Analysis of 100 Consecutive Cases: Four-Year Experience in Anatomic Subunit Cleft Lip Repair

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ABSTRACT

Background: The anatomical subunit approximation technique is becoming more popular among surgeons and craniofacial centers, dealing with cleft lip management; such a technique is easy to learn and teach, with predictable results and excellent final nasolabial harmony. The literature and clinical studies show continuous improvement in the outcome since the original study describing the technique in 2005. In this study, we aim to detail our experience of utilizing this surgical technique at the Royal Rehabilitation Center.

Methods: This retrospective study examines 100 consecutive patients with unilateral cleft lip who were classified and surgically treated in The Royal Rehabilitation Centre's cleft unit from January 2016 to May 2020. Presurgical orthodontic and nasoalveolar molding (NAM) were applied in the vast majority of patients; surgical techniques include anatomical subunit approximation and primary nasal tip plasty. All the surgeries were performed on inpatient bases. The average follow-up period was 2 years.

Results:

Patients' ages at time of surgery ranged between 3 and 9 months with mean age of 4.5 months; male–female ratio was 70%:30%. The ratio of complete to incomplete deformity was 54%:46% respectively, while left to right deformity was 66%:34% respectively. Average weight at the time of surgery was 5.4 kg. The most common associated congenital anomaly was congenital heart disease with the commonest type being atrial septal defect, found in 30% of the cases. Family history was recorded to be positive in 6% of the cases.

Mean operative time was 100 minutes and mean hospitalization period 36 hours. Morbidity consisted of 2 cases with stitch sinuses and 2 cases of hypertrophic scars. There was no mortality.

Most common secondary deformities were vertical height nostril collapse in 30% of the cases, excess vermilion deformity in 5%, vermilion border mismatch in 2%, and hypertrophic scars in 2%. Utilizing the Pennsylvania scoring system to analyze our outcome: results were good in 58%, fair in 40%, and poor in 2% of the patients.

Conclusion: The anatomical subunit approximation technique for unilateral cleft lip repair produces pleasant and desirable results among all types of clefts. The preoperative markings require the identification of several landmarks; most of these are standard anthropometric points that are used for cleft deformity analysis. This hybrid technique mixes both principles of geometric and rotation advancement techniques. Continuous improvement of results is related to the learning curve; the technique is easy to learn and teach, with excellent overall nasolabial harmony and final cosmetic results, with fine scars hidden at the shadows of the lip subunits.

JRMS DECE 2024; 31 (3): 10.12816/0062035.

INTRODUCTION

Cleft lip is a congenital condition that results from the failure of embryonic processes (fusion of lateral and medial maxillary processes) in the fifth week of intrauterine life,[1] and it is the most common congenital craniofacial anomaly.[2] Successful treatment requires technical skill, knowledge of the abnormal anatomy, and appreciation of three-dimensional facial aesthetics.[2] The repair of cleft lip has been described as the "most important day in [a] child's life."[3] The repair is a gift to the infant, their family, and the surgeon.

From the departments of: [*]Plastic Surgery

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Patients and Methods

This retrospective study examines 100 consecutive patients with unilateral cleft lip who were classified and surgically treated in The Royal Rehabilitation Centre's cleft unit from January 2016 to May 2020. Presurgical orthodontic and nasoalveolar molding (NAM) were applied in the vast majority of patients; surgical techniques include anatomical subunit approximation and primary nasal tip plasty. All the surgeries were performed on inpatient bases. The average follow-up period was 2 years. We utilized the Pennsylvania Lip and Nose Scoring System for the postoperative assessment of the results. This scoring system consists of 2 main parameters; it divides the nose into N1 to N3 and the lip into L1 to L3. N1 and L1 account for near perfection with nearly unnoted asymmetry at conversational distance. N2 and L2 account for moderate deformities with some lip or nasal tip asymmetry at conversational distance and may require minor revision. N3 and L3 account for severe deformities with significant lip and/or nose asymmetry that will require a major revision

Ethical approval was obtained at the Directorate of Royal Medical Services . The requirements for confirmed consent were waived by the directorate in light of the anonymous nature of the study. Though, all patients' consents provided by parents for surgery.Consecutive patients who underwent primary unilateral cleft lip repair performed by one surgeon, Mohammad N. Bdour, were included in this study.

