RESEARCH PAPER

TWO-LAYER VERSUS THREE-LAYER CLOSURE IN CLEFT PALATE REPAIR: A NARRATIVE REVIEW OF SURGICAL OUTCOMES AND POSTOPERATIVE COMPLICATIONS

Dr. Kaushik Kashyap Pathak[1], Dr. Himanshu Bhutani[2], Dr. Sanjeev Kumar[3], Dr. Monika Yadav[4], Dr. Anshika Mittal[5], Dr. Dhabe Manali Ravi[6]

[1]MDS 3rd year Dept of Oral and Maxillofacial Surgery, ITS Dental College Hospital and Research Centre, Greater Noida, Mail - pathakkaushik001@gmail.com
[2]Professor, Head of the dept Oral and Maxillofacial Surgery, ITS Dental College Hospital and Research Centre, Greater Noida, Mail - himanshubhutani@gmail.com
[3]Professor, dept of Oral and Maxillofacial Surgery, ITS Dental College Hospital and Research Centre, Greater Noida.
[4]MDS 3rd year Dept of Oral and Maxillofacial Surgery, ITS Dental College Hospital and Research Centre, Greater Noida.
[5]MDS 2nd year Dept of Oral and Maxillofacial Surgery, ITS Dental College Hospital and Research Centre, Greater Noida.
[6]MDS 1st year Dept of Oral and Maxillofacial Surgery, ITS Dental College Hospital and Research Centre, Greater Noida.

Abstract

Background: Cleft palate repair aims to restore normal speech, feeding, and palatal function while minimizing postoperative complications. Two-layer and three-layer closure techniques are widely practiced; however, their relative effectiveness remains a subject of ongoing debate.

Objective: To compare the clinical outcomes of two-layer and three-layer closure techniques in cleft palate repair, with emphasis on speech outcomes, fistula formation, velopharyngeal insufficiency (VPI), and postoperative complications.

Methods: A narrative review was developed using evidence identified from PubMed, MEDLINE, Embase, Cochrane Library, EBSCOhost, and Google Scholar. Studies published between 1982 and 2024 evaluating two-layer and three-layer cleft palate closure techniques were reviewed. Evidence regarding surgical principles, functional outcomes, postoperative complications, and clinical implications was synthesized narratively.

Results: The available evidence consistently demonstrated comparable postoperative speech outcomes with both techniques. However, three-layer closure showed superior functional and structural outcomes by significantly reducing the incidence of oronasal fistula formation and velopharyngeal insufficiency through anatomical reconstruction of the muscular layer. Although technically more demanding and associated with longer operative time, the three-layer technique provided improved palatal integrity and reduced need for secondary surgical intervention. Two-layer closure remained a suitable option for selected patients with smaller defects or limited tissue availability when performed with meticulous surgical technique.

Conclusion: Current evidence suggests that three-layer closure offers superior overall postoperative outcomes compared with two-layer closure, particularly in minimizing fistula formation and velopharyngeal insufficiency while maintaining similar speech outcomes. Surgical technique should be individualized according to cleft characteristics, patient-specific factors, and surgeon expertise. Further high-quality randomized controlled trials with long-term follow-up are required to strengthen the evidence base.

Keywords: Cleft Palate; Palatoplasty; Two-Layer Closure; Three-Layer Closure; Velopharyngeal insufficiency; oronasal fistula and speech outcome.

How to cite this article: Pathak KK, Bhutani H, Kumar S, Yadav M, Mittal A, Ravi DM. Two-layer versus three-layer closure in cleft palate repair: a narrative review of surgical outcomes and postoperative complications. Int J Drug Deliv Technol. 2026;16(75s): 1547-1553. DOI: 10.25258/ijddt.16.75s.165

Introduction

Cleft palate is a congenital anomaly that disrupts the continuity of the oral and nasal cavities, significantly affecting speech, feeding, and overall craniofacial growth1. The primary goal of cleft palate repair is to restore the structural and functional integrity of the palate, facilitating proper speech development while minimizing complications such as oronasal fistulas, velopharyngeal insufficiency, and maxillary growth disturbances1. Surgical closure techniques have evolved over time, with the two-layer and three-layer closure methods being two commonly adopted approaches2. Each technique has unique strengths and challenges, making their comparative evaluation essential for optimizing patient outcomes3.

