Cleft Rhinoplasty Columellar Lengthening: Comparison of Techniques

Abstract
Background: Nasal deformity in bilateral cleft lip and palate (BCLP) correction is highly challenging. Several solution has been proposed. The aim of the present study is to assess qualitatively and quantitatively the results of Cronin’s flap, Fork flap, and Abbe’s flap for BCLP rhinoplasty at a follow-up period. Materials and Methods: Records of all BCLP rhinoplasty performed between 2010 and 2016, fulfilling inclusion and exclusion criteria were collected. From records, qualitative improvement and previously described methods of quantification of columella length were performed. These collected data were analyzed with descriptive statistics, Chi-square tests, and one-way analysis of variance tests. Results: Forty-eight cases fulfilled the criteria of which 31 patients had Abbe’s flap, 9 Cronin, and 8 forked flaps. The mean age of the study population was 20.33 ± 4.94 years in 21 females and 27 males with a mean follow-up of 15.3 ± 2.3 months. The success of the lengthening of columella at immediate postoperative period as compared to the preoperative columella length was not statistically different (P = 0.176) between the three flaps, while the same was statistically different at 1-year period (P = 0.031). The extent of change was very minimal for the Abbe flap with a high degree of statistical significance (P = 0.000). At 1-year postoperative period, 83.9% (n = 26) of Abbe flap patients felt their nose to be good after surgery while the same was 55.6% (n = 5) in Cronin flap and 37.5% (n = 3) in forked flap design (P = 0.007). Discussion and Conclusion: Abbe flap gave the best results under most of the common BCLP rhinoplasty, and a flap choice algorithm for choice of flap was arrived based on this experience. Keywords: Abbe flap, cleft rhinoplasty, columella lengthening, Indian nose

Introduction
After the correction of bilateral complete cleft lip and or palate (BCLP), nasal deformities are highlighted. Often the deformity is characteristic. The nasal rims flare widely and forms a tip that is broad, flat and often deviated. The alar bases are widely placed, and pathognomically, the columella height is short. Invariably, all these features are marked in all cases of BCLP but with varying extent. The cause could be due to primary dysmorphogenesis, usually hypoplasia and or deformation and secondary consequences of the surgical repair. The latter is more important because it is iatrogenic in origin and occurs irrespective of the technique used. The media crura are pulled to an inferior-posterior position contributing to shortness of columella by the buckling of genua leading to caudal positioning ofalar rims and thereby causing oblique anterior nasal angle.[1] Since this identification and description, several methods have been tried to correct the surgical principles that lie behind the correction of the deformity. It is a surgical challenge to idealize and recreate an ideal columella for each case. This probably emanates from the fact that reconstructed columella is often thick and retracted. Addition of autogenous cartilage would solve the issue in most of the instances. Moreover, it would help to design proper nasal tip, contour.[2,3]

It was converse who proposed to lengthen and straighten the columella.[4] Cronin in 1958 advanced the surgical advancement of the skin of the nasal floor and alae into columella, thereby increasing the columella length.[5,6] Around the same period, Millard,[7,8] Marcks et al,[9] Peskova and Fara,[10] Brauer and Foerster,[11] Randall and Brown,[12] Randall and Lynch,[13] McComb,[14,15] Skoog,[16] and Stenström[17] proposed various methods to correct the deformities. Each of these had their own merits and demerits. Customization of the flap/approach based on age and extent of defect dictated the type of approach. Millard’s modification of Duff’s technique[18] of “forked flaps” and
Cronin’s technique was the most commonly used technique along with the Abbe flap.[19] The “Abbe flap” introduced by Dr. Robbert Abbe as “lip switch” flap in 1898 for the secondary correction of a cleft lip deformity is still most widely used flap albeit with several modifications. Often this flap is used to recreate the philtral subunit which is often deficient in BCLP.[20,21] These pioneers also had favored different time of surgery owing to varying reasons – including fear of early manipulation of nasal cartilage while the fear remained unsupported by evidence.[20-22]

Till date, only a few reports document the challenge and outcome of the cleft rhinoplasty correction in Indian nose. The aim of this manuscript is to present and compare the surgical results of Cronin’s, Millard’s Forked flap technique, and Abbe’s flap for columella lengthening in BCLP.

