

# UNILATERAL CLEFT LIP REPAIR TREATMENT OUTCOMES USING TRIANGULAR FLAP AND ROTATION-ADVANCEMENT TECHNIQUES: A SYSTEMATIC REVIEW

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## ABSTRACT

**INTRODUCTION:** Cleft lip and palate is a common congenital facial malformation that significantly impacts developmental, physical, and psychological aspects of patients and their families. It is essential to measure treatment outcomes in cleft surgery to evaluate cleft management in the era of evidence-based medicine.

**OBJECTIVES:** This review aimed to analyze and compare outcomes of two primary unilateral cleft lip repair techniques, such as triangular flap and rotation-advancement.

**MATERIAL AND METHODS:** Articles were retrieved from PubMed, Medline, Cochrane Library, and ScienceDirect based on PRISMA guidelines, to find relevant articles published between 1990-2021. Two reviewers independently appraised articles in separate rounds. A total of 1,241 articles were retrieved. However, only eight studies were selected based on inclusion criteria.

**RESULTS:** The rotation-advancement technique group showed better results in the shape of nostril and the length of Cupid's bow, but with a higher finding of notching and nasal deformities. Meanwhile, the triangular flap technique group showed better results in philtral height, Cupid's bow shape, vermilion height, lip height, and nasal width, despite having a more significant number of nasal defect formations compared with the rotation group.

**CONCLUSIONS:** The triangular flap and rotation-advancement techniques have their respective advantages and disadvantages. Nevertheless, post-operative deformities can be found in some cases, including asymmetry of Cupid's bow, flattened philtrum, elongated white lip, tilted columella, and flattened ala nasi. Further systematic review studies should be conducted to analyze treatment outcomes of primary cleft lip surgery in other techniques, according to various measurement methods.

**KEY WORDS:** treatment outcome, triangular flap, cleft lip repair, rotation-advancement.

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## INTRODUCTION

Cleft lip and palate is a common congenital facial malformation that significantly impacts the developmental, physical, and psychological aspects of a patient, and its occurrence is estimated as 1 in 600 live births. Therefore, good outcomes of cleft lip and palate reconstruction are indispensable [1]. The goal of surgical treatment for

children born with cleft lip and palate is to restore esthetical appearance of the lip and nose and continuation of the primary and secondary palate, and to improve speech, language, and hearing functions. Additional goal is to restore airway patency, occlusion and mastication function, and normal psycho-social development [1, 2].

In recent decades, the understanding of surgical cleft lip repair has evolved, allowing for an improved ability to

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restore anatomical shape and function [3]. The first documented cleft lip repair occurred in the fourth century AD in the Tang dynasty in China. The simple surgical technique involved incision and suturing of the cleft edges, and the child was instructed not to speak post-operatively for about three months [4, 5]. In the early 20<sup>th</sup> century, a Rose-Thompson method has developed as a straight-line technique, and was used by many surgeons. This technique was later found to have disadvantages in vertical scar formation that causes a notch in the upper lip [3-7]. This condition has led many surgeons to develop other unilateral cleft lip surgery techniques, such as quadrilateral flap, triangular flap, and rotation-advancement [4]. The rotation-advancement technique was introduced by Dr. Ralph Millard in 1955 and until now, it was the most widely used lip repair technique [8-12]. The triangular flap technique was introduced by Dr. Charles Tennison in 1952 and developed by Dr. Peter Randall in 1959, and it has also attracted interest of many surgeons [13-16]. The two primary techniques have undergone many modifications, including Mohler technique as an improvement of Millard rotation-advancement technique and Cronin technique for Tennison-Randall triangular flap technique. Each method has advantages, and addresses the importance of muscle repositioning into correct anatomical orientation to achieve both functional and aesthetic outcomes [15, 16].