The two-layer closure technique, which involves approximating the oral mucoperiosteum and nasal mucosa, is a relatively straightforward approach. It is often employed in scenarios where the palatal defect is smaller or when surgical resources are limited4. Proponents of this method argue that it achieves adequate closure with reduced operative time and morbidity. However, critics highlight its limitations in ensuring muscular continuity, which is essential for velopharyngeal function4. As Schweckendiek and Doz (1957) observed, "Simpler closure techniques can yield satisfactory outcomes in selected cases but may fall short in addressing complex functional demands5."

Conversely, the three-layer closure technique incorporates meticulous dissection and repair of the oral, nasal, and muscular layers, particularly focusing on re-establishing the continuity of the levator veli palatini muscle5. This method aims to provide a robust repair that supports speech development and reduces the risk of postoperative complications.

Furlow (1986) emphasized the importance of functional restoration, stating, "Reconstruction of the muscular sling is not merely anatomical—it is fundamental to achieving dynamic closure during speech6."

Advocates of the three-layer technique also highlight its role in preventing oronasal fistulas, a common complication following cleft palate repair. Sommerlad (2003) noted, "Layered closure offers enhanced structural integrity and functional outcomes, particularly in larger or more complex cleft defects6."

However, the three-layer approach is not without drawbacks. It requires advanced surgical skills, longer operative times, and may carry an increased risk of tissue necrosis due to the additional dissection required7. Surgeons must carefully balance these factors against the potential benefits in each case. Recent studies suggest that patient-specific considerations, such as age, cleft size, and associated anomalies, play a pivotal role in determining the most appropriate surgical approach8.

This discussion highlights the need for evidence-based decision-making in cleft palate surgery. By comparing outcomes such as speech intelligibility, fistula rates, and overall patient satisfaction, surgeons can tailor their techniques to the unique needs of each patient, ultimately advancing the field of cleft care. Further research, including randomized controlled trials and long-term follow-up studies, is essential to refine these techniques and establish clear guidelines for their application.

Materials and Methods

Study Design

This review was conducted to compare the clinical outcomes of two-layer and three-layer closure techniques in cleft palate repair. A comprehensive literature search and narrative synthesis of the available evidence were performed following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

A total of 800 records were initially identified through database searching. After removing 175 duplicate records, 625 articles underwent title and abstract screening. Of these, 583 studies were excluded because they did not meet the predefined eligibility criteria. The remaining 42 full-text articles were assessed for eligibility, and 33 studies were further excluded due to insufficient data or failure to satisfy the inclusion criteria. Finally, nine studies were included for qualitative analysis and evidence synthesis. The selected studies were critically appraised, and data regarding study characteristics, patient population, surgical techniques, postoperative complications, speech outcomes, fistula formation, and velopharyngeal insufficiency were extracted and narratively synthesized to compare the clinical effectiveness of two-layer and three-layer cleft palate closure techniques.

Search Strategy

An electronic literature search was conducted using PubMed, MEDLINE, Embase, Cochrane Library, EBSCOhost, and Google Scholar databases to identify relevant articles published between January 1982 and December 2024. The search strategy included combinations of Medical Subject Headings (MeSH) and free-text keywords such as cleft palate, palatoplasty, two-layer closure, three-layer closure, velopharyngeal insufficiency, oronasal fistula, and speech outcome. Reference lists of eligible studies were also manually screened to identify additional relevant publications.

