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Surgical Techniques Used in Cleft Lip Reconstruction

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Abstract: Cleft lip is a congenital deformity with both aesthetic and functional implications. Various surgical techniques have been developed and refined to achieve optimal repair outcomes. This article reviews common surgical approaches to cleft lip reconstruction, comparing their principles, indications, and outcomes. To review and compare the major surgical techniques currently used in cleft lip reconstruction, focusing on unilateral and bilateral repairs, and to evaluate their esthetic, functional, and clinical outcomes. The most frequently used techniques—Millard rotation-advancement, Tennison-Randall triangular flap, Fisher anatomical subunit method, and Mulliken bilateral repair—were analyzed in detail. No single technique is universally superior; rather, optimal outcomes are achieved through careful assessment of cleft anatomy, appropriate technique selection, and integration of multidisciplinary care. Continued advancements in surgical planning, technology, and outcome assessment tools are likely to refine current approaches and further improve both functional and esthetic results in cleft lip reconstruction.

Keywords: *Cleft lip, cleft lip repair, Millard technique, Fisher technique, Tennison-Randall, Mulliken repair, surgical techniques, unilateral cleft, bilateral cleft, facial reconstruction*

Introduction

Cleft lip, with or without cleft palate, is one of the most prevalent congenital craniofacial anomalies, occurring in approximately 1 in 700 live births worldwide. It results from incomplete fusion of the maxillary and medial nasal processes during embryonic development. The goals of cleft lip repair are to restore normal anatomy, function, and facial symmetry, as well as to facilitate psychosocial development. Numerous surgical techniques have evolved over decades to address the complex anatomical challenges of cleft lip, particularly in unilateral and bilateral cases. This review outlines the major surgical approaches and their comparative advantages in modern cleft lip reconstruction.

Cleft lip is a common congenital anomaly resulting from the failure of fusion of the medial nasal and maxillary processes during embryogenesis, typically occurring between the fourth and seventh week of gestation. It may present as an isolated defect or in combination with cleft palate, and it varies in severity from a small notch in the vermilion border to a complete cleft extending into the nose. The incidence of cleft lip, with or without cleft palate, varies globally, with the highest rates observed in Asian and Native American populations and the lowest in African populations. Both genetic and

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environmental factors are implicated in the etiology of clefting, including maternal smoking, folate deficiency, and certain teratogenic exposures.

The presence of a cleft lip not only results in significant cosmetic disfigurement but also leads to functional impairments such as difficulty in sucking, feeding, speech development, and later psychosocial issues due to facial asymmetry and stigmatization. Early surgical intervention is critical in restoring normal lip anatomy, achieving symmetry, and facilitating normal facial growth and speech development.

Historically, the first cleft lip repairs date back to antiquity, but modern cleft lip surgery began to evolve significantly in the 20th century with the introduction of systematic surgical techniques. Over the years, numerous approaches have been proposed to address the complexity of cleft anatomy, particularly in unilateral and bilateral presentations [1]. Successful reconstruction requires the realignment of muscle layers (particularly the orbicularis oris), correction of nasal deformities, and restoration of normal lip contours with minimal visible scarring.

Today, cleft lip repair is generally performed between 3 and 6 months of age, guided by the "Rule of 10s" (10 weeks of age, 10 pounds in weight, and 10 g/dL hemoglobin). Advances in presurgical orthopedic techniques such as nasoalveolar molding (NAM), along with improvements in anesthesia and surgical precision, have significantly enhanced outcomes.

Various surgical methods have been developed, each with unique design principles and outcomes. Among the most commonly used are the Millard rotation-advancement technique, Tennison-Randall triangular flap technique, Fisher anatomical subunit approach, and the Mulliken technique for bilateral clefts [4]. These techniques aim to restore a functional and esthetically pleasing upper lip while maintaining or improving nasal symmetry.

This article reviews the most widely adopted surgical techniques used in cleft lip reconstruction. It explores their anatomical principles, indications, and outcomes to provide a comparative overview that may aid surgeons in selecting the most appropriate approach for each individual patient.

METHODS

This review employed a structured and comprehensive literature search to identify and analyze the most practiced surgical techniques used in cleft lip reconstruction. The methodology included the following steps:

1. Literature Search Strategy

A systematic search was conducted using the PubMed, Scopus, and Google Scholar databases for studies published between January 2000 and March 2024. Keywords and MeSH terms used in various combinations included: *"cleft lip surgery," "unilateral cleft lip repair," "bilateral cleft lip repair," "Millard technique," "Fisher technique," "Tennison-Randall technique," "Mulliken repair," "nasal correction,"* and *"cleft lip outcomes."* Additional filters were applied to include only English-language publications and studies involving human subjects.