Materials and Methods

Records of all cleft rhinoplasty cases performed in the author’s center since January 2010 till December 2016 was screened for this retrospective analysis. All cases of bilateral cleft lip and palate (BCLP), which had abnormal nose architecture requiring columella lengthening procedure, were selected. The inclusion criteria included (i) BCLP with nasal abnormalities requiring columella lengthening procedures, (ii) have not previously treated for the same, (iii) no other developmental abnormalities or muscular problems, and (iv) all relevant details including follow-up for at least 12 months’ period. The exclusion criteria included (i) previously treated for nose abnormality, (ii) other craniofacial developmental or congenital abnormalities, and (iv) patients with inadequate records or insufficient follow-up.

Details of age, gender, surgical method, duration of follow-up, and their perception of change of appearance were noted. The pre- and post-operative photograph was compared and analyzed with the photograph. The patients themselves were requested to compare their pre- and post-surgical appearance and asked to rate their nasal appearance as “good,” “better than before,” “acceptable,” or “worse than before.” These data formed the qualitative data. If the patient is below 8 years of age, the immediate caregiver replied the details.

Using previously described measurement procedures of Eski et al.[21] the pre- and post-rhinoplasty lateral photographs were quantitatively assessed using Adobe Photoshop CS4 and Adobe InDesign CS4 software. Outline of the patient obtained and standardized as per protocol. The length of the columella (from subnasale to the most inferior line of the infralobular triangle) was measured in pixels on standardized pre- and post-operative images. The differences between the preoperative – immediate postoperative as well as immediate – 1-year postoperative measurements were calculated and expressed as percentages. The difference between the 1-year postoperative measurements and immediate postoperative measurements indicate the stability of the correction.

Surgical procedures

The preoperative assessment of patients included all standard BCLP rhinoplasty. Specific consideration for rehabilitation of nose included symmetry of the alar bases and nostril shape, length of the columella, any deformations or deficiencies of the nasal lining, associated lip deformity due to a lack of correct muscle realignment at primary surgery. All eligible patients had undergone various degrees of presurgical orthodontics and would require further postsurgical orthodontics for refinement of their dental apparatus if required.

Forked flap

In this technique, depending on the previous lip surgery or scar [Figure 1a and b], the tissue was taken from either side of the prolabium in the form of bilateral “V-“ shaped flaps, based on the columella and extending down to the high points of the cupids bowline on the repaired lip. The flaps were raised. For adequate nasal tip advancement, incisions were carried up the membranous septum, freeing the flaps, and columella entirely from the septal attachment. Soft tissue was removed from the nasal tip. The alar cartilages were approximated by nonresorbable sutures [Figure 1c and d]. Since the curvature and consistency of the conventionally used ear cartilage grafts are often inadequate, additional graft harvested from the costal cartilage was fixed to the nasal spine as a strut graft to maintain adequate length and for enhanced tip projection. The forked flaps were sutured together, and the lip incisions are closed. This results in a lengthening of the columella [Figure 1e].