Cleft Lip Repair

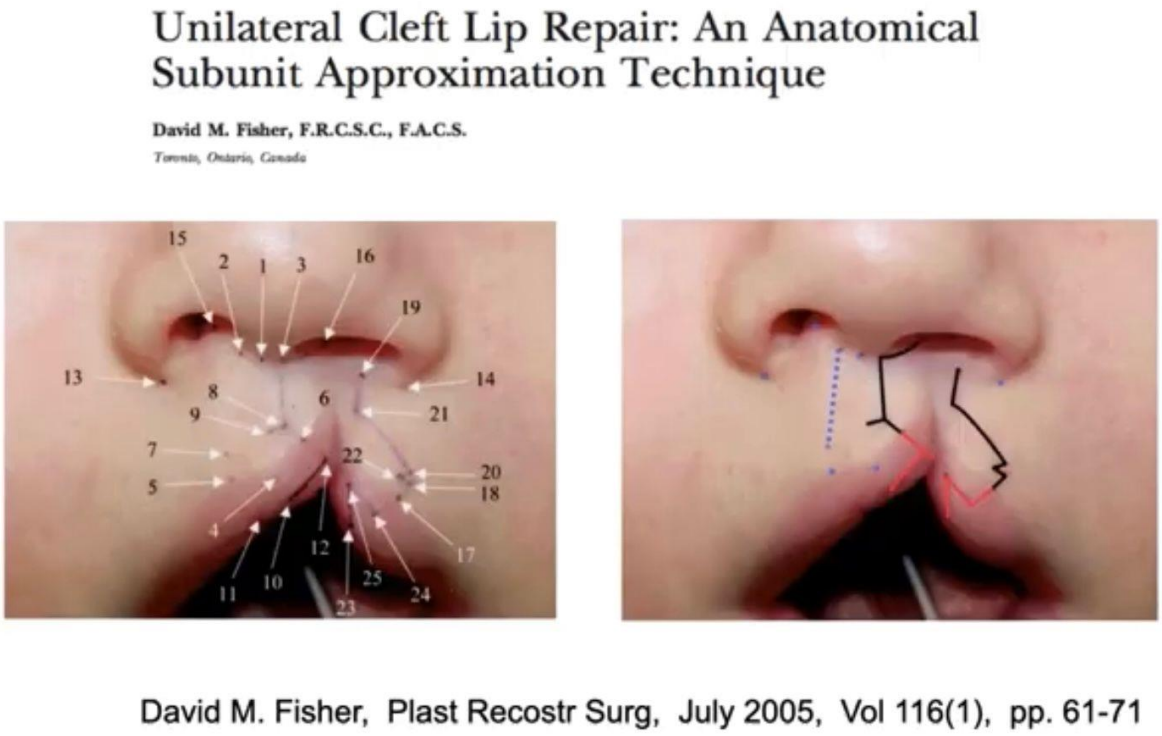
Surgical Evaluation and Classification

The newborn infant with a cleft lip is ideally evaluated by the cleft team in the first weeks of life. The increasing number of clefts detected by prenatal imaging allows early preparation of the family and introduction to the treatment plan. The cleft lip deformity is typically divided into unilateral or bilateral and then subdivided into complete, incomplete, or microform based on the pattern of embryonic fusion.[2] Initial counseling and family education at our multidisciplinary cleft clinic were performed with feeding instruction and necessary consultations and patient preparation.

Design/Lip Marking

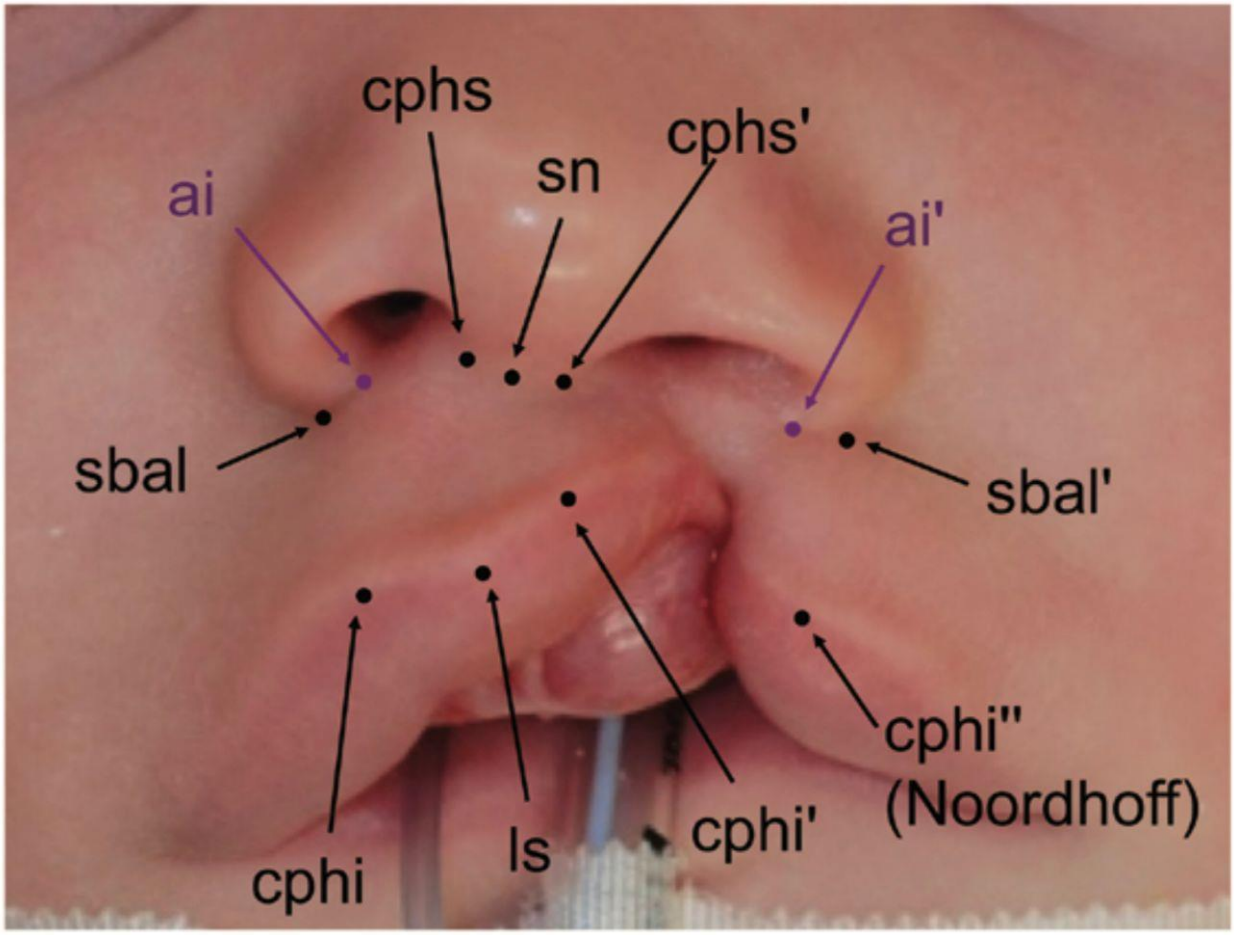
There are several components of cleft lip repair, and for this study, we will focus on the plan and design of anatomical subunit approximation that was described by Fisher in 2005.[4]

