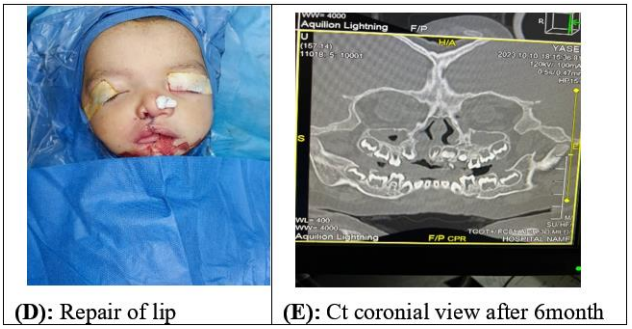
Outcomes and Measures: The study assessed the outcome, benefits, and drawbacks of Gingivoperiosteoplasty for the treatment of alveolar cleft.



(A): Preoperative picture unilateral cleft lip and alveolus

(B): After elevation of mucoperiosteal flap and rasping bone ends

(C): After repair of alveolar box



(D): Repair of lip

(E): Ct coronial view after 6month

Figure 1. Surgical procedure

3. Results

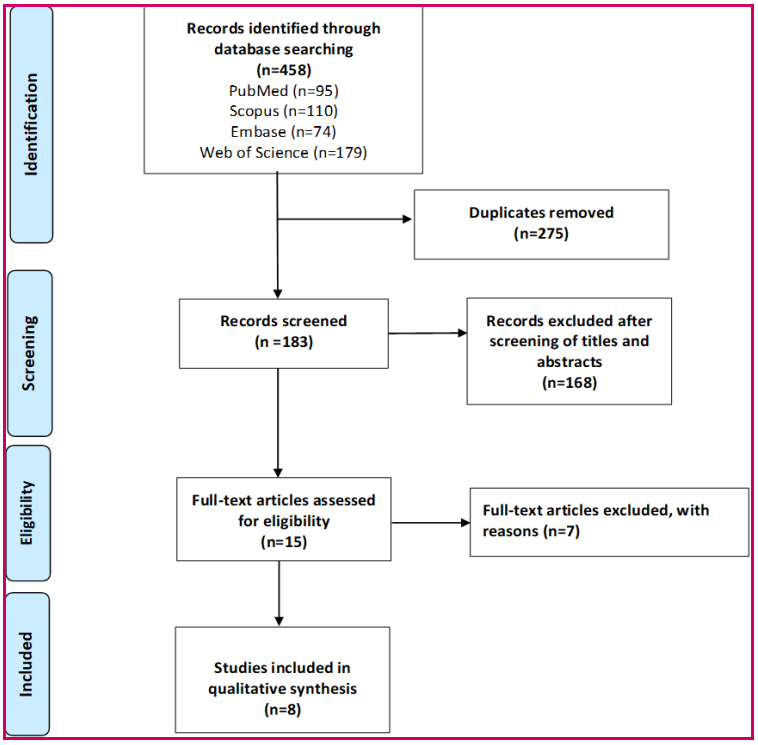


Figure 2: PRISMA Flow Diagram of the Study Selection Process

Table 1. Patient Characteristics (N = 8 studies, 185 patients)

FIRST AUTHOR	NO.	GENDER		DATE OF BIRTH	AGE AT REPAIR, YR	AGE AT EVALUATION, YR
		Male	Female			
WOOD[8]	11	NA	NA	NA	3	5-6
SMAHEL AND MULLEROVA[9]	35	35	0	1973-1976	8.4	9-11
MATIC AND POWER (A) [10]	25	15	10	Before 1996	2-6	8.4-20.8
MATIC AND POWER (B) [11]						
HSIEH[12]	26	18	8	1999-2001	3-6	5.1±0.4
CAGANOVA[13]	48	48	0	1972-1978	9	10-15
WANG[14]	25	16	9	1999-2002	2.1-7.5	8-14
JABBARI[15]	15	NA	NA	1960-1977	4±0.7	5-18

NA: DATA NOT AVAILABLE

All studies reported gender distribution except for Wood et al,[8] & Jabbari et al.[15] The majority of patients were males, ranging from 60% to 100%., whereas the female percentage ranged from 0% to 40%. All studies except Wood et al.[8] reported the date of birth ranging from 1960 to 2002. All studies reported the age of repair and evaluation, ranging from 2 to 9 years, and from 5 to 20.8 years, correspondingly.