Cronin’s technique

Bilateral incisions were made at the base of the alae, in the nasolabial groove and extended medially across the floor of the nose [Figure 2a and b]. On reaching the columellar-philtral angle, the incision was curved upward in the columella to meet in the midline as an inverted “V” [Figure 2c]. A medial intranasal incision starting medially at the level of the intercrrural angle and extending downward through the septal mucosa was made to separate the columella from the caudal end of the septum. The bilateral intranasal incisions were then continued laterally and posteriorly across the floor of the nose and about half way up the lateral nasal wall [Figure 2d]. These parallel the nostril floor and nasal border. Through these incisions, extensive dissection was carried out to free the soft tissue of the nose entirely from the underlying bony and cartilaginous skeleton. The bippeded flaps were first undermined between the medial crura of the alar cartilage and the septum. Dissection extended as
high as the glabella, including the submucous dissection of the septum and extended downward to include the nasal spine. Dissection was then continued laterally across the nasal floor, incorporating as much thickness of the nostril floor as was possible. It is then continued between the overlying skin and the outer surface of the lateral crus of the alar cartilage laterally. Thus, two substantial bipedicled flaps based medially on the columella and laterally on the alae were elevated. The connective tissue in the tip of the nose, lying between the alar cartilages was excised. This radical undermining has yielded improved results, as it makes it easier to put the cartilages into the corrected position and hold them there. The nostril was then hooked forward advancing the bipedicled flaps in V-Y fashion where they were approximated to each other and the septum by buried nonresorbable sutures. A strut graft of septal cartilage was harvested and extended for extra tip projection. The alar base incisions were closed through and through mattress sutures tied over bolsters. Bolsters were used extra- and intra-nasally to obliterate dead space and to splint the bipedicled flaps in their corrected position [Figure 2e and f]. In some cases with excessive alar flare, bilateral alar base excisions were carried out to narrow the broad nostril.

**Abbe flap**

Before surgery, a presurgical counseling about the procedure was performed. Information and consent was obtained from patients and their caretakers. Special emphasis was on the two staged procedure – the part where there is need to raise the flap from the lower lip and most importantly the temporary union of upper and lower lip. Diagrams were used appropriately.

Under general anesthesia and orotracheal intubation, the 1st stage of the procedure was carried. Epinephrine was avoided to prevent possible immediate labial swelling and thus distortions in the surgical site. The surgical margins (in the upper and lower lip) were outlined and marked. After eliminating any fistulas, cleft lip segments were mobilized by incisions onto the nostril floor. The release incision of the oral mucosa and muscle from the premaxilla and pyriform margin allowed the medial advancement of the lateral lip segments without tension.

The standard open rhinoplasty was performed. The incision was placed along the lower border of alar cartilages. A small lateral incision was placed just behind the columella. This was extended upward and into nostrils. Through this incision, the nasal columella was slightly raised. If nasal tip modifications formed the part of the surgical plan, additional subcutaneous dissection of the nasal skin envelope was performed. At every phase and incisions, hemostasis was achieved. Cartilage grafts that were previously harvested, preshaped (to prevent warping) was used to support the medial crus of the lower nasal lateral cartilage. Care was taken to ensure correct columellar lengthening. Additional nasal tip morphology correction was also performed if required. The nasal skin was checked and lateral margins of the lip flap were approximated to the columella base. Alar cinch sutures were placed to keep the redesigned nostril width and height.

As per previous marking on lower lip, Abbe flap design was raised using a minimal, narrow portion of graft to recreate the missing upper labial philtrum region. The flap at its end was cut to a classic “W” shape to match and fit the columellar base incision. A Bard-Parker blade 11 was used to raise a full thickness graft with a cuff of tissue on one side. This was to facilitate donor site closure. The basic requirement of sufficient vascularity via the inferior labial branch of facial artery for the flap was ensured. The flap was then carefully rotated upward to the recipient site without any vascular distortion or impingement and approximated. The edges were trimmed, and donor site carefully closed in layers to prevent scar formation. Standard postoperative medicines and care instructions were given. The Abbe flap was dissected under local anesthesia on postoperative 10–14 days [Figures 3 and 4].

**Statistics**

All details were entered and analyzed using Statistical Package for Social Services (Version 23.0, IBM, Chicago, IL, USA). Demographics, descriptive statistics, and appropriate inferential statistics of Chi-square tests, one-way analysis of variance (ANOVA) were employed. P ≤ 0.05 was taken as statistically significant.

**Results**

Of the 109 cases of BCLP cleft rhinoplasty performed in time-phased of 2010–2016, only 48 cases fulfilled the inclusion and exclusion criteria. Of these 48 cases, 31 patients had been reconstructed with Abbe flap, 9 with Cronin, and 8 with forked flaps in the study population. The mean age of the study population was 20.33 ± 4.94 years, a median of 19 years, range of 13–29 years with an interquartile range of 16–25 years. There were 21 females and 27 males forming this study group. The average follow-up for the group was 15.3 ± 2.3 months.