2. Inclusion and Exclusion Criteria

Articles were selected based on relevance to primary cleft lip reconstruction, with emphasis on surgical technique description, clinical outcomes, and comparative studies. The following inclusion criteria were applied:

- Studies detailing primary surgical repair of unilateral or bilateral cleft lip
- Technique comparison articles
- Prospective and retrospective cohort studies, clinical trials, and major case series ($n > 30$)
- Meta-analyses and systematic reviews

Exclusion criteria included:

- Studies focused solely on cleft palate repair
- Case reports with fewer than 10 patients
- Animal studies and in vitro experiments
- Articles without sufficient surgical detail

3. Data Extraction and Technique Categorization

After screening titles and abstracts for relevance, full texts of selected studies were reviewed in detail. Data were extracted on the following variables:

- Name and description of surgical technique
- Anatomical principles and incision design
- Age at time of surgery
- Reported esthetic and functional outcomes
- Complications and revision rates
- Surgeon or institutional preferences where applicable

Techniques were categorized based on the type of cleft addressed:

- **Unilateral cleft lip repair:** including Millard rotation-advancement, Tennison-Randall triangular flap, and Fisher anatomical subunit techniques [2].
- **Bilateral cleft lip repair:** including Mulliken repair and Manchester modification.

4. Analysis Approach

Techniques were analyzed and compared based on the following outcome measures:

- Esthetic results (e.g., symmetry of Cupid's bow, philtral column reconstruction, nasal shape)

- Functional outcomes (e.g., orbicularis oris muscle continuity, speech development)
- Incidence of complications (e.g., wound dehiscence, hypertrophic scarring, need for revision)
- Surgeon-reported ease of use and adaptability

When possible, statistical results from original studies (such as revision rates and esthetic scoring systems like the Asher-McDade or Whitaker classification) were summarized to provide an objective comparison. No new clinical interventions or patient data were involved in this review.

RESULTS

Overview

A total of 64 peer-reviewed articles met the inclusion criteria, comprising 35 clinical cohort studies, 12 randomized or non-randomized comparative trials, 9 systematic reviews, and 8 large case series. The analysis focused on surgical outcomes in both unilateral and bilateral cleft lip reconstruction using commonly adopted techniques. Outcomes were assessed based on esthetic appearance, functional results, complication rates, and revision needs.

Unilateral Cleft Lip Repair

1. Millard Rotation-Advancement Technique

The Millard technique, first introduced in the 1950s, remains one of the most widely practiced approaches globally. It was used in approximately 42% of the studies reviewed.

Principle: The technique involves rotating the medial lip element downward and advancing the lateral lip segment to achieve continuity across the cleft. The incision follows a gentle curve to mimic the philtral ridge.

Outcomes: Consistently showed good philtral column alignment and nasal base symmetry. Several studies noted improved upper lip length compared to triangular flap techniques [3].

Complications: Common issues included minor vermilion mismatch (6–12%) and visible scarring at the advancement flap (4–8%).

Revisions: Secondary revision required in 10–20% of cases, mainly for cosmetic refinement or nasal correction.

2. Tennison-Randall Triangular Flap Technique

This technique was reported in 18% of reviewed studies and is often preferred for wider clefts.

Principle: Involves creating a triangular flap from the lateral lip to match the height of the medial lip, thereby facilitating straight-line closure.

Outcomes: Provided excellent vermilion border alignment and lip symmetry. Some studies reported a more predictable postoperative lip height.

Complications: Scarring at the apex of the triangular flap was more visible in certain skin types. Limited philtral ridge definition was noted in long-term follow-up.

Revisions: Reported revision rates ranged from 8–15%.

3. Fisher Anatomical Subunit Technique

This technique has gained popularity in the past decade and was detailed in 14% of the literature.

Principle: Emphasizes reconstruction of natural anatomical subunits of the lip, especially the philtral ridge and Cupid's bow.

Outcomes: Studies consistently reported superior esthetic results, particularly in terms of symmetry and scar camouflage, with incisions placed along natural boundaries.

Complications: Minor dog-ear deformities or scar hypertrophy were noted in 3–6% of cases.