## OBJECTIVES

Since treatment guidelines have become an integral part of contemporary clinical practice, it is essential to

measure treatment outcomes in cleft lip and palate surgery to evaluate the cleft treatment and improvement in the era of evidence-based medicine. Studies have been conducted to evaluate the outcomes of each surgical technique, including dento-facial growth and development, facial shape, speech function, breathing function, hearing ability, quality of life, and patient satisfaction. The aim of the current systematic review was to analyze and compare repair outcomes of the primary unilateral cleft lip using triangular flap compared with rotation-advancement techniques.

## MATERIAL AND METHODS

### SEARCH STRATEGY

In selecting articles, preferred reporting items for systematic reviews and meta-analysis (PRISMA) guideline was employed in several databases, including PubMed, Medline, ScienceDirect, and Cochrane Library. Key words used for selecting articles were (Cleft lip surgery OR Cleft lip repair) AND (Triangular OR Cronin OR Tennison Randall) AND (Rotation-advancement OR Millard) AND (Outcome OR Result). Detailed selection procedure is shown in Figure 1.

### INCLUSION AND EXCLUSION CRITERIA

Inclusion criteria were analyzed based on PICOS components, as shown in Table 1. Population (P) – subject with unilateral cleft lip with or without alveolar cleft or

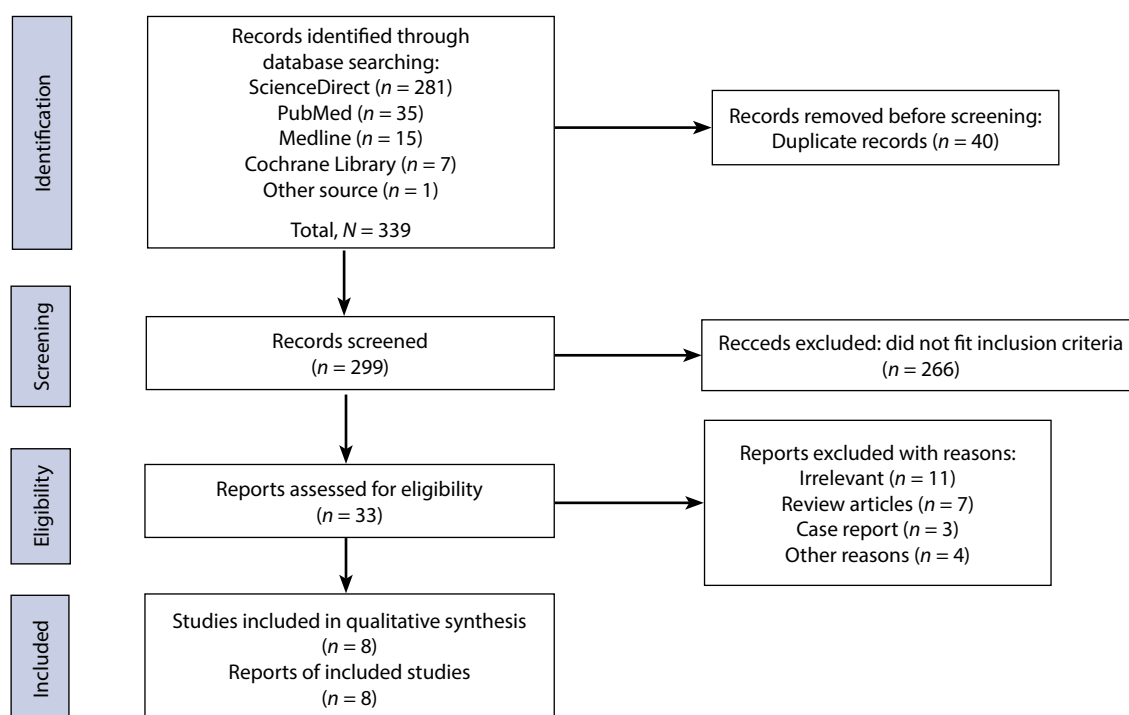


FIGURE 1. Study selection process

**TABLE 1.** Description of inclusion criteria based on PICOS criteria

<b>P</b>	<b>Population</b>	Patients diagnosed with unilateral cleft lip
<b>I</b>	<b>Intervention</b>	Patients who have undergone primary cleft lip repair
<b>C</b>	<b>Comparison</b>	Surgical technique used rotation-advancement technique or triangular flap technique
<b>O</b>	<b>Outcome</b>	All data of post-operative surgical outcomes measured with manual, anthropometric, photographic, and scoring basis measurements
<b>S</b>	<b>Study design</b>	Retrospective/ prospective/ ambispective cross-sectional studies, cohort studies, and randomized clinical trials

