INTRODUCTION

Cleft lip with or without cleft palate is one of the most common birth defects, with a worldwide prevalence of 9.9 per 10,000 births. The prevalence within the United States is similar: 10.2 per 10,000 births.1 The first known surgical repair for cleft lip, Rose’s straight-line repair, was reported in 1891. Since then, various techniques for cleft lip repair have been described and are routinely performed today.2

The rotation-advancement technique for unilateral cleft lip repair was introduced by Millard in 1955 and subsequently became the predominately used technique worldwide.3 In 1987, Mohler introduced a modification to the rotation-advancement repair, resulting in a more symmetric positioning of the scar.4 In his discussion of the article, Millard5 stated his concerns about the technique being unable to gain adequate length except in the incomplete cleft lip. In 2003, Court Cutting6 introduced a modification of the Mohler cleft lip repair, which he named the “extended Mohler cleft lip repair”. This modification involved extending the back cut down to the non-cleft philtral column. Subsequently, 2 major shortcomings were identified with these repairs: (1) complex nonanatomic scars under the nasal sill and (2) transverse shortening of the lateral lip element to avoid under rotation and elevation of cupid’s bow peak.3

In 2005, Fisher published the anatomic subunit approximation technique to address these shortcomings. The Fisher repair places the scar at the interface of anatomic subunits along the “ideal line of repair” and thus eliminates the nasal sill scar seen with the nonsymmetrical Mohler repair.7

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Improved aesthetic outcomes can be achieved with the anatomic subunit repair compared to the rotation-advancement technique, with a lower revision rate and improved scar outcomes.8

Background: The extended Mohler rotation-advancement repair and the Fisher anatomic subunit repair are commonly used for the surgical correction of unilateral cleft lip. The rotation-advancement repair was the initial technique of choice by the senior surgeon. However, due to recurring suboptimal aesthetic results, the senior surgeon transitioned to the anatomic subunit repair. This study was performed to compare the outcomes of the rotation-advancement repair and the anatomic subunit repair.

Methods: A retrospective study of all consecutive patients undergoing unilateral cleft lip repair by the senior author between 2009 and 2016 was conducted. Demographic data, the presence of scar shortening/contraction, hypertrophy, widening, and revision rates were recorded.

Results: There were 68 patients identified for inclusion. Thirty-four patients had a rotation-advancement repair and 35 had an anatomic subunit repair. Twelve patients (36%) with the rotation-advancement repair and 1 patient (2.9%) with the subunit repair required anterior lip revision (P < 0.001). Conversely, 2 patients (6.1%) with the rotation-advancement repair and 13 patients (37.1%) with the subunit repair required minor debulking of excess red vermilion fullness (P < 0.005).

Conclusions: Transitioning from the rotation-advancement repair to the anatomic subunit repair has resulted in improved lip aesthetics with decreased incidence of scar contracture, hypertrophy, and widening as evidenced by a decrease in the revision rate for these suboptimal scars. However, the rate of debulking procedures of the red vermilion did increase early in the adoption of the anatomic subunit repair, requiring minor modifications in the technique. (Plast Reconstr Surg Glob Open 2020;8:e2919; doi: 10.1097/GOX.0000000000002919; Published online 23 June 2020.)

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rotation-advancement repairs. In addition, this repair uses a cutaneous triangle inserted above the white roll to correct the medial lip height. This technique avoids the need to adjust Noordhoff’s point, which could ultimately compromise lateral lip transverse length.3,7,8

During the first 4 years of his practice, the senior author used the extended Mohler rotation-advancement repair to correct the unilateral cleft lip. The patients were noticed to have an unacceptable occurrence of suboptimal aesthetic results, such as scar contraction, hypertrophy, and widening, especially at the junction of vertical and horizontal scar lines just below the columellar base. Two examples of these suboptimal results are shown in Figure 1. These undesired outcomes led the senior author to explore alternative techniques and to adopt the anatomical subunit repair. Anecdotally, the adoption of this technique better achieved the desired lip aesthetics. Examples of satisfactory results are shown in Figure 2.

In this study, we compared the rotation-advancement and anatomical subunit style repairs performed by a single surgeon at our institution. We hypothesized that adoption of the Fisher repair led to more desirable lip aesthetics with acceptable lip scars that ultimately result in fewer major cleft lip revisions.