Table 2. Surgical Characteristics

FIRST AUTHOR	PSIO	LIP SURGERY	PALATE SURGERY	GPP TECHNIQUE
WOOD[8]	Passive moulding plates	Rotation advancement at 3 ms	NA	NA
SMAHEL AND MULLEROVA[9]	No PSIO	Tennison or Veau at 8.4 ms	Push-back pharyngeal flap surgery at 5 yr	Modified Skoog
MATIC AND POWER (A) [10]	Latham	Lip adhesion at 3 ms and formal repair at 18 ms	Bardach 2-flap palatoplasty or Veau-Wardill Kilner at 12 ms	Millard
MATIC AND POWER (B) [11]				
HSIEH[12]	NAM	Lip repair at 3 - 6 ms	2-flap palatoplasty at 12 ms	NA
CAGANOVA[13]	No PSIO	Tennison or Veau at 9 ms	Push-back pharyngeal flap surgery at 5 yr	Modified Skoog
WANG[14]	Figueroa or NAM	Modified rotation advancement at 3-6 ms	1-stage 2-flap palatoplasty at 12 ms	Millard
JABBARI[15]	No PSIO	Lip repair at 3.5 ms	NA	Skoog

NA: DATA NOT AVAILABLE

Passive molding plates were applied by Wood et al,[8] the Latham device was used by Matic and Power[10], nasoalveolar molding was used by Hsieh et al,[12] & Wang et al.[14] All studies reported a single stage lip surgery at 3 to 9 months, except for Matic and Power[10] who performed lip adhesion at three months, and formal repair at 18 months.

Table 3. Facial Growth-AP Skeletal Relations

FIRST AUTHOR	SNA, °	SNB, °	ANB, °	A-PMP, MM
SMAHEL AND MULLEROVA[9]	75.7	73.5	2.2	44.9
MATIC AND POWER[10]	75	75	NA	43
HSIEH[12]	77.6±5.2	77.1±5.4	0.46±2.9	40.2±2.6
CAGANOVA 10 YR[13]	75±4.2	73.1±3.3	1.9±3.1	44.6±2.6
CAGANOVA 15 YR[13]	73.8± 4.1	74.6±3.9	-0.79±3.2	46.3±3
JABBARI 5 YR[15]	84.7±1.8	77.4±1.6	5.87±1.2	NA
JABBARI 10 YR[15]	82.1±1.5	77.4±1.3	4.8±1.1	NA

NA: DATA NOT AVAILABLE

Smahel and Mullerova[9] showed that SNA was 75.7, mandibular relation to cranial base (SNB) was 73.5, ANB was 202, and maxillary length (A-PMP) was 44.9.

Table 4. Facial Growth – Vertical Skeletal Relations

FIRST AUTHOR	N-ANS, MM	MAXILLARY PLANE, °	INTERMAXILLARY PLANES, °	N-ANS/N-GN	S-GO/N-GN
SMAHEL AND MULLEROVA[9]	44.9	7.4	31.2	41.9	60.6
MATIC AND POWER[10]	45.6	NA	NA	41.9	NA
HSIEH[12]	43.1±4.1	NA	NA	NA	NA
CAGANOVA 10 YR[13]	46.9±2.9	6.6±2.8	31.6±5.2	41.8±2.1	60.9±3.5
CAGANOVA 15 YR[13]	52.3±3.2	5.9±3.2	30.9±6.8	41.4±2.1	62.7±4.3
JABBARI 5 YR[15]	NA	4.5±0.9	NA	NA	NA
JABBARI 10 YR[15]	NA	5.2±1.1	NA	NA	NA

NA: DATA NOT AVAILABLE

Table 4 demonstrated the mean vertical skeletal relations, including vertical height of maxilla (A-ANS), maxillar plane/cranial base, intermaxillary planes, upper facial height to total facial height ratio (N-ANS/N-Gn), and posterior facial height ratio (S-GO/N-Gn).

Table 5. Facial Growth – Soft Tissue Analysis

FIRST AUTHOR	LS + LI, MM	N′ -PRN-PG″, °
SMAHEL AND MULLEROVA[9]	2.7	NA
CAGANOVA 10 YR[13]	2.8 ± 2.2	143.7 ± 6.1
CAGANOVA 15 YR[13]	1.6 ± 2.6	141.4 ± 7.1

Table 5 demonstrated the mean parameters for soft tissue analysis, including upper lip to lower lip (Ls + Li) and facial convexity (N′ -Prn-Pg″).

Table 6. Effect of GPP on Facial Growth

AGE OF EVALUATION	STUDY	MAIN FINDINGS
AT 5 YEARS	Wood et al.[8]	No significant maxillary impairment was observed in the GPP patients by shape coordinate analysis
	Hsieh et al.[12]	People with Gingiviperosteoplasty revealed a more significant adverse effect on the growth of the maxilla, specifically in terms

		of length & height, as contrasted with the control group.
	Jabbari et al.[15]	The GPP group revealed no statistically significant variation in cephalometric measurements when in contrast to the control group.
AT 10 YEARS	Smahel and Mullerova[9]	The GPP group had significantly lower values in maxillary length & vertical height in contrast to the control group.
	Caganova et al.[13]	The control group had a significantly better vertical maxillary development in contrast to the Gingiviperosteoplasty group.
	Jabbari et al.[15]	The GPP group indicated a significantly larger degree of maxillary retrusion in contrast to the control group.
AT 15 YEARS	Matic and Power[10]	The Gingiviperosteoplasty group showed a reduction in maxillary height and protrusion in contrast to the SBG group.
	Caganova et al.[13]	The SBG group had greater soft tissue convexity in comparison to the GPP group.

Table 6 summarized the main findings regarding the impact of gingiviperisteoplasty on facial growth at different intervals.