cleft palate. Intervention (I) – patient who has undergone primary cleft lip surgery or repair. Comparison (C) – surgical technique using rotation-advancement or triangular flap techniques. Outcome (O) – all surgical outcomes measured with manual, anthropometric, photographic, and scoring basis measurements. Study design (S) – retrospective/prospective/ambispective cross-sectional studies, cohort studies, and randomized clinical trials. Exclusion criteria were case reports, review papers, letters to editors, studies with inadequate follow-up time, and non-English written articles. The research question of this study was “How are treatment outcomes of unilateral primary cleft lip repair using triangular flap technique compared with rotation-advancement technique?”

## STUDY SELECTION

Two reviewers independently reviewed title and abstract of each study identified through electronic searching. Studies that did not have adequate information in the abstract and did not meet inclusion criteria were not included in eligibility assessment. Adequate studies that were approved underwent eligibility assessment. If reviewers disagreed, an independent third reviewer was involved.

## DATA EXTRACTION

Data extracted from eligible articles were author (s), year of publication, number of subjects, diagnosis, surgical technique, variable assessed, measurement methods, and clinical outcomes.

## CRITICAL APPRAISAL OF STUDIES

An independent risk of bias assessment was conducted by two reviewers using Newcastle-Ottawa scale [17]. This scale uses a star system with a maximum of 9 stars. Studies that obtain 9 stars reflect a low-risk of bias, a score of 7 or 8 indicates medium-risk, while a score below 7 indicates a high-risk of bias. Aspects evaluated included subject selection technique, comparability of study group, ascertainment of outcomes, and exposures of interest. Disagreements were resolved through discussions involving an independent third party.

## SUMMARY MEASURES AND SYNTHESIS OF RESULTS

Data obtained in this study were analyzed based on descriptive statistics. Data on primary cleft lip repair clinical outcomes using triangular flap and rotation-advancement techniques were tabulated, including data of follow-up period. Publication bias in selected studies used funnel plots. In addition, regression analysis was also performed to identify a trend between each therapy and its recurrence rate.

## RESULTS

### RESULTS OF LITERATURE SEARCHING

Studies selection process is shown in Figure 1. The initial database search obtained 339 articles. After screening for duplication, 40 articles were eliminated, leaving 299 articles to be screened for titles and abstracts. Eligibility screening was carried out through extensive reading of the abstract, where 266 articles did not meet the inclusion criteria. There were 33 articles for eligibility assessment; 24 were eliminated due to various factors regarding relevancy issues. Ultimately, eight studies were selected for review (Chowdri *et al.*, 1990; Lazarus *et al.*, 1998; Yamada *et al.*, 2002; De Silva Amaratunga, 2004; Cheema *et al.*, 2012; Iliopoulos *et al.*, 2014; Gadre *et al.*, 2016; Adetayo *et al.*, 2018).

### DESCRIPTION OF INCLUDED STUDIES

Complete description of the selected articles is presented in Table 2. Most of the studies are retrospective (5 studies), prospective (2 studies), and cross-sectional (1 study). Four hundred ninety-one subjects' data were analyzed with 1-10 years of follow-up.