Eligibility Criteria

Inclusion Criteria

- Studies were included if they:
- Evaluated patients undergoing primary cleft palate repair.
- Compared two-layer and/or three-layer palatoplasty techniques.
- Reported at least one postoperative outcome, including speech, fistula formation, velopharyngeal insufficiency, bleeding, infection, or hematoma.
- Included randomized controlled trials, prospective or retrospective cohort studies, original research articles, or systematic reviews published in English.

Exclusion Criteria

- Studies were excluded if they:
- Included syndromic cleft palate or submucosal clefts.
- Included patients with previous cleft palate repair.
- Were case reports, conference abstracts, editorials, letters, or duplicate publications.
- Lacked sufficient outcome data for evaluation.

Study Selection

The review was structured according to the Population, Intervention, Comparison, and Outcome (PICO) framework. The population comprised patients with cleft palate undergoing primary cleft palate repair. The intervention of interest was cleft palate repair performed using the three-layer closure technique, while the comparison involved repair using the conventional two-layer closure technique. The primary outcomes assessed

included the long-term success of the surgical procedures, with particular emphasis on postoperative functional outcomes such as speech improvement and velopharyngeal competence, as well as the incidence of postoperative complications including oronasal fistula formation, bleeding, infection, hematoma, and the need for secondary surgical intervention.

This framework facilitated a systematic comparison of the two surgical techniques to determine their relative effectiveness, safety, and overall clinical outcomes

Data Extraction

The following data were extracted from each eligible study:

First author and year of publication

Study design

Sample size

- Patient characteristics
- Surgical technique (two-layer or three-layer closure)
- Duration of follow-up
- Postoperative outcomes including:
- Speech outcome
- Oronasal fistula formation
- Velopharyngeal insufficiency (VPI)
- Bleeding
- Infection
- Hematoma
- Requirement for secondary surgery

Outcome Measures

The primary outcome measures included:

- Incidence of postoperative oronasal fistula
- Velopharyngeal insufficiency
- Speech outcome

Secondary outcome measures included:

- Postoperative bleeding
- Infection
- Hematoma
- Need for revision surgery

Data Synthesis

The findings of the included studies were summarized narratively. Clinical outcomes of two-layer and three-layer closure techniques were compared with emphasis on functional outcomes, postoperative complications, and overall surgical success. Due to heterogeneity in study design, patient characteristics, and outcome assessment methods, quantitative meta-analysis was not performed.