There was no significant difference in the mean age among the three types of flaps as revealed by ANOVA tests with

| Table 1: Basic demographics of the study population (n=48) |
|----------------------------------------------------------|
| Abbe flap | Cronin | Forked | P |
| Mean±SD (years) | 21.00±4.95 | 18.56±4.75 | 19.75±5.12 | 0.406 |
| Gender | | | | |
| Male | 16 (51.6) | 7 (77.8) | 4 (50) | 0.351 |
| Female | 15 (48.4) | 2 (22.2) | 4 (50) | |

SD=Standard deviation
a $P = 0.406$. Similarly, gender was also not a statistically significant ($P = 0.351$) [Table 1].

Overall, the comparison between 1-year postoperative with immediate postoperative with the immediate post- to pre-operative columella measurements revealed the change to be having a mean percentage of $-2.8 \pm 2.12$ with a median of $-2.18$ ranging from $-6.46$ to $0.12$. The interquartile range was $-4.68$ to $-1.17$. The success of the lengthening of columella at the immediate postoperative period as compared to the preoperative columella length was not statistically different ($P = 0.176$) between the three flaps, while the same was statistically different at 1-year period ($P = 0.031$) [Figure 5]. The extent of change was very minimal for the Abbe flap with high degree of statistical significance ($P = 0.000$) [Table 2 and Figure 3].

Qualitatively, at 1-year postoperative period, 83.9% ($n = 26$) of Abbe flap patients felt their nose to be good after surgery while the same was 55.6% ($n = 5$) in Cronin flap design and 37.5% ($n = 3$) in forked flap design. The difference was statistically significant ($P = 0.007$) [Table 3].

**Discussion**

Correction of the BCLP nasal deformity presents a difficult problem.\textsuperscript{[20]} It has been managed successfully only in the late 20\textsuperscript{th} Century. With the innovation in techniques and deeper understanding of the etiology and mechanism

![Figure 1](image1.png)

**Figure 1:** (a and b) Preoperative view showing nose and lip defect. (c and d) Intraoperative view of forked flap reconstruction of columella. (e) Postoperative view of nose after suture removal

![Figure 2](image2.png)

**Figure 2:** (a and b) Preoperative view showing nose defect. (c and d) Intraoperative view with Cronin flap reconstruction with alar base incision extended up the columella for columellar lengthening of nose. (e and f) Postoperative view of reconstructed nose

| Type of flap | Mean | SD  | 95% CI for mean | Minimum | Maximum | $P$  |
|--------------|------|-----|----------------|---------|---------|------|
|              | Lower| Upper|
| Length of columella-immediate postoperative (percentage) as compared with preoperative length | Abbe | 53.58 | 5.82 | 51.44 | 55.71 | 42.40 | 61.82 | 0.176 |
|              | Corin | 51.47 | 4.35 | 48.12 | 54.81 | 44.54 | 57.80 |       |
|              | Forked | 56.35 | 3.76 | 53.21 | 59.49 | 48.97 | 59.67 |       |
| Length of columella 1-year postoperative (percentage) as compared with immediate postoperative length | Abbe | 52.09 | 6.34 | 49.76 | 54.42 | 40.38 | 61.94 | 0.031 |
|              | Corin | 46.17 | 4.26 | 42.90 | 49.44 | 39.34 | 52.32 |       |
|              | Forked | 51.24 | 4.13 | 47.79 | 54.70 | 42.69 | 54.89 |       |
| Extent of change (1-year immediate postoperative) | Abbe | $-1.49$ | 1.29 | $-1.96$ | $-1.01$ | $-3.70$ | 0.12 | 0.000 |
|              | Corin | $-5.30$ | 0.81 | $-5.92$ | $-4.68$ | $-6.46$ | $-4.25$ |       |
|              | Forked | $-5.11$ | 0.79 | $-5.77$ | $-4.45$ | $-6.28$ | $-3.68$ |       |
behind the BCLP, more success has been registered.\cite{24-27} Irrespective of the approach, the present study shows that the stability of the columella lengthening is best with Abbe flap so as its perception. By patient’s satisfaction and the 1-year stability, Abbe flap has the best results. As shown in Table 2, the immediate results do not vary with flap indicating the response to each of the flap design was not significantly different while at 1-year period, it is observed that it has become significant indicating that stability of the Abbe flap rhinoplasty is much higher than the other designs.