### RESULTS OF VARIABLE OUTCOMES

This study analyzed treatment outcomes of primary cleft lip repair using triangular flap and rotation-advancement techniques in various measurements, including anthropometric, photographic, dental cast analysis, and manual measurement using a caliper. The variables also analyzed the shape of the nose, the shape and length

TABLE 2. Description of included studies

Author(s), [Ref.]	Year	Study design	Number of subjects	Subject	Diagnosis	Surgical technique	Measured variable	Measurement methods	Clinical outcomes
Chowdri <i>et al.</i> [23]	1990	Retrospective	108	Human	UCL	Millard triangular ( <i>n</i> = 58) Tennison-Randall rotation-advancement ( <i>n</i> = 50)	Vertical length, scar, vermillion, lip pout, Cupid's bow, nasal tip, and nasal septum	Facial photographs with scoring system	No significant difference were found in the lip and nose appearance post-operatively between two types of surgical treatment.
Lazarus <i>et al.</i> [9]	1998	Retrospective	72	Human	UCL	Millard rotation-advancement ( <i>n</i> = 22) Tennison triangular ( <i>n</i> = 10)	Quality of scar, Cupid's bow, evenness of the vermillion, alignment of white roll and the lip pout	Manual measurement using calipers	Similar surgical outcomes were found, except for rotation advancement flap technique, which tended to result in an shorter lips measured on the repaired side.
Yamada <i>et al.</i> [20]	2002	Retrospective	20	Human	UCLAP	Triangular flap ( <i>n</i> = 10) Rotation-advancement ( <i>n</i> = 10)	Shapes of nose, shape of Cupid's bow, length of Cupid's bow	Anthropometric using 3D optical scanner	Better result of shapes of the nose and nostril in the rotation-advancement group, Cupid's bow in triangular group. In the triangular group, length of Cupid's bow was found more/extended.
De Silva Amaratuna <i>et al.</i> [21]	2004	Retrospective	59	Human	UCL	Millard rotation-advancement ( <i>n</i> = 18) Cronin – triangular ( <i>n</i> = 21) Combination (modified Millard incision and a 2 mm triangular flap placed 1 mm above the white roll) ( <i>n</i> = 20)	Vermilion height, philtral height, and Cupid's bow height	Component symmetry index score	Index score of component symmetry from the philtral, vermillion, and Cupid's/bow height in combined method was comparable with Cronin method, and superior compared with Millard method. Result of combined method: Philtral width was better than Cronin method but not significantly different from Millard technique.
Cheema <i>et al.</i> [22]	2012	Cross sectional	40	Human	UCL	Millard rotation advancement ( <i>n</i> = 40) Noordhoff triangular ( <i>n</i> = 40)	Presence of notch	Manual measurement	Noordhoff triangular flap: better notching result due to the break of linear repair on the vermillion, which the procedure to bring the vermillion from lateral to medial segment help to reconstruct a symmetrical vermillion.
Iliopoulos <i>et al.</i> [15]	2014	Retrospective	44	Human	UCL with or without alveolar and palate cleft	Tennison-Randall triangular flap ( <i>n</i> = 44)	Lip and nose aesthetic evaluation Variable for lip: overall appearance, continuity of vermillion border, symmetry of Cupid's bow, red lip deficiency, mucosal drop, cleft repair scar Variable for nose: overall appearance, nostril symmetry, nostril stenosis, symmetry of columella, centrality of nasal bridge	Photographic evaluation	Tennison-Randall technique proved to be a very satisfying method in terms of aesthetic (nasolabial appearance) long-term outcome.

TABLE 2. Cont.