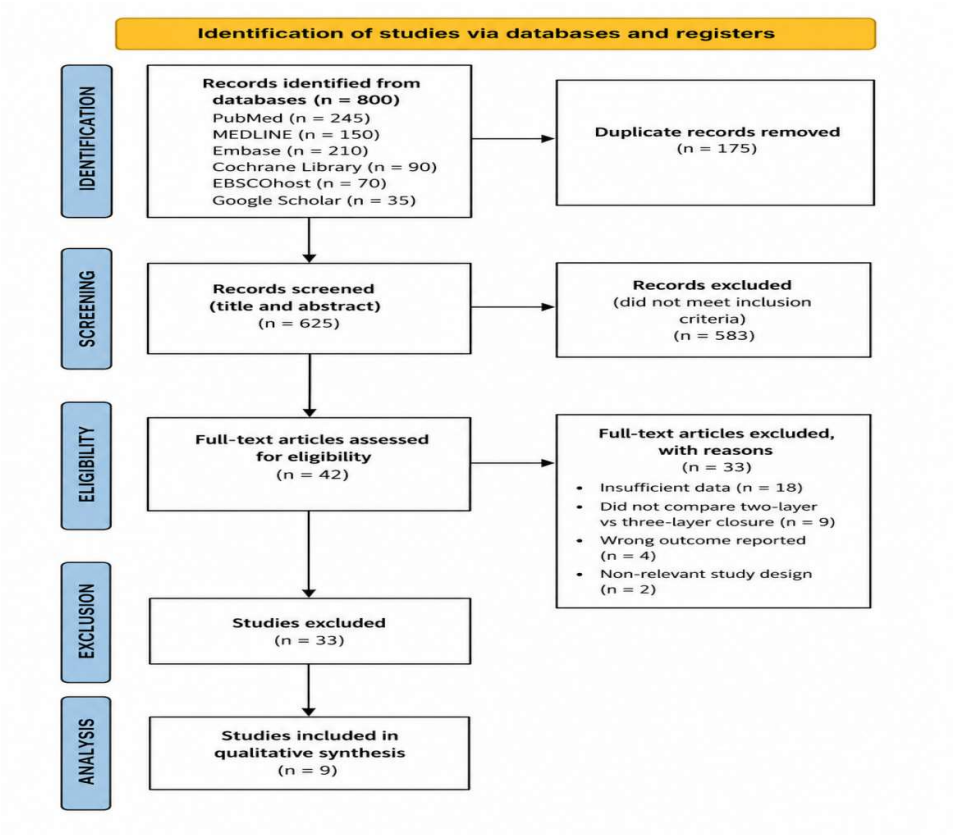

Fig 1: Prisma Flow Chart

Result

A total of 230 patients were treated for cleft palate repair, where they were divided into two groups accordingly and the treatment regime were given under the criteria set for study and under that the systematic review has been recorded for data collection.

Various post operative analysis is done to compare the results of included studies. Among all the 230 patients, 113 belongs to Group A (Two-layer palatoplasty) where as 177 belongs to Group B (Three-layer palatoplasty). (Table 1) Among the 113 patients, 110 patients showed improved speech impairment in Group A, but 3 patient showed lack of speech improvement. But in group B 113 patient showed improvement, and only 4 patient showed persisted speech insufficiency. (Table 2).

Among 117 patients in Group B, 97 patients showed no sign of fistula formation after 1st surgery, though the remaining 20 patient had fistula after 1st surgery. Similar in Group A where out of 113 patients only 28 patients showed no sign of fistula formation but 85 patient showed sign of fistula formation. As concluding after evaluating both the groups, here the sign of fistula formation is more in Group A as compared to Group B, suggesting that Three layer closure gives a better outcome in case of fistula formation post operatively as compared to two layer closure in cleft palate repair. (Table 3) Among 113 patients in Group A about 30% showed velopharyngeal insufficiency when compared to Group B with 117 patients where the rate of velopharyngeal insufficiency of 10%, giving a significant difference between the two groups, suggesting of three layer closure producing less amount of velopharyngeal insufficiency post operatively. (Table 4)

Various evaluation criteria under this study provide us with cumulative information that there was no significant post operative difference between the outcome of speech impairment in both the groups but in case of fistula formation Group A includes 85 patients that needed a second surgery for the complete closure whereas in Group B only 20 patients out of 117 patients needed a second surgery. In case of velopharyngeal insufficiency as well Group A showed 30 % patients with the defect where as mere 10% patient showed the defect in Group B. So, Group B i.e. Palatal closure by three layers stand better in terms of post operative outcomes and minimal associated complications.

Table 1: Total Number Of Patient Evaluated In Different Studies (n=230)

Authors	Total Number Of Patients	Group a – Two Layer Closure	Group b – Three Layer Closure
Mohamed E Hassan, 2005	70	32	38
Nicola Freda, 2010	117	58	59
John W. Hudson, 2015	6	3	3
Ahmed Elsherbiny, 2017	37	20	17

Table 2: Evaluation Of Speech Impairment

Group	Patients (n=230)	Improved	Persisted
Group a - Two Layer Closure	113	110	3
Group b - Three Layer Closure	117	113	4

Table 3: Evaluation Of Fistula Formation

Groups	Patients (n=230)	Complete Closure After 1st Surgery	Complete Closure After 2nd Surgery
Group a - Two Layer Closure	113	28	85
Group b – Three Layer Closure	117	97	20