4. Discussion

As regards surgical characteristics, Palate repair was carried out by all studies except for Wood et al.,[8] and Jabbari et al.,[15] Employing a 2-flap palatoplasty procedure at 12 months or a push-back pharyngeal flap technique at five years. Cleft palate repair aims to reconstruct the palatal muscle sling, mend the palatal defect, establish a structural basis for appropriate palatal movement and speech, and separate the oral cavity from the nasal cavity. [16]

The gingiviperosteoplasty technique was described in all studies except for Wood et al.,[8] and Hsieh et al.,[12]. The Skoog technique was used by Jabbari et al. [15], Smahel and Mullerova[9] used modified Skoog technique, and Casanova et al.,[13] Millard technique was used by Matic and Power., [10] and Wang et al.,[14]

Concerning the effect of GPP on Facial Growth, the current systematic review revealed that no significant effect on facial growth following peiosteoplasty was observed by Wood et al., [8], and Jabbari et al.,[15] at five years using the shape coordinate analysis and cephalometric measurements, respectively, and by Smahel & Mullerova,[9], at ten years.

Casanova et al.[13] indicated a significant difference in vertical maxillary growth (measured by N-ANS) by 3.2 mm at ten years. Jabbari et al..,[15] also showed a more significant maxillary retrusion (measured by maxillary plane) following perioosteoplasty.

Matic and Power,[10,11] found a significant difference in SNA, ANS-PNS (maxillary length), and N-ANS (maxillary vertical height) by 4.7°, 5 millimeters, 5.6 millimeters, correspondingly, at 15 years following periosteoplasty. In addition, a lower soft tissue convexity (measured by N′ -Prn-Pg″) was observed by Caganova et al.,[13] following periosteoplasty by 5.9°.

In the research conducted by Wang et al.[14], it was demonstrated that secondary alveolar bone grafting had better results in comparison to primary GPP in cases with unilateral cleft lip and palate. The research involved fifty individuals, with twenty-five in each group. The findings showed that those who underwent primary gingivoperiosteoplasty had a higher need for additional bone grafting than those who underwent secondary alveolar bone grafting (28 % Vs 4 %, correspondingly). The residual cleft defect was more significant in people who underwent initial GPP for repair than those who underwent secondary alveolar bone grafting (305.8±176.5 mm3 vs 178.6±122.0 mm3, correspondingly). In contrast to individuals who underwent secondary alveolar bone grafting, those who underwent initial GPP were more likely to have remaining palatal coronal and palatal apical deficits.

Also, Caganova et al.,[13] examined the impact of secondary alveolar bone grafting (n=18 instances) in comparison to initial peri osteoplasty (n=48 cases) in cases diagnosed with unilateral cleft lip and palate. Despite primary peri osteoplasty cases, individuals who received secondary alveolar bone grafting reported significant enhancements in the positioning of the upper and lower dentoalveolar structures in relation to the facial plane. In addition, the soft profile's overall convexity increased, maxillary inclination improved, and vertical intermaxillary associations improved.

In addition, Hsieh et al.,[12] determined how 62 cases with full unilateral cleft lip and palate (UCLP) fared after undergoing gingivoperiosteoplasty regarding facial development. According to the results, GPP significantly affected the 5-year-old SNA's position and the association among the ANB, PMP-ANS, and PMP-A. Compared to the GPP group, the non-GPP group displayed larger SNA and ANB

angles, with 3.0u and 2.6u variations, respectively. Maxillary alveolar length (PMP-A) was 2.9 mm, and maxillary nasal length (PMP-ANS) was 2.1 mm longer in the non-GPP group compared to the GPP group.

A more recent systematic review meta-analysis by Jahanbin et al.,[17] Investigated the extended effectiveness of GPP and nasoalveolar molding (NAM) in individuals with cleft lip and palate. The analysis included seven papers. The findings indicated that 71 percent of the subjects achieved positive outcomes using NAM with GPP. The confidence interval of 95% ranged from 54% to 85%, depending on the preservation of the alveolar bone integrity. When NAM and GPP therapy were combined, the need for additional bone transplants was eliminated in 71 percent of cases. There was no significant difference in the success rate (risk ratio=1.00, 95% confidence range=0.64-1.58) or mean Bergland score (mean difference=0.64, 95% confidence interval = −1.04 to 2.31) between the use of NAM + GPP and skeletal bone graft. The meta-analysis found that the success rate and alveolar height after combining NAM and GPP were comparable to those observed with secondary alveolar bone grafting. Moreover, this combination is less intrusive and has decreased morbidity.

4. Conclusion

The GPP operation is associated with a decline in alveolar bone quality and an increased risk of Bergland type III. Performing cleft correction at an early stage may impede the growth of the maxilla. PSIO treatment may impact the results of alveolar bone and maxillary growth. Secondary alveolar bone grafting yields superior outcomes to primary gingivoperiosteoplasty (GPP). Nevertheless, the outcomes of secondary alveolar bone grafting are superior when preceded by primary gingivoperiosteoplasty, compared to secondary alveolar bone grafting performed without initial gingivoperiosteoplasty.

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Authorship

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