Author(s), [Ref.]	Year	Study design	Number of subjects	Subject	Diagnosis	Surgical technique	Measured variable	Measurement methods	Clinical outcomes
Gadre <i>et al.</i> [25]	2016	Prospective	60	Human	UCL	Millard rotation advancement (n = 30) Tennison-Randall triangular (n = 30)	White roll match, scar quality (i.e., satisfactory, hypertrophic or stretched), Cupid's bow symmetry, lip length, lip height, notching, alar base symmetry	Photographic evaluation	Tennison-Randall technique showed better results for the white roll match, scar quality, Cupid's bow symmetry and lip notching. Total lip length and lip height in both the groups remained approximately the same.
Adetayo <i>et al.</i> [16]	2018	Prospective	48	Human	UCL	Millard rotation advancement (n = 24) Tennison-Randall triangular (n = 24)	Horizontal and vertical lip/height, nasal width, Cupid's/bow width, and philtral width	Anthropometric measurements, using full frontal facial photograph	Millard group: greater post-operative increase in horizontal length and vertical lip height; better reduction of total nasal width. Tennison-Randall group: better reduction of Cupid's bow width and better philtral height.

TABLE 3. Result of variable outcomes

	Shape of nostril	Shape of Cupid's bow	Length of Cupid's bow	Philtral height	Vermilion height	Lip height	Nasal width	Notching	Nasal deformities	Nasal defect	Scar hypertrophy	White roll match	Satisfactory scar quality
Triangular flap	-	√	-	√	√	√	√	√	-	√	-	√	√
Rotation-advancement flap	√	-	√	-	-	-	-	-	√	-	√	-	-

√ - better result in measurements

TABLE 4. Critical appraisal of included studies

Author(s)	Year	Representative of exposed cohort	Selection of non-exposed cohort	Ascertain of exposure	Demonstration that outcome of interest not present/at/start	Control for treatment	Comparability among measurement method	Assessment of outcome	Follow-up (min. 1 year)	Adequacy of follow-up	Score	Overall appraisal
Chowdry <i>et al.</i>	1990	A	A	A	A	A	A	B	A	A	8/9	Medium-risk
Lazarus <i>et al.</i>	1998	A	A	A	A	A	A	A	B	A	9/9	Low-risk
Yamada <i>et al.</i>	2002	A	A	A	A	A	A	A	B	A	9/9	Low-risk
De Silva Amaratinga <i>et al.</i>	2004	A	A	A	A	A	A	B	B	A	8/9	Medium-risk
Cheema <i>et al.</i>	2012	A	A	A	A	A	A	A	A	A	9/9	Low-risk
Iliopoulos <i>et al.</i>	2014	A	A	A	A	A	A	A	B	A	9/9	Low-risk
Gadre <i>et al.</i>	2016	A	A	A	A	A	A	A	A	A	9/9	Low-risk
Adetayo <i>et al.</i>	2018	A	A	A	A	B	B	A	A	A	8/9	Medium-risk

of Cupid's bow, philtral height, vermilion height, presence of a notch, white roll match, and satisfactory scar. From the results of the 8 systematic studies, 3 used photographic analysis, 2 used anthropometric studies, and 2 used manual measurement studies using a caliper. Recapitulation and comparison of clinical outcomes between the triangular flap and rotation-advancement techniques are shown in Table 3.

Table 3 shows that the rotation-advancement group presented better results in the shape of the nostril and the length of the Cupid's bow, but with a higher finding of notching and nasal deformities. Meanwhile, the triangular flap group showed more desirable results in the Cupid's bow shape, philtral height, white skin roll match, satisfactory scar, vermilion height, lip height, and nasal width. On the contrary, the triangular flap group had a more significant number of nasal defect formations compared with the rotation-advancement group.

## RISK OF BIAS WITHIN STUDIES INCLUDED

The risk of bias in each study was analyzed using Newcastle-Ottawa scale assessment form for cohort studies [17]. Each article was evaluated based on several critical aspects regarding case selection, comparability, and outcome. In this systematic review, scores greater than 7 showed a high-quality study. From the 8 studies, five articles obtained a score of 9. This result indicated that the article had a low-risk of bias. Meanwhile, three articles obtained a score of 8, showing that the article had a medium-risk of bias [17]. Details of critical appraisal are listed in Table 4.