Columellar lengthening with tissue from the nasal floor, originally described by Carter was refined by Cronin.\cite{5,6} Cronin elevated bilateral bipedicled flaps that included columellar base, nostril floor, and alar base. The technique simultaneously corrected the alar flaring, wide nostril floor and short columella. If adequate length is not obtained, the procedure can be repeated many months later. It was later modified by rotating skin and mucoperiostium upward and placing a cartilage strut graft for support. Such composite grafts are useful to gain additional length of the columella in patients with otherwise satisfactory relationships of lip, nasal tip, and alae. Later, this underwent subsequent modifications.\cite{22}

According to Cronin and Upton,\cite{6} operation for lengthening the columella can be classified into three groups on the basis of source of material, lip, nose, or ear. They reported that, when observed from lateral profile, the middle of the lip provides one-fourth to one-third of the forward projection of the columella as compared with the level of the alar bases. Hence, they visualized to use the skin of the prolabium to lengthen the columella.\cite{6} However, use of the prolabium during primary lip repair to reconstruct the length of the columella may create complications for definitive cleft lip repair. The prolabium should be used for reconstruction of the philtrum only. However, if the prolabium is used for rhinoplasty purpose, a resultant short columella would occur and accentuate the nasal deformities that are often presented with BCLP. Nevertheless, they reported that early lengthening of the columella using prolabial tissue can be carried out because, according to them, the prolabium usually contains more than enough tissue to create a philtrum of normal size.\cite{6} Later, Stark

### Table 3: Qualitative perceptions of their nose at 1-year postoperative follow-up as compared with preoperative stage

| Qualitative perception | Abbe flap, n (%) | Cronin, n (%) | Forked, n (%) | P |
|------------------------|-----------------|---------------|--------------|---|
| Acceptable             | 0               | 1 (11.1)      | 3 (37.5)     | 0.007 |
| Better than before     | 5 (16.1)        | 3 (33.3)      | 2 (25)       |    |
| Good                   | 26 (83.9)       | 5 (55.6)      | 3 (37.5)     |    |
and Ehrman postulated that although the prolabium is embryonically part of the lip, it offers a convenient compromise for lengthening the columella while McComb ascribed the majority of secondary BCLP nasal deformities to the incorporation of the prolabium into the lip repair. In response, later in 1986, he advocated advancing forked flaps into the columella at 6 weeks’ postoperatively to prevent the nasal deformity. This later became the basis of forked flaps.

Kenneth Salyer performed a Cronin type of secondary revision in patients 2–3 years of age to increase the amount of nasal soft tissue. He reinforces that the fragile alar cartilages must remain attached to mucosa or skin at this age since they can make surgical manipulations difficult. Later, Mulliken described a new strategy to construct the columella and nasal tip by anatomic positioning of the alar cartilages and sculpting the investing skin at the time of primary lip repair. According to Mulliken, the forked flap produced abnormal nostril shape, broad tip, overly long columella, and nexus of scars at the columellar labial junction. Based on the observation, Mulliken concluded that incorporation of columella into the prolabium is nonanatomic.

Lindsay and Farkas based on their observations concluded that in many cases, the columellar shortening noted in infancy was more apparent than real. They advised avoiding dissection and displacement of the columella at the initial lip repair thus allowing columellar growth to continue and reducing the need for secondary revision. Pigott and Millard added to this observation that a normal infant’s nose had less projection and is broader than the adult’s nose; therefore, surgical intervention should be delayed till the nasal growth is achieved and there is always a possibility of self-correction. Noordhoff advocates elongation of the columella at 1–6 years of age using the banked fork-flap and by advancing the nasal floor tissue onto the columella and repositioning the alar cartilages superiorly and medially. When nasal floor tissue is inadequate, he uses a composite free ear graft for columellar lengthening. The timing for the surgery has to be noted. Thus in literature, there is ambiguity on the timing of the rhinoplasty. In this part of the world, late presentation is not uncommon. The delay in correction can be argued for the need of orthodontic intervention, maturation of the lower nasal cartilage maturation that would provide a strong, stable, support for redesigned nasal tip, and facilitate completion of cleft palate correction.