At first glance, it appears very complicated (Figure 1):



(Figure 1) [4]

However, Tse and Lien from the Seattle Children's Hospital, University of Washington, came up with a simpler method by removing the numbered points and highlighting the standard anthropometric landmarks that an experienced cleft surgeon should already recognize and any new cleft surgeon should learn about (Figure 2).[5]

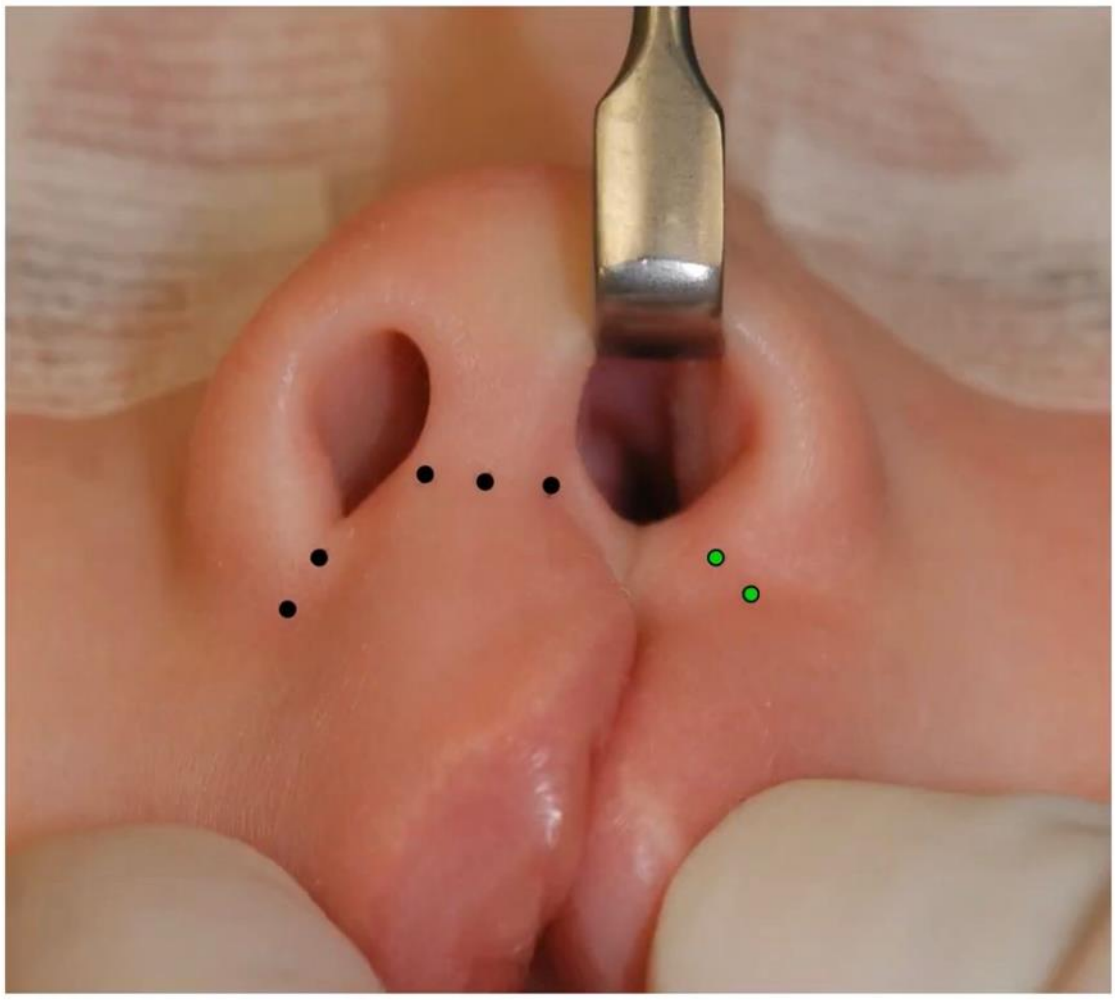


(Figure 2) [5]