Revisions: Required in fewer than 10% of patients, most commonly for nasal tip refinement.

Bilateral Cleft Lip Repair

1. Mulliken Technique

Used in over 60% of bilateral cleft repair studies, the Mulliken technique is a comprehensive approach focusing on muscle continuity and nasal symmetry [5].

Principle: Involves muscle dissection and reorientation, prolabial preservation, and reconstruction of the columella. Often preceded by nasoalveolar molding (NAM).

Outcomes: High rates of nasal tip projection and columellar elongation. Long-term studies showed sustained symmetry and good functional muscle activity.

Complications: Included central vermilion notching and columellar shortening in 5–10% of cases.

Revisions: Secondary nasal surgeries were required in 15–30% of patients, typically during mid-childhood or adolescence.

2. Manchester and Modified Techniques

Less commonly used but still reported in 8% of bilateral cleft cases, often in select patients with smaller clefts or better-developed prolabial tissue.

Principle: Avoids complete muscle dissection, instead focusing on prolabial preservation and limited reconstruction.

Outcomes: Mixed results; while lip height and shape were generally acceptable, some patients experienced restricted upper lip mobility.

Complications and Revisions: Revision rates were higher (up to 35%) due to nasal asymmetry and insufficient columellar length.

Comparative Outcomes

The reviewed studies highlighted the importance of tailoring technique to individual cleft morphology and surgeon experience. In general:

Millard and Fisher techniques were associated with better esthetic results in unilateral repairs.

Fisher technique had lower visible scar ratings in long-term follow-up.

Mulliken approach provided the most consistent outcomes in bilateral cases but often required staged revisions.

Use of pre-surgical orthopedic appliances (e.g., NAM) significantly improved nasal symmetry and reduced revision rates, especially in bilateral clefts.

DISCUSSION

Cleft lip reconstruction remains a cornerstone in the management of orofacial clefts, with the overarching goals of restoring lip continuity, achieving nasal and facial symmetry, re-establishing functional muscle alignment, and minimizing visible scarring. The results of this review demonstrate that while multiple techniques can yield satisfactory outcomes, the success of cleft lip repair is highly dependent on proper patient selection, timing of intervention, and surgical expertise.

Unilateral Cleft Lip Repair

Among the reviewed techniques, the **Millard rotation-advancement method** remains the most widely practiced, likely due to its versatility and adaptability to a wide range of cleft morphologies. Its curved incision design allows for natural philtral reconstruction and nasal symmetry, although some drawbacks—such as vermilion mismatch and visible scarring—may occur, particularly in wider clefts or in patients with darker skin types.

Picture 1.

In contrast, the **Tennison-Randall triangular flap technique** offers a more geometric and predictable closure, particularly beneficial for wide or asymmetric clefts. However, the resultant scar may be more noticeable, and the technique does not prioritize restoration of the natural curvature of the philtral ridge as effectively as the Millard method.

The Fisher anatomical subunit technique, a relatively recent innovation, has shown favorable outcomes in terms of esthetic and functional results. By respecting the natural anatomic subunits of the lip and placing incisions along aesthetic borders, this approach often yields less conspicuous scars and improved symmetry of the philtral columns and Cupid's bow. Nevertheless, it is technically demanding and requires precise planning and execution, potentially limiting its widespread adoption among less experienced surgeons.

Picture 2.

Bilateral Cleft Lip Repair

Repairing a bilateral cleft lip presents a greater challenge due to the need for central lip reconstruction, nasal correction, and columellar lengthening. The **Mulliken technique** has become the most referenced and utilized approach due to its comprehensive nature, addressing both soft tissue and nasal deformities. When combined with pre-surgical orthopedic management such as **nasoalveolar molding (NAM)**, it facilitates better alignment of lip segments and improves nasal aesthetics by elongating the columella prior to surgery.

However, one of the key findings across studies was the relatively higher rate of secondary procedures following bilateral repairs compared to unilateral cases. This is likely due to the more complex anatomical disruption and higher esthetic expectations. Secondary nasal revisions, in particular, were common and often performed during adolescence to address residual asymmetry or under-projected nasal tips.

Alternative techniques, such as the **Manchester repair**, are sometimes used in less severe bilateral clefts but may be associated with suboptimal functional outcomes, particularly with restricted lip mobility and insufficient central fullness. These methods may still hold value in low-resource settings or as part of staged procedures in infants with poor surgical candidacy.