The versatility of Abbe flap to correct the BCLP, especially the philtral area has been previously documented. The flap relies on the principle that it utilizes an extra amount local tissue – the lower labial tissues to correct the deformity in the upper lip. Moreover, the dimensional variations between the lips help the transfer of tissue. As the flap is a local flap, ideal color, tissue type matching is possible as accurate as possible. Hence, as observed in this study, the esthetics perception is always high with Abbe flap. The Abbe flap rhinoplasty technique is often reserved for a patient who shows a nasal and upper labial deformity in spite of early intervention. As in this method used, the entire philtral subunit is redesigned; it gives a well-desired esthetic appeal.

Based on the study and observation, an algorithm to choose flap design is proposed. On comparison of the three techniques for the elongation of the columella, it is proposed that the Abbe procedure is best suited when the whole mid unit is to be altered and especially when esthetic concerns are more. Cronin procedure can be used when the nostril size is normal, and there is a relatively good configuration of the domes of the lower lateral cartilages. The shortcoming of the Cronin’s procedure is the damage of the columella–lip junction. Cronin procedure can be used to elongate the columella when the nostril size is normal, and there is a relatively good configuration to the domes of the lower lateral cartilages. It is not a suitable procedure when nostril is too large or when the medial crus of the lower lateral cartilage are splayed out and broad. In addition, it results in a transverse scar from the base of the nostril from the alar base, which sometimes is unsightly. The addition of the cartilage strut is necessary to achieve adequate support for the tip.

The forked flap is best useful as a procedure when the prolabium is very broad, to narrow the prolabium. A criticism of the forked flap technique is the presence of multiple vertical scars in the columella, which rarely gives a favorable esthetic result. In addition, there may be problems with the vascularity of the flap tips, sometime causing necrosis of the flap. The meeting of multiple lines at the lip-columella angle and the resultant interference with its smooth sweep and contour is probably the most unsatisfactory feature of the forked flap procedure. The use of forked flap from the lip is not advocated except as a secondary procedure to correct lip deformities in addition to
elongation of the columella. If the columella alone is to be elongated the forked flap can also be taken from the nostril floor, or from the banking of the flaps. This reduces the additional scars on the Cupid’s bow and the philtrum. Thus, the forked flap is elevated and inserted into the columella for additional length. The additional support from the costal cartilage strut is essential to maintain adequate length. The additional advantage of the forked flap cheiloplasty is that the wide nostril floor can be narrowed by advancing the alar base in a V-Y manner and fixed to the nasal spine to achieve narrowing of the ala. There is less scarring across the floor of the nose in the forked flap elongation of the columella as compared to Cronin’s. [26]

The limitation of the study is that the bias in qualitative assessment. However, previous studies have shown that use of modified rhinoplasty outcome evaluation question such as the one used in the study are valuable tools. [27] The present study is unique as, to the best of our knowledge, this is the first of its kind to estimate the success in Indian nose that is entirely different from Asian and other human nasal structures.

Conclusion

Early repair of congenital deformities, before the age of recall, is preferred to avoid the child from being exposed to any psychological trauma due to appearance. Simultaneous repair of the columella together with the lip is not advocated. Columella lengthening is deferred until the preschool age, to permit normal nasal growth. Secondary revision of the nasal deformity, which fortunately is usually symmetric, is therefore reformed during the preschool years. The optimal columellar lengthening procedure should be selected according to the particular nasolabial deformity. In case of marked deformities of midface, Abbe flap is the most suited choice, as shown in the present study. The proposal presented needs verification with larger sample size for Indian BCLP noses.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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