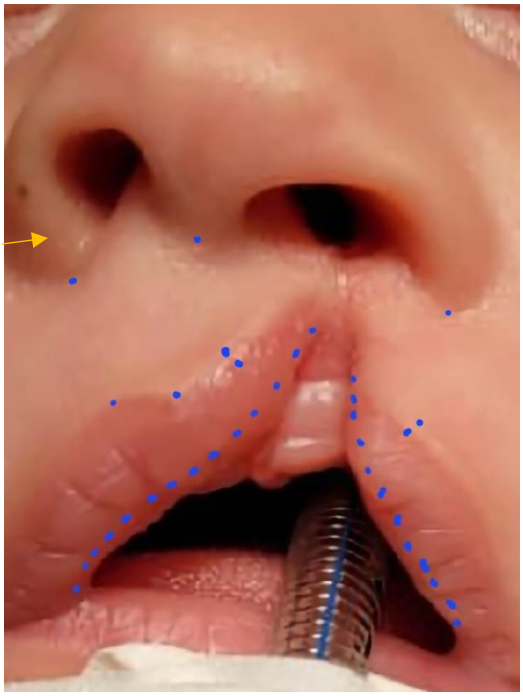
These modifications made the designs easier. We also designed an easier marking plan and approach describing each anthropometric point by name and anatomical position that divides the whole marking into 3 main domains: nasal base, lip complex, and vermilion marking.

1. Marking of Nasal Base

The nasal base includes the following markings: the columella midline, the columella-labial junction on the cleft and non-cleft sides, the sub ala on the cleft and non-cleft sides, and the nasal sill (columellar alar crease at the non-cleft side, using a caliber to mirror the distance for the cleft side) (Figures 3 and 4).

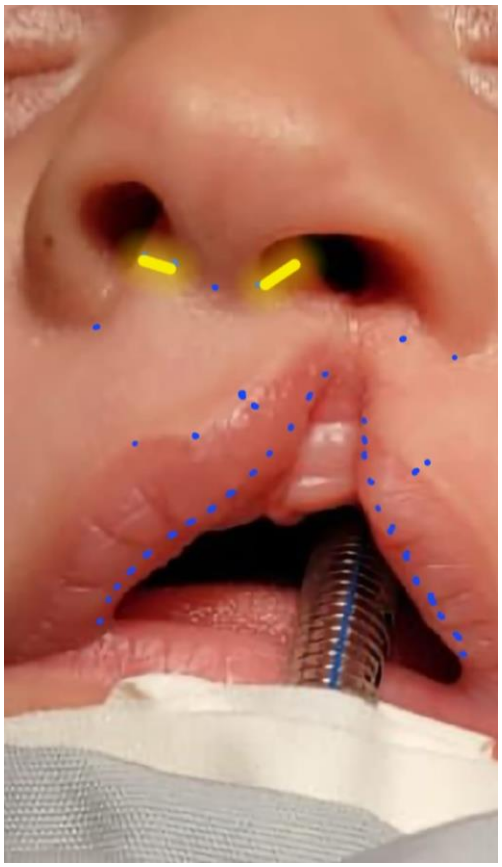


(**Figure 3**)



(Figure 4) Marking Columella Midline

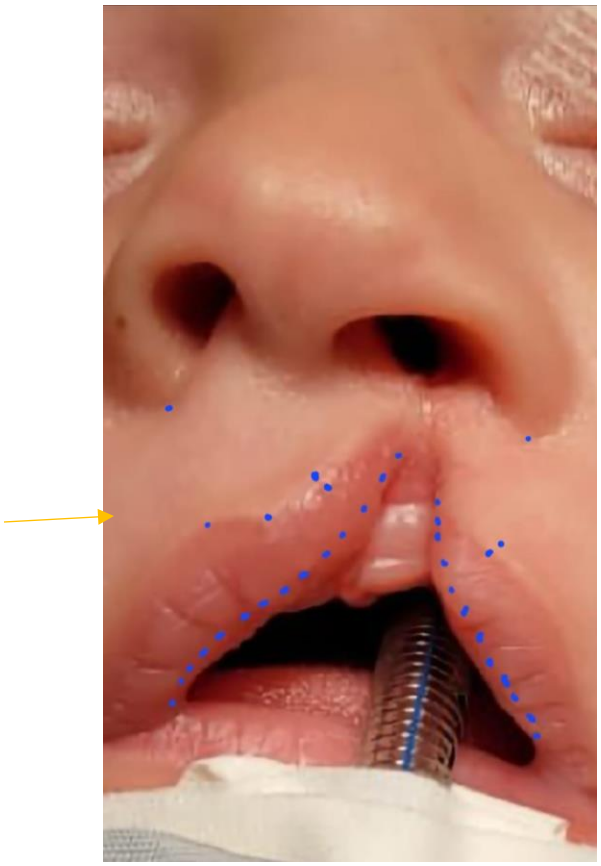
At this point, the mirror image using a caliber at two incision lines was translated from the non-cleft side. The first line connects the sub ala to the nasal sill on the lateral segment of the cleft side. The second line connects the columella-labial junction to the nasal sill on the lateral cleft segment (Figure 5).



(Figure 5) Measuring Distance between **columella-labial junction and nasal sil on non-cleft side to mark nasal sil on medial segment**

2. Marking of Cleft Lip Complex

These markings include the wet to dry vermilion line, Cupid's bow at the non-cleft side, and the nidus of the philtrum (lowest point of Cupid's bow) at the medial segment of the cleft side (Figure 6).