## DISCUSSION

Cleft lip is the most common congenital anomaly, with as many as 76% classified as unilateral [18, 19]. Surgical cleft lip repair procedure has become a challenge for surgeons since surgical outcomes can affect the patient's quality of life in the future [7]. There are various methods of cleft lip repair, but the most commonly used are rotation-advancement and triangular flap techniques. Both the techniques have their respective advantages and disadvantages. Nevertheless, post-operative deformities can be found in some cases, including asymmetry of the Cupid's bow, flattened philtrum, elongated white lip, tilted columella, and flattened ala nasi [20].

Yamada *et al.* [20] conducted a study to evaluate facial morphology after primary cleft and lip repair through a triangular flap and rotation-advancement techniques in three-dimensional analysis. This study showed that nasal protrusion and nostril symmetry were better in the rotation-advancement group due to simple reconstruction of the orbicularis oris muscle. This technique also stabilizes the nasal base and makes the alar to rotate. On the contrary, a better Cupid's bow shape was found in the triangular flap group. In some cases, the length

of Cupid's bow in the triangular group was more extended due to distribution of the large orbicularis oris muscle in the lower part of the lip. Moreover, the tubercle in the upper lip was pulled towards the cleft side [20].

The outcome of philtral and vermilion heights was discussed in a study by De Silva Amaratunga *et al.* [10] by calculating cleft lip component symmetry index score. In this study, the philtral height outcomes in the triangular flap group (Cronin technique) obtained a better score, so the results of vermilion height. The poor result of the philtral height symmetry in the rotation group (Millard technique) was caused by the inadequacy of rotation and contracture in the straight-line scar. Cronin technique is considered more able to overcome this problem through mathematical calculations and breaking the scar line by introducing the triangular flap [21].

Adetayo *et al.* [16] analyzed comparative surgical outcomes of the two techniques using quantitative anthropometric measurements. The results exhibited that the Millard group had a more significant increase in vertical lip height post-operatively and a greater reduction in the nasal width than the triangular flap group using Tennison-Randall technique. However, reasons for this finding were not clearly explained [16].

Cheema *et al.* [22] conducted a cross-sectional study analyzing the presence of a notch in the repaired vermilion area in Millard rotation-advancement and Noordhoff triangular flap techniques. This study revealed that a notch of more than 1 mm in Millard technique was evident in two cases (5%), whereas Noordhoff technique did not show any wide notch at the vermilion. Similarly, in the Millard group, two sub-groups of 0.5 mm and 0.5-1 mm notch presented a slightly higher number than the Noordhoff technique (3 cases in each sub-group). Therefore, it can be concluded that the triangular group was proven to reduce the possibility of notching. The better notching result of the triangular flap group was caused by the break of linear repair on the vermilion, in which the procedure to bring the vermilion from lateral to the medial segment helped to reconstruct a symmetrical vermilion [22].

Chowdri *et al.* [23] reported no significant difference in overall lip and nose post-operative appearance between the two types of repairs. However, in the rotation-advancement group, a larger hypertrophic scar was found [23]. The overall incidence of hypertrophic scar was 6.5%, smaller than reported in a study by Holtmann and Wray [24], which stated that there was a hypertrophic scar of 47.4% [23, 24]. Similar results were also reported by Gadre *et al.* [25], who revealed that scar quality was better in the Tennison-Randall triangular flap group than in the Millard rotation-advancement group [25].

## CONCLUSIONS

Overall, the rotation-advancement group showed better results in the nostril shape and length of the Cu-

pid's bow, but with a higher finding of notching and nasal deformities. Meanwhile, the triangular flap group presented more desirable results in the Cupid's bow shape, philtral height, vermilion height, white roll match, satisfactory scar quality, lip height, and nasal width, despite having a more significant number of nasal defect formation compared with the rotation-advancement group. Further systematic review studies should be conducted to analyze the treatment outcome of unilateral primary lip repair using other surgical techniques, with various measurement methods and larger number of subjects.

## CONFLICT OF INTEREST

The authors declare no potential conflicts of interest concerning the research, authorship, and/or publication of this article.

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