Table 4: Evaluation Of Velopharyngeal Insufficiency

Groups	Patients (n=230)	Present	Absent
Group a Two Layer Closure	113	32(30%)	81
Group b Three Layer Closure	117	17(10%)	100

Discussion

Cleft palate repair has undergone remarkable evolution over the past century, with surgical techniques progressively refined to achieve optimal anatomical reconstruction and functional rehabilitation while minimizing postoperative morbidity. Contemporary palatoplasty aims to restore separation between the oral

and nasal cavities, establish competent velopharyngeal function, facilitate normal speech development, preserve maxillary growth, and reduce the incidence of postoperative complications such as oronasal fistula formation. Although numerous surgical modifications have been introduced, two-layer and three-layer closure techniques continue to represent the most widely practiced approaches, with the choice of technique largely influenced by cleft morphology, surgeon preference, and institutional protocols. Recent clinical reviews have emphasized that successful cleft palate repair depends not only on defect closure but also on restoration of muscular anatomy and maintenance of vascular integrity during flap elevation.^(14,24)

The present review demonstrated that both two-layer and three-layer closure techniques provide satisfactory postoperative speech outcomes. Approximately 97.3% of patients treated with two-layer closure and 96.6% of those undergoing three-layer closure exhibited improvement in speech, suggesting that either technique can achieve acceptable speech rehabilitation when performed meticulously and followed by appropriate speech therapy. Similar observations have been reported by Liao et al., who demonstrated that postoperative speech outcomes are influenced not only by the surgical technique but also by the timing of repair and subsequent multidisciplinary rehabilitation.(9) Likewise, Funayama et al. highlighted that meticulous reconstruction of the soft palate, irrespective of the surgical modification employed, contributes significantly to favorable speech outcomes, while emphasizing that surgeon experience and postoperative speech therapy remain equally important determinants of long-term functional success.(15) Hudson and Pickett further demonstrated that reinforcement of palatal closure using an interpositional collagen graft improved tissue healing without compromising speech outcomes, indicating that successful speech rehabilitation depends on the quality of tissue reconstruction rather than the number of closure layers alone.(16)

Despite comparable speech outcomes, the incidence of postoperative oronasal fistula formation differed considerably between the two techniques. Patients undergoing three-layer closure exhibited substantially lower fistula rates and required fewer secondary surgical interventions than those treated with two-layer closure. The superior structural integrity achieved by independent closure of the nasal mucosa, reconstruction of the muscular layer, and tension-free approximation of the oral mucosa appears to provide a more reliable barrier between the oral and nasal cavities. Similar findings have been reported by Freda et al., who demonstrated that meticulous multilayer reconstruction significantly improves closure of anterior palatal fistulae and minimizes recurrence.(10) Losken and Van Aalst also reported that multilayer palatal repair combined with meticulous tissue handling is associated with consistently low fistula rates and improved wound healing.(11) Elsherbiny and Grant further confirmed that multilamellar suturing techniques enhance tissue stability and significantly improve fistula repair outcomes by reducing wound tension.(18) Furthermore, Tachec reported that inadequate tissue mobilization and excessive closure tension remain the principal risk factors for postoperative fistula formation, reinforcing the importance of layered reconstruction in primary palatoplasty.(22)

Another important finding of the present review was the significantly lower incidence of velopharyngeal insufficiency (VPI) following three-layer closure compared with two-layer repair. Restoration of the levator veli palatini muscle during three-layer closure recreates the physiological muscular sling responsible for competent velopharyngeal function during speech and swallowing. Consequently, only 10% of patients in the three-layer group demonstrated postoperative VPI compared with approximately 30% in the two-layer group. These findings are consistent with those of Hassan and Askar, who demonstrated that intravelar veloplasty and anatomical muscle reconstruction significantly improve velopharyngeal competence and reduce postoperative hypernasality.(7) Funayama et al. similarly concluded that accurate muscular reconstruction remains one of the most critical determinants of long-term speech quality following primary palatoplasty.(15) Rossell-Perry also observed lower rates of velopharyngeal dysfunction among patients undergoing surgical protocols emphasizing meticulous muscle repair compared with conventional techniques.(20)