(Figure 6) Marking Nidus of philtrum (lowest point of Cupid's bow)

Then the distance between these two points is used to find the highest point of Cupid's bow, the medial segment of the cleft side. At this point, we mark the vermilion red line and the white roll cutaneous junction (perpendicular to each other) (Figure 7).

(Figure 7) This distance is transferred to medial cleft segment.

The marking of the highest point of Cupid's bow at the lateral cleft segment (Noordhoff point) is the point where the dry vermilion gets its highest vertical height (Figure 8) when we move from medial to lateral on the lateral cleft segment. Here, two points were marked in a perpendicular fashion: the red vermilion line border and the white roll cutaneous junction (Figure 9).

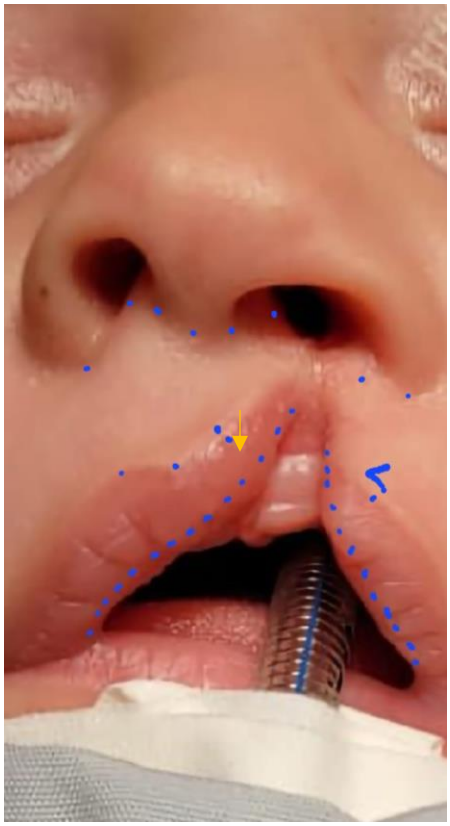
(Figure 8) Noordhoff point is the point of highest dry vermillion

(Figure 9) Marking wet dry mucosa line

3. Marking of Vermilion

At the Noordhoff point, on the lateral cleft lip segment, the triangular vermilion flap is designed. The height of this flap is the highest point of the dry vermilion, and the length of this flap must not exceed the midpoint of the philtrum after inset. The marking of the back cut is on or just above the wet to dry line on the medial cleft lip segment for inset of the

Noordhoff flap. To mark the triangular white roll skin flap on the lateral cleft segment, we take two important measurements (as proposed by Fisher in 2005)[4] (Figure 10).



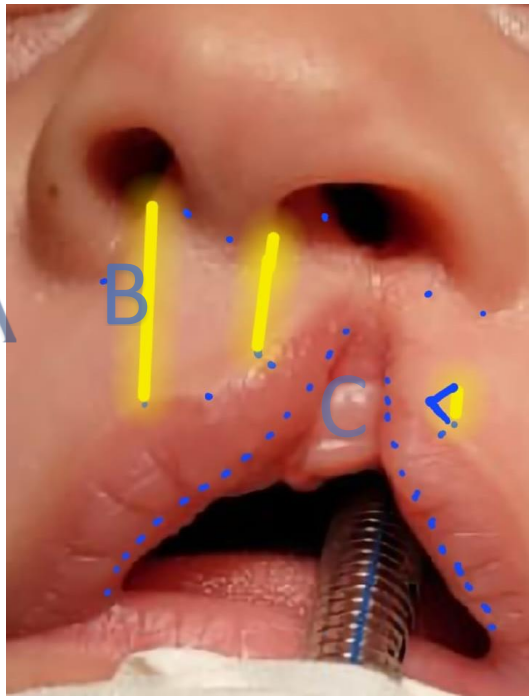
(Figure 10) Design of Triangular skin flap

Total Lip Length (TLL) = distance between the highest point of Cupid's bow and the columella-labial junction at the non-cleft side

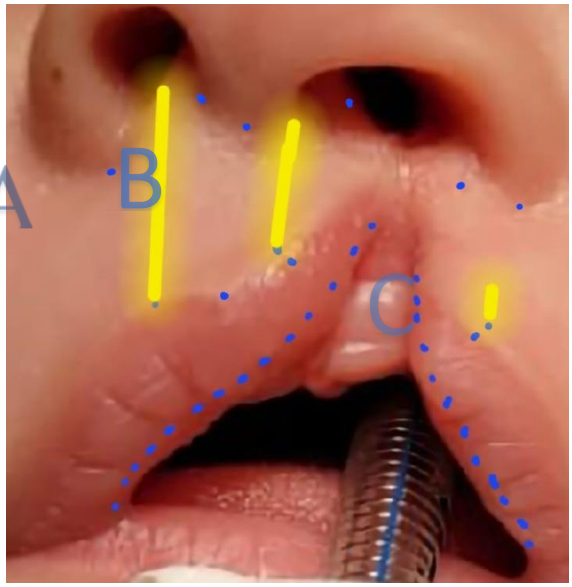
Lesser Lip Length (LLL) = distance between the highest point of Cupid's bow and the columella-labial junction at the medial segment of the cleft side

Width of Triangular White Roll Skin Flap = TTL − LLL − 1 mm (1 mm is the Rose–Thompson lengthening effect, which results from closing the curved lines to a straight line at the final closure)

The final design of the WRTF must be parallel to the white roll cutaneous junction on the medial segment; this back cut must be parallel to the white roll (Figures 11 and 12).