METHODS

Extended Mohler Repair

The senior author began his practice exclusively using the extended Mohler rotation-advancement technique for unilateral cleft lip repair (Fig. 3). These repairs were performed as described by Dr. Cutting’s modification of Dr. Mohler’s original technique.4,6 Briefly, the length of
the philtral column on the non-cleft side was measured and transposed on the cleft side, starting at the site of the planned peak of cupid’s bow. Instead of extending the incision along the columellar base and onto the ipsilateral philtral column, the incision extends onto the columella. A 90-degree back cut is designed to allow for advancement of the philtrum. The intranasal repair of the nasal floor was performed with the extended nasal lining flaps, as previously described.9

**Fisher Repair**

After 4 years of practice, the senior author transitioned from the extended Mohler rotation-advancement repair to the Fisher anatomic subunit repair (Fig. 3). The procedures were performed as previously described by Fisher et al.10 With this technique, the philtral column on the medial lip element is lengthened through the creation of a small back cut above the white roll that is filled with a small triangular flap from the lateral lip element. The suture line extends from the vermilion border and is broken up with the triangular advancement flap and then extends linearly up to the columellar base point and curves into the nasal floor. This does not require the need for a transverse scar below the nasal sill.9 The intranasal scar line becomes contiguous with the nasal lining closure with the use of extended nasal lining flaps as previously described.9

**Data Collection and Analysis**

All unilateral cleft lip procedures performed by the senior surgeon between 2009 and 2016 were included and reviewed. A retrospective study was performed, and the occurrence of cleft lip revisions was recorded. The reasons for cleft lip revisions were identified. These included lip shortening/contraction, scar hypertrophy, and/or scar widening. Statistical analyses were performed using R (R package, version 3.5.1; R Foundation, Vienna, Austria).

**RESULTS**

There were 68 patients identified for inclusion. Thirty-three (33) patients underwent rotation-advancement repair, and 35 patients underwent repair with the anatomic subunit technique. Average age at the time of cleft lip repair was 8.6 months (median, 3.8 months; range, 2.6–122.3 months) in the rotation-advancement repair and 5 months (median, 4.2 months; range, 2.9–37.8 months) in the anatomic subunit repair ($P = 0.388$; $t$ test). Average follow-up was 44 months (range, 6.4–79.0 months) for the former technique and 37 months (range, 6.7–69.2 months) for the latter technique ($P = 0.131$; $t$ test). There were no significant differences in the laterality, type of cleft, or occurrence of simultaneous cleft palate between the 2 groups (Table 1). More patients in the anatomic subunit repair group underwent nasoalveolar molding compared with the rotation-advancement group ($P = 0.027$; Fisher test). We coincidentally instituted more routine nasoalveolar molding at our center during this time period.

**Table 1. Comparison of Patient Characteristics between the Surgical Groups**

|                          | Rotation Advancement Repair (n = 33) | Anatomic Subunit Repair (n = 35) | $P$  |
|--------------------------|--------------------------------------|----------------------------------|------|
| Age (SD)                 | 8.61 (20.82)                         | 5.43 (5.89)                      | 0.388|
| Male, %                  | 18 (54.5)                            | 21 (60.0)                        | 0.834|
| Complete cleft lip, %    | 21 (65.6)                            | 29 (82.9)                        | 0.128|
| Laterality, %            |                                      |                                 | 0.411|
| Left                     | 13 (69.7)                            | 20 (57.1)                        |      |
| Right                    | 10 (30.3)                            | 15 (42.9)                        |      |
| Cleft palate, %          | 20 (60.6)                            | 27 (77.1)                        | 0.225|
| NAM, %                   | 3 (9.1)                              | 12 (34.3)                        | 0.027|
| Stents, %                | 23 (69.7)                            | 30 (85.7)                        | 0.194|
| Duration of stents (wk)  | 5.87 (0.88)                          | 6.10 (1.12)                      | 0.420|
| Follow-up (SD)           | 44.46 (20.88)                        | 37.11 (18.79)                    | 0.131|

NAM, nasoalveolar molding.
Thirteen patients underwent a surgical revision for lip shortening, scar hypertrophy, or scar widening: 12 patients (12/33, 36%) with the rotation-advancement repair and 1 patient (1/35, 3%) with the anatomic subunit repair had revisions performed for these problems. This difference was statistically significant (P < 0.001; Fisher test) by univariate analysis (Table 2). Moreover, multivariate logistic regression model revealed that the type of repair was the greatest predictor of anterior lip revision (odds ratio, 23.1; 95% confidence interval, 3.3–503.9) (Table 3).