The principal advantage of the three-layer closure technique lies in its ability to restore normal palatal anatomy by separately reconstructing the nasal mucosa, muscular sling, and oral mucosa. This layered reconstruction provides improved mechanical stability, enhances vascular support, minimizes dead space, and reduces wound dehiscence, thereby decreasing postoperative complications. However, these advantages are accompanied by increased operative time, greater technical complexity, and the need for advanced surgical expertise. Conversely, two-layer closure remains technically less demanding and may be appropriate in carefully selected patients with narrow clefts, adequate tissue availability, or limited surgical resources. Similar conclusions have been drawn by Adeyemo et al., who recommended adjunctive reconstructive techniques for wide clefts to reduce tissue tension and improve healing.(19) Aljodah and Al-Zajrawee likewise demonstrated that improved nasal layer reconstruction contributes significantly to reducing postoperative fistula formation in patients with complete cleft palate.(23)

Advances in cleft palate surgery continue to focus on improving functional outcomes while minimizing surgical morbidity. Modern microsurgical instrumentation, magnification systems, biological graft materials, growth factors, and tissue engineering strategies have enhanced surgical precision and postoperative healing.(16,24) Furthermore, increasing evidence supports a multidisciplinary approach involving oral and maxillofacial surgeons, plastic surgeons, otolaryngologists, orthodontists, pediatric dentists, and speech-language pathologists to optimize long-term outcomes in cleft care.(12,14,17) Although both closure techniques remain clinically effective, current evidence

consistently favors anatomical muscle reconstruction and multilayer closure whenever feasible.

The findings of this review should be interpreted with caution because of the heterogeneity among the included studies regarding patient characteristics, cleft severity, surgical protocols, follow-up duration, and outcome assessment methods. Additionally, the limited number of comparative prospective studies and randomized controlled trials restricts the strength of the available evidence. Future multicenter randomized clinical trials employing standardized outcome measures, objective speech assessment protocols, and long-term follow-up are required to establish robust evidence-based recommendations regarding the optimal surgical approach for cleft palate repair.

Conclusion

The findings of this review suggest that three-layer closure is superior to two-layer closure in reducing postoperative complications, particularly oronasal fistula formation and velopharyngeal insufficiency, while achieving comparable speech outcomes. Therefore, three-layer closure may be considered the preferred technique, especially for complex cleft palate cases.

References:

1. R M Bumsted, A new method for achieving complete two-layer closure of a massive palatal cleft Arch Otolaryngology 1982 Mar;108(3):147-50.
2. J A Lehman Jr, B K Douglas, W C Ho, T W Husami One-stage closure of the entire primary palate Plastic Reconstruction Surgery 1990 Oct;86(4):675-81
3. W.P. Smith, A.F. Markus, J. Delaire Primary closure of the cleft alveolus: a functional approach 1995 Volume 33, Issue 3.
4. Anne Harding, Pamela Grunwell, Characteristics of cleft palate speech 1996 Volume31, Issue, October.
5. David S. Precious Primary Cleft Lip and Palate 1999 J Can Dent Assoc; 65:279-83.
6. R J Rohrich , E J Love, H S Byrd, D F Johns Optimal timing of cleft palate closure Plastic Reconstruction Surgery 2000 Aug;106(2):413-21
7. M. Hassan, Sherif Askar Does Palatal Muscle Reconstruction Affect the Functional Outcome of Cleft Palate Surgery 2005
8. Karoon Agrawal cleft palate repair and variation 2009 indian journal of plastic surgery supplement 1 volume 42
9. Yu Fang Liao, I Ying Yang, Ruby Yang, Claudia Yun, Chiung-Shing Huang Two stage palate repair with delayed hard palate closure is related to favourable maxillary growth in unilateral cleft lip and palate 2010 American society of plastic surgeons.
10. Freda, Nicola; Rauso, Raffaele; Curinga, Giuseppe; Clemente, Marco; Gherardini, Giulio Easy Closure of Anterior Palatal Fistula with Local Flaps 2010 Journal of Craniofacial Surgery 21(1) 229-232.
11. Dr H. Wolfgang Losken Dr John A. Van Achieving Low Cleft Palate Fistula Rates: Surgical Results and Techniques 2011 Volume 48, Issue 3
12. Elizabeth J Leslie and Mary L Marazita genetics of cleft lip and cleft palate 2013, PMCID: PMC 3925974.
13. Xue xu , hyuk-jae kwon, bing shi, qian zheng , heng yin, chenghao li Influence of different palate repair protocols on facial growth in unilateral complete cleft lip and palate 2014, J Cranio-maxillo-facial Surgery, Jan;43(1):43-7
14. Mahdi A Shkoukani , Lauren A Lawrence, Daniel J Liebertz, Peter F Svider Cleft palate: a clinical review 2015, Birth Defects Res C Embryo Today, Dec;102(4):333-42
15. Emi Funayama a, Yuhei Yamamoto a, Noriko Nishizawa b, Tadashi Mikoya c, Toru Okamoto d, Satoko Imai b, Naoki Murao a, Hiroshi Furukawa a, Toshihiko Hayashi a, Akihiko Oyama a Important points for primary cleft palate repair for speech derived from speech outcome after three different types of palatoplasty 2014, Volume 78, Issue 12
16. John W Hudson 1, David O Pickett A 5-Year Retrospective Review of Primary Palatoplasty Cases Utilizing an Acellular Collagen Inter-positional Graft 2015 J Oral Maxillofacial Surgery,73(7):1393.
17. Anna Elander , Christina Persson , Jan Lilja , Hans Mark Isolated cleft palate requires different surgical protocols depending on cleft type 2017 J Plastic Surgery Hand Surgery.
18. 18. Ahmed Elsherbiny 1, John H Grant 3rd Total Palatal Mobilization and Multilamellar Suturing Technique Improves Outcome for Palatal Fistula Repair 2017, Ann Plastic Surgery,79(6):566-570
19. Wasiu L. Adeyemo, Adebayo A. Ibikunle, Olutayo James, Olanrewaju A. Taiwo, Buccal Fat Pad: A Useful Adjunct Flap in Cleft Palate Repair 2017, Maxillofacial Oral Surg,18(1):40–45.
20. Percy Rossell Perry, Two Methods of Cleft Palate Repair in Patients With Complete Unilateral Cleft Lip and Palate, 2018, The Journal of craniofacial surgery 29(6):1
21. Ghulam Qadir Fayyaz , Nauman Ahmad Gill , Iftikhar Alam , Ayesha Chaudary , Muhammad Aslam , Irfan Ishaaq , Abdul Hameed , Ashraf Ganatra , Tahir Sheikh , Muhammad Bilal Continuous Versus Interrupted Sutures for Primary Cleft Palate Repair 2018, Plast Reconstruction Surgery Glob Open,13;6(11):e2001

22. Ana Tachec On the Frequency of Oronasal Fistulation After Primary Cleft Palate Repair, 2019, Volume 56, Issue 10
23. Mohammed Abd-Alhussein Aljodah, Mustafa Zahi Al-Zajrawee, Prospective evaluation of the effect of early nasal layer closure on definitive repair in cleft palate patients, 2022 Volume 88, Issue 1
24. Priyanka Naidu 1, Caroline A Yao 2, David K Chong 3, William P Magee 3rd 2 Cleft Palate Repair: A History of Techniques and Variations, 2022 Plast Reconstruction Surgery, Glob Open, 28;10(3):e4019.