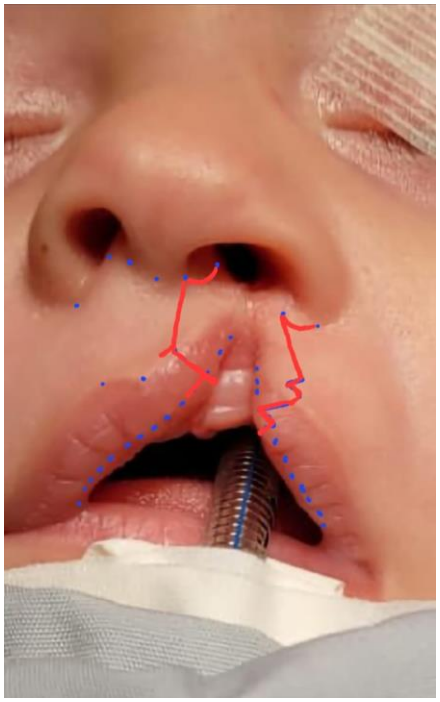


(Figure 11) Design of Triangular skin flap (C=A-B-1mm)



(Figure 12) Width of Triangular skin flap C=A-B-1mm (1mm: Rose Thompson effect)

All lines between the cardinal points and flaps are connected in straight lines. The lines crossing the white roll and cutaneous junction and vermilion must cross these units in perpendicular fashion (Figure 13).



(Figure 13) Final medial and lateral incision design (Rose Thompson effect: closing curved angled lines to straight line give extra 1mm)

Remeasure and Cut As You Go (Details of the Cutting Part of the Procedure)

Our surgical procedure starts with securing the patient's safety by placing him in a secured supine position, with cervical spine protection, and eye closure using a 3M Steri-Strip. A tube is centralized in the midline of the face, not affecting the geometry of the upper and lower lips. At least 2 IV lines are secured by a pediatric anesthesiologist, and a prophylactic dose of second-generation cephalosporine is given. A single dose of dexamethasone is given at the start of the procedure, which helps decrease postoperative edema. The patient undergoes initial marking before scrubbing and toweling. Scrubbing of the face is done using normal saline, followed by the usual toweling. The operation table is lifted to the level of the surgeon umbilicus. The marking is double-checked with a stick, methylene blue, and a sterile caliber. Local anesthesia consists of Xylocaine 1%, and adrenaline (1:100000) is given at the gingivobuccal sulcus as a mini-infra orbital nerve block, with infiltration at the cleft using Pyriform. We avoid injection of local anesthesia at the lip and vermilion so as not to disturb the final geometry and volumetry of the final repair. Transcutaneous infraorbital nerve block is performed bilaterally using long-acting local anesthesia (Marcaine).

1. Medial Segment

We start our operation at the medial cleft segment. Incisions are created using a number 11 blade in the perpendicular straightway; the surgeon is standing at the top of the patient's head. Single hook bimanual finger traction applied to the mucosal aspect of the medial segment is highly useful to maintain hemostasis. Release of the frenulum band, if present, is also helpful to avoid a short lip with healing. The muscle at the medial cleft segment is dissected starting from the nasalis to the marginalis using a number 15 blade; this dissection plane between the dermis and the muscle must not exceed the mid philtrum (to mimic muscle decussation at the philtral dimple after final closure). The mucosa is dissected 1–2 mm just to the level of the submucosa gland. A back cut is created to rotate the marginalis muscle at the level of Cupid's bow. The nasalis muscle is then released and rotated from its abnormal peri columellar attachment. Then the 2 medial crura of the lower lateral cartilage are dissected using blunt scissors to release the fibrofatty tissue reaching the nasal tip.