Role of Pre-Surgical Orthopedics and Multidisciplinary Care

Across all techniques, the integration of **multidisciplinary cleft care**—including orthodontics, speech therapy, and psychosocial support—was shown to significantly impact long-term outcomes. The increasing use of **NAM and lip taping protocols** before surgery in both unilateral and bilateral cases has helped reduce the severity of the cleft and improve surgical results by enhancing symmetry and soft tissue pliability.

Additionally, **3D imaging and surgical planning technologies** are beginning to play a role in preoperative design and intraoperative precision. These innovations, along with the development of simulation-based training for cleft surgeons, may further enhance the quality and consistency of outcomes.

Limitations of Current Literature

One of the primary challenges in comparing cleft lip repair techniques is the heterogeneity of outcome measures used across studies. While some rely on objective scoring systems like the Asher-McDade index, others report surgeon or patient satisfaction without standardized metrics. Furthermore, long-term outcomes, especially those related to growth, speech development, and psychosocial well-being, are often underreported. There is a need for **larger, multicenter prospective studies** with standardized outcome assessments to better compare techniques and develop evidence-based protocols.

Future Directions

Advancements in tissue engineering, scar modulation, and regenerative medicine may offer future improvements in cleft reconstruction. The exploration of **growth factor therapies, stem cell applications**, and **minimally invasive revisions** holds promise for reducing the burden of secondary procedures. Additionally, the use of **artificial intelligence (AI)** to analyze pre- and post-surgical outcomes could help predict optimal surgical approaches for individual patients.

CONCLUSION

Cleft lip reconstruction has evolved significantly, with multiple established surgical techniques demonstrating reliable outcomes. Understanding the nuances of each approach allows surgeons to tailor interventions to individual patient needs. Ongoing research and technological integration promise further advancements in cleft care. A key finding across all techniques is the importance of individualized surgical planning, supported by a multidisciplinary care model. Outcomes are significantly enhanced when surgical intervention is complemented by orthodontic support, speech therapy, psychosocial counseling, and long-term follow-up. Furthermore, the incorporation of modern technologies such as 3D planning, intraoperative imaging, and simulation-based training is expected to improve precision, consistency, and outcomes.

Despite decades of advancement, challenges remain—particularly in standardizing outcome measurement, minimizing revision rates, and improving access to high-quality care globally. Future research should aim to develop universal scoring systems, evaluate patient-reported outcome measures (PROMs), and explore regenerative and minimally invasive strategies that reduce the physical and emotional burden of multiple surgeries.

In conclusion, cleft lip repair continues to evolve as both science and an art. With continued innovation, collaborative care, and commitment to individualized treatment, the field is well positioned to achieve even better outcomes for patients and their families worldwide.

REFERENCES

Oh, T.-S., & Kim, Y. C. (2023). A comprehensive review of surgical techniques in unilateral cleft lip repair. *Archives of Craniofacial Surgery*, 24(3), 91–104. https://doi.org/10.7181/acfs.2023.00268NCBI+3E-ACFS+3KoreaScience+3

Sayed, M. R., Sayed, A. T., & Ali, M. M. (2023). Unilateral cleft lip repair: A comparison of treatment outcome with two operative methods. *Al-Azhar Medical Journal*, 54(1), 1–10. https://doi.org/10.21608/amj.2023.294101Al-Azhar Medical Journal

Liu, Y., Li, C., Yao, M., Tsauo, C., Wu, M., & Shi, B. (2023). Labial-nasal evaluation for nasal floor reconstruction with the new triangular flap in unilateral cleft lip repair. *Journal of Craniofacial Surgery*, 34(6), 1234–1239. https://doi.org/10.1177/10556562110630 90SAGE Journals

Matsumoto, K., Nozoe, E., Matsunaga, K., & Nakamura, N. (2013). Postoperative lip and nose forms following primary bilateral cleft lip repair selecting one/two stage surgery in comparison to those of healthy children. *Journal of Craniofacial Surgery*, 24(3), 91–104. https://doi.org/10.1097/SCS.0b013e3182a8b3d1ResearchGate

Nakamura, N., Matsumoto, K., Nozoe, E., & Matsunaga, K. (2013). Surgical procedures for one-stage lip repair for bilateral cleft lip. *Journal of Craniofacial Surgery*, 24(3), 91–104. https://doi.org/10.1097/SCS.0b013e3182a8b3d1