The difference in overall revision rates was not statistically significant between the 2 groups. Patients who underwent anatomic subunit repair had a separate, unanticipated issue of excess fullness of the red vermilion (Table 2). There were 13 patients (13/35, 37%) who required revision of the vermilion in anatomic subunit repair group compared with 2 patients in the rotation-advancement group (2/33, 6%). This difference was statistically significant (P = 0.005; Fisher test).

DISCUSSION

The rotation-advancement repair and the anatomic subunit repair are 2 widely used techniques for the correction of unilateral cleft lip. In this single institution, single-surgeon series of consecutive patients undergoing unilateral cleft lip repair, the difference in overall revision rate between patients with the anatomic subunit repair and the rotation-advancement repair was not statistically significant. However, those patients with the anatomic subunit repair had significantly fewer cutaneous derangements and required fewer revisions of the cutaneous lip subunit relative to those who had the rotation-advancement repair. The issues of scar shortening/contraction, hypertrophy, and widening seen with the rotation-advancement repair are more visible deformities and more challenging to correct. Patients who underwent the anatomic subunit repair did require more revisions of the red vermilion. An example of typical excess red lip fullness is shown in Figure 4. However, the excess tissue is limited to the vermilion, which is a simpler problem to correct. A simple wedge excision of the excess red vermilion produced satisfactory results (Fig. 4).

A comparison of the immediate postoperative aesthetic outcomes of the Mohler and Fisher techniques was recently reported by Deshmukh et al,11 where a single surgeon was randomized to perform either a Mohler or a Fisher repair on each of 50 patients. This study demonstrated an improvement in postoperative aesthetic outcome, as determined by laymen, with the Fisher repair.11 Although Deshmukh et al11 measured aesthetic outcome from a laymen perspective, in our study, aesthetic analysis of the scar was made by the surgeon. The senior author has a standard threshold for offering cleft lip revision surgery to parents with the understanding that revising the scar is more likely to improve the lip aesthetics rather than worsening the appearance. This offers a stand-in evaluation of the cleft lip outcome from the perspective of an experienced observer (surgeon) and the parents. Due to the age of the patients, it was not possible to determine the patients’ perspective on the aesthetic quality of the surgical outcome. Ideally, an objective rating of the cleft outcomes would be performed for all patients. This was not performed contemporaneously, and photographs were not obtained on all patients. Instead of removing patients from the study, the surgeon’s decision to perform a revision is used as a proxy for cosmetic outcome.

Another study published recently by Kwong et al12 used eye-tracking technology to compare rotation-advancement repairs to the anatomic subunit repair. The study presented data suggesting that viewers from multiple levels of training found cleft lips repaired with the Fisher technique to be more aesthetically pleasing than those repaired with Mohler or Millard techniques. This outcome further supports our data, which suggests that superior aesthetic outcomes can be achieved with the Fisher technique for cleft lip repair. The study by Kwong et al12 offers a more objective evaluation of cleft lip repair outcomes, but it does not have a complete sample of all consecutive cleft lip repairs performed by the senior author. This study uses surgeon revision rates as a proxy for the quality of surgical outcome. Although this involves a less objective evaluation of cosmetic outcome, it allows one to evaluate all consecutive patients over the course of multiple years.

Table 2. Comparison of Surgical Revisions Performed on Patients within the Two Surgical Groups

|                          | Rotation Advancement Repair (n = 33) | Anatomic Subunit Repair (n = 35) | P   |
|--------------------------|-------------------------------------|---------------------------------|-----|
| Skin revision, %         | 12 (36.4)                           | 1 (2.9)                         | 0.001|
| Vermilion revision, %    | 2 (6.1)                             | 15 (37.1)                      | 0.005|
| Any revision, %          | 13 (39.4)*                          | 13 (37.1)*                     | 1.000|

*One child in each group had both types of revisions performed.