2. Lateral Segment

With the surgeon standing at the patient's head, a number 11 blade is used to create the incision on the lateral lip segment in a perpendicular straight fashion. Dissection between the dermis and the muscle must not exceed 1–2 mm all the way through from the nasalis to the marginalis using a number 15 blade. Dissection occurs between the muscle and the mucosa 1–2 mm or just to the level of the submucosal glands. This is followed by a back cut and rotation of the marginalis at the level of Cupid's bow, along with the release and adequate rotation of the nasalis from its abnormal perialar attachment. In complete cleft cases, medial and lateral mucosal flaps are designed and created to reconstruct the nasal floor. We proceed with our 1st stay suture using Vicryl 5-0 at the wet–dry line (wet gauze over the tissue clamp is used to apply gentle traction), followed by closure of the oral mucosa using Vicryl 5-0 (keeping in mind to maintain adequate deep gingivobuccal sulcus). It is important not to close the distal mucosa at this stage so as not to affect the geometry of the final vermilion plasty. The 2nd stay suture is applied to the marginalis muscle with a horizontal mattress suture using 5-0 clear PDS. A cardinal suture is used to tuck the nasalis in the lateral cleft segment to the anterior nasal spine (ANS) and caudal septum; this tucking suture is important in the centralization of the whole lateral lip complex. Aesthetic and functional reconstruction of the muscle sphincter is done with a vertical mattress suture using clear 5-0 PDS. From lateral to medial, this brings the lateral muscle segment over the medial muscle segment to mimic muscle dissection and insertion at the mid philtrum. An alar cinch stitch connects the cleft and noncleft ala using clear 5-0 PDS, with accurate vertical leveling as mentioned in the markings; it is important while tying this suture to avoid nostril stenosis. Through a clear basal view of the surgeon to the nasal base, a back cut is created at the white triangular roll skin flap. As mentioned in the markings, this back cut must be parallel to the white roll cutaneous junction on the medial segment to hide the final scar within the lip subunits of the final closure. Then we proceed with our 3rd stay suture at the white roll (a dermal suture connecting the medial and lateral flap segments using clear Monocryl 6-0 "Poliglecaprone"). The cardinal points of the redline and white roll are sutured using Vicryl 7-0 "Polygalctin" interrupted sutures (it is important not to tie the dermal sutures at the white roll before this step to avoid blanching at the red line lip). This is followed by inset of the white triangular roll skin flap (WTRSF), completion of wound closure with dermal stitches (clear Monocryl 6-0 on skin with Vicryl 7-0, simple and continuous), and proper inset of ala with dermal and skin stitches. We proceed with vermilion plasty by creating a back cut for the Noordhoff triangular vermilion flap on or just above the wet–dry line on the medial segment, as mentioned above in the markings; to reiterate, the width of the Noordhoff triangular vermilion flap is the highest point of the dry vermilion, and the length should not exceed the mid philtrum after insertion. Completion of the vermilion closure is performed with Vicryl 7-0 and above the wet–dry line and mucosal closure with Vicryl 5-0 below the wet–dry line.

3. Nasal Tip Plasty

Our nasal tip plasty starts, as mentioned previously, with adequate lengthening and mobilization of the columella and release of fibrofatty tissue of the nasal sill. This is followed by adequate mobilization of the lateral alar complex and adequate closure of the nasal floor with medial and lateral mucosal flaps in complete cleft cases. After leveling with an alar cinch stitch in relation to the vertical facial plane, gentle single hook traction at the cleft nostril doom in the superomedial direction is applied before the following stitches using PDS 5-0 clear:

A) A couple of trans fixation stitches at the alar cheek groove junction to augment the groove from outside and control the vestibular webbing from inside to hold the lower lateral cartilage in the corrected position

B) An interdomal stitch

C) A columellar flare control stitch

A silicon nasal comforter (splint) is applied and held in place with a non-absorbable suture to maintain the surgical results.

Postoperative Care

A 3M Steri-Strip is applied to the wound from lateral to medial to protect the repair. The patient then undergoes postoperative nursing in the recovery position (lateral position). Bottle or breastfeeding is resumed after full recovery from anesthesia. Discharge of the patient occurs 24–48 hours after full family education and full adequate oral feeding. A normal saline nasal toilet with nasal drops is provided. Antibiotics ointment is applied to the wound after the Steri-Strip falls off, usually at the 5th postoperative day, when bathing is permitted. Scar management starts on the 10th postoperative day with a silicon-based product gentle frequent massage. The nasal stent is removed and reapplied depending on family cooperation for 4 months.

Results

The age of the patients at the time of surgery ranged between 3 months and 9 months (mean age 4.5 months). The male–female ratio was 70%:30 %. The ratio of complete to incomplete deformity was 54%:46%, while the ratio of left to right deformity was 66%:34%. The average weight at the time of surgery was 5.4 kg, and the most common associated congenital anomaly was congenital heart disease (the most common being atrial septal defect), found in 30% of the cases. Family history was recorded to be positive in 6% of the cases.

Age	Youngest (3 months)	Oldest (9 months)	Mean age (4.5 months)
Gender	Male (70 patients)	Female (30 patients)	
Deformity	Complete (54 patients)	Incomplete (46 patients)	
Laterality	Right (34 Patients)	Left (66 Patients)	
Family history	Positive (6 patients)	Negative (94 patients)	

Table (1) Demographic Result

The mean operative time was 100 minutes and the mean hospitalization period was 36 hours. Morbidity consisted of 2 cases with stitch sinuses and 2 cases of hypertrophic scars. There was no mortality. The most common secondary deformities encountered were vertical height nostril collapse in 30% of the cases, excess vermilion deformity in 5%, and vermilion border mismatch in 2%.

Many virtual scoring systems have been proposed for the aesthetic outcome evaluation of the cleft lip repair results. In our study, the author utilized the Pennsylvania Lip and Nose Scoring System for postoperative assessment of the results (Table 2) based on postoperative outcome and as follows ; Regarding the lip and nose score, the surgical outcome was good when the average score was 1 (no revision was necessary), fair if it was 2 (minor revision was indicated), and poor if it was 3 (complete revision of the surgery was deemed necessary). In this study group ,good results were achieved in 58% of the patients, fair results in 40% (all minor revisions were performed on an outpatient basis), and poor results in 2%, who required total revision. Most of the patients showed an acceptable vertical height of the nostrils, although mild to moderate collapse was noted, especially in cases of severe cleft lip palate. Primary rhinoplasty is evidenced based on decreasing the overall cleft stigmata in childhood, although this does not replace the need for secondary rhinoplasty.