Table 3. Multivariate Logistic Regression to Predict Revision of Vertical Component / Lip Skin

|                        | Coefficient (β) | SE   | P       | OR   | 95% CI       |
|------------------------|-----------------|------|---------|------|--------------|
| Intercept              | −6.45           | 1.89 | 0.001   | 1.62E-03 | 2.0E-05 to 0.04 |
| Mohler repair          | 3.14            | 1.18 | 0.008   | 23.07 | 3.30–503.9   |
| Complete cleft lip     | −0.18           | 1.06 | 0.863   | 0.83  | 0.10–7.09    |
| Cleft palate           | 0.17            | 0.89 | 0.850   | 1.18  | 0.21–7.38    |
| Follow-up              | 0.05            | 0.02 | 0.021   | 1.05  | 1.01–1.11    |
| NAM                    | 0.82            | 1.12 | 0.464   | 2.27  | 0.23–29.6    |
| Stents                 | 0.32            | 1.07 | 0.761   | 1.38  | 0.17–13.0    |

CI, confidence interval; NAM, nasoalveolar molding; OR, odds ratio.
Many surgeons would agree that it can be challenging to fully embrace a new surgical technique when already comfortable with another. The optimal surgical correction of the cleft lip has been an ongoing evolution as evidenced by the many iterations from our predecessors. However, most of the techniques leave something to be desired. The senior author was dissatisfied with the resulting lip aesthetics of the rotation-advancement technique to an extent that he explored other methods with the hope of achieving more desirable results.

Without formal training in the anatomic subunit technique, he was able to produce quality, repeatable results of the cutaneous lip with this repair. These improved results were seen immediately after shifting techniques. Although the senior surgeon was further into his practice at this point, he had been using and improving his technique with the extended Mohler repair for years. Upon switching techniques, he had minimal experience with the Fisher repair and was able to immediately produce better results. These improved results were seen immediately after shifting techniques.

This study revealed that the anatomic subunit repair more frequently results in an excess of vermilion tissue. This may be due to multiple factors, which include over-recruitment of the labial sulcus from lateral lip element, excess bulk in the red vermilion triangular flap (if used), and/or over-plication of the orbicularis oris fibers. There is minimal guidance on how best to repair the undersurface of the mucosal lip and sulcus or on how tight to make the muscle repair in cleft lip surgery. Therefore, it has required modifications via trial and error. Currently, the senior surgeon accommodates for this by decreasing the amount of sulcus tissue that is recruited from the lateral lip, decreasing the thickness of the vermilion triangular flap when used, and not overtightening the muscle. The muscle is brought together to a point where the skin edges are in close approximation. Since many changes do not manifest for several years, the long-term results of these changes are not yet known.

Fortuitously, surgical revision of the vermilion is much easier to perform than revision of the vertical component of the lip from the vermilion border to the nose. It is very challenging to correct the short lip, hypertrophic scars, or wide scars. For example, re-rotation of the medial lip element to lengthen the short lip is often unsuccessful due to recurrent scar contraction. Derangement of the cutaneous lip requires complete revision of the skin of the vertical component of the lip repair, whereas, fullness of the vermilion can be managed with a simple elliptical wedge excision and primary closure within the red lip alone. Of note, none of the children requiring vermilion lip debulking required additional surgical revisions thereafter.

There are various reasons for us to believe the anatomic subunit repair results in a better outcome. The Mohler

![Fig. 4. Vermilion fullness with the Fisher repair. Photographs demonstrating excess vermilion fullness before (A, B) and after (C, D) debulking.](image)
repair requires essentially a 4-point closure where the c-flap meets the nasal sill and lateral lip elements. This leads to well-known inherent wound healing concerns. The Fisher repair simply brings 2 flaps of skin together. This extends up into the nasal floor when combined with the medial and lateral nasal lining flaps. This avoids the horizontal scar under the nasal sill, which is highly visible and also can contribute to blunting of the alar base anatomy. Additionally, the anatomic subunit repair has a repeatable method for correcting lip length discrepancies that has been shown by this study and the author’s experience to be highly reliable.

**CONCLUSIONS**

The use of the anatomic subunit repair has resulted in improved aesthetic outcomes and a decrease in cutaneous lip scar derangements and revisions when compared with the rotation-advancement repair. However, this comparison has elucidated a higher incidence of excess vermilion fullness with the anatomic subunit repair. This is likely a technical issue that can be easily corrected with better attention to mucosal and muscle elements at the time of primary repair. Recruiting less of the sulcus from the lateral lip, making a smaller red triangular flap, and precise muscle placement may decrease the vermilion fullness seen occasionally in our results with the anatomic subunit repair. We believe it is critically important to consistently analyze aesthetic outcomes in cleft lip repair and be willing to modify various components of the repair (no matter how small or large) to strive for better results.

**PATIENT CONSENT**

Patients provided written consent for the use of their images.

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