	Lip	Nose
Good	L1	N1
Fair	L2	N2
Poor	L3	N3

Table (2) Pennsylvania Lip and Nose Scoring System for postoperative assessment of the results

Outcome	Good	Fair	Poor
	58 patients	40 patients	2 patients
Complications	No complications	Complication	Mortality
	96 patients	4 patients	0 patients

Table (3) Results using the Anatomic Sub-unit Technique in Unilateral Cleft Lip

Discussion

The anatomical subunit approximation technique can be applied among all types of unilateral cleft lip regardless of the degree of severity. Correct anthropometric measures were achieved in all cases. The lip markings based on anatomical land markers rather than dimensions naturally adjust across the spectrum of cleft lip.

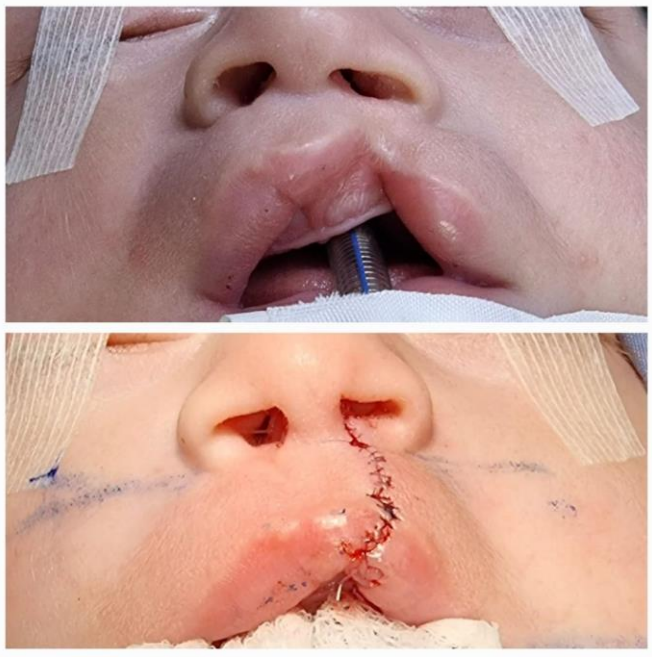
Greater surgeon experience was found to have barely changed over time. The anthropometric measures were not that different early and late in this study. In opposition to the freehand, cut-as-you-go approach of rotation advancement, Fisher's original description has 25 numbered landmarks.[4] These numbered standard anthropometric landmarks appear to be bulky and inconvenient for less experienced surgeons and residents. However, an experienced cleft surgeon is able to identify these landmarks while examining the cleft deformity. Full comprehensive knowledge of the system of landmarks helps reduce the steepness of the learning curve.

More time spent on identifying landmarks and marking incisions will eliminate hesitancy and improve outcomes to meet desirable anthropometric measures for less experienced surgeons and residents in training. The experienced surgeon who constantly delivers the desired results may have no need to learn new techniques. Nevertheless, for a few, this approach may add a foundation of measurements for more refined results.

Favorable results are produced by lip marking, wide surgical release, and component reconstruction. The attention on the release, repositioning, and retention of the nasal foundation in a three-dimensional space is postponed to a later stage in the patient's life because of the underlying bone deformity. The alar base and caudal septum[6] are repositioned in an aggressive way. Reconstruction of the nasal floor and lateral nasal wall is a focal point to maintain the basal nose components in space.[5] Reviewing the cases of this study, muscle dissection became more aggressive, which allowed the creation of an empty triangle of muscle lateral to the alar base. This dissection points out the alar crease when the muscle is repaired and adds soft tissue stability. Admitting a clear difference was not observed using outcome measures at early follow-up; the additional soft-tissue corrections may be more subtle than can be measured and may contribute to the long-term retention of the corrected form. Dissection of the nasal tip was not performed in this study to prevent unnecessary laceration. Skin sutures were made in a way so that they do not need to be removed at the clinic because we used absorbable sutures. The timing of surgery in this study was around 4.5 months of age for the patient.

Images were analyzed preoperatively and postoperatively in a two-dimensional fashion to concentrate on the technique of surgical planning, the aim of which is to produce nasolabial balance at the end of a cleft lip repair. However, previous studies have shown that immediate outcomes are the best predictor of later-on results[7, 8] and that lip dimensions stay stable over time.[7, 8, 9, 10,11] Long-term follow-up is useful, and we have a plan to reevaluate all the subjects of this study at 4 years of age (preschool age).

These figures (Figures 14, 15, 16, and 17) represent a sample of our follow-up results:



(Figure 14: Incomplete cleft lip, immediately post operation)

(Figure 15: 4-years follow-up)

(Figure 16: Right complete cleft lip, 3-years follow-up)

(Figure 17: Left incomplete, 4-years follow-up)

Conclusion

The anatomical subunit approximation technique for unilateral cleft lip repair produces pleasant and desirable results among all types of unilateral clefts. There is a little change in the outcome with experience. Preoperative markings require the identification of several landmarks; most of these are standard anthropometric points that are used for cleft deformity analysis. The long-term results need to be evaluated.

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