Management of Secondary Maxillary and Nasal Deformities in Adolescent Cleft Lip and Palate Patients

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INTRODUCTION

Management of secondary maxillary and nasal deformities in the adolescent cleft patient can present a formidable surgical challenge. The functional as well as aesthetic needs of each patient must be given careful consideration. A team approach can optimize the preoperative planning, procedure selection, and postoperative management. Team members include Speech and Language Pathologist, Orthodontist, Dentist, Prosthodontist, and Psychologist. The author’s management protocol for surgical correction of deformities of the midface and nose in adolescent patients is presented. This has been successfully used at Children’s Healthcare of Atlanta for over 17 years.

MANAGEMENT OF CLEFT/MAXILLARY DEFORMITIES

Approximately 15% to 20% of adolescents with unilateral or bilateral cleft lip and/or palate will have some degree of maxillary hypoplasia. The underdevelopment of the maxilla may be noted soon after birth and is often progressive. In many cases correction requires a combined orthodontic and surgical approach. The results of maxillary hypoplasia include Class III malocclusion with abnormal wear and tear on the teeth, masticatory difficulties, nasal and nasopharyngeal airway obstruction, and aesthetic facial deformity. Dental deformities often accompany the maxillary deformities and can include missing dental units, supernumerary teeth, hypoplasia of dental enamel, and deformed teeth (Fig. 1).

I consider the nose and maxilla to be a single aesthetic unit when considering planning for surgical correction. The position and size of the lower jaw and chin are also assessed aesthetically. The midface appears to be concave rather than convex, which decreases nasal base projection, as well as tending to make the ala somewhat splayed. The upper lip is poorly supported and there is often inadequate dental show. The underlying skeletal deformity magnifies the cleft nasal deformity (Fig. 1). As part of the treatment planning process cephalometric radiographs, facial and dental photographs are taken. The cephalometric data can be digitized to allow for precise treatment planning (1,2). Computerized facial imaging which simulates both the maxillary procedure and the subsequent nasal surgery is often helpful in explaining the treatment challenges and goals to the patient and family (3,4). The ultimate aesthetic and functional goals are discussed with the patient and their family. Each step in the process, including dental and orthodontic preparation, surgical correction of the maxillary and nasal deformity, finishing orthodontics, prosthetic dentistry, and if necessary psychological evaluation are presented. The patient, family and multidisciplinary team have to agree on the process, timeline, and goals prior to the start of treatment. Reasonable expectations are discussed and agreed on by all participants. I prefer to correct the maxillary deformity first, thus establishing a bony base for future definitive nasal reconstruction. At least nine months are allowed between maxillary advancement and the definitive internal and external nasal
Maxillary Advancement

Planning for surgical correction of severe maxillary hypoplasia in the cleft patient has to begin early in life. Ideally, I perform a gingivoperiosteoplasty at the time of lip repair. In some cases this will suffice and avoid alveolar bone grafting in the future. Even when there is not enough alveolar bone after gingivoperiosteoplasty, it often helps to align the maxillary segments and avoid chronic oral/nasal fistulas. If a child does need alveolar bone grafting, this is coordinated with his/her orthodontist. Orthodontic preparation for bone grafting includes maxillary expansion and, if necessary, aligning the teeth adjacent to the cleft. My bone graft technique includes a minimal incision, utilization of a bone harvesting mill, and packing the donor site with a bupivacaine impregnated resorbable implant (5). I have found that this routine makes the procedure relatively painless and allows for 23 hour stay in the hospital and resumption of normal activity within two to three days. Orthodontic treatment is resumed within three to four weeks after the alveolar bone grafting, but the palatal expansion device is left in place for four to six months to allow bony consolidation. Maxillary advancement can proceed after 12 to 18 months of bone consolidation. This approach allows for a single piece maxillary advancement rather than multiple segments with simultaneous bone grafting to the alveolar cleft at the time of maxillary advancement.

Orthodontic preparation for maxillary advancement begins approximately one year prior to the time of the scheduled surgery (6). This includes aligning and leveling the occlusion, as well as any dental extractions that may be necessary to get proper dental spacing.
Approximately two weeks prior to the planned maxillary surgery heavy orthodontic wires are placed, along with hooks. At the same time, mounted models are taken for model surgery (7,8). During the same visit, a complete speech and language evaluation, including nasal endoscopy, air flow, and articulatory studies, are performed. This allows us to identify the patients at high risk for velopharyngeal incompetence after maxillary advancement. The patient and parents are informed, if this is the case, preparing them for the possibility of a pharyngoplasty or pharyngeal flap in the future if velopharyngeal incompetence does occur. Model surgery is performed using articulated models, to achieve optimal occlusion, and intraoperative splints are made.

Special considerations at the time of surgery include preoperative antibiotics and intravenous steroids. Hypotensive anesthesia is preferred and all patients are asked to donate a unit of autologous blood or donor-directed blood. The preoperative nasal endoscopy will reveal the location and portal size if a previous pharyngeal flap is present. The design of the osteotomies can vary according to the patient’s aesthetic needs (9). In patients with hypoplastic malar regions, the osteotomies are made quite high, just under or including a portion of the inferior zygomatic arch under the inferior orbital nerve, in order to get maximal bony fullness with the advancement. Vertical measurements are taken from the medial canthus to the incisor brackets on both sides to assure that the occlusion stays level and to determine the vertical dimensions. Care is taken to dissect out the mucosa of the medial and inferior nasal cavities and to protect the nasotracheal tube. Once the osteotomies have been completed, the maxilla is mobilized with a combination of Rowe disimpaction forceps and Wolfe disimpaction devices. If there is a restrictive pharyngeal flap, it is taken down at this time to allow full mobilization of the maxilla. In many cases scar tissue will make mobilization difficult requiring considerable force. The color of the gingival should be carefully monitored during mobilization to avoid devascularization. The patient is then put into the pre-fabricated occlusal splint, from the model surgery, and then into intermaxillary fixation. Once the patient has been put into intermaxillary fixation with both rubber bands and wires, the final vertical dimensions are determined. This is done from preoperative analysis and photographs. Bony interferences are taken down if an impaction is required. If necessary, the Golden Rule, as popularized by

**FIGURE 2** Drawing of maxillary advancement and horizontal osteotomy of mandible. Note placement of rigid fixation plates at medial and lateral buttress and bone grafting of advancement gap.
Rickett’s, serves as a very useful guide to determine the optimal aesthetic proportions. In most cases, it will be necessary to bone graft the gap between the proximal and distal segments (Fig. 2). I prefer to use iliac crest bone graft for this. I have found that the easiest and least painful donor site simply involves going back through the old bone graft incision, if one is present, extending it slightly, retracting the soft tissues medially, and then harvesting the inner table of the iliac crest with a reciprocating saw and osteotomes. A very large cortical cancellous graft can, thus, be obtained. Because the iliac crest height has not been violated, this does not leave a hip contour defect. The wound is closed in the same fashion as done for alveolar bone grafting. If a substantial graft has been obtained, a drain is left overnight to prevent hematoma formation. Next, the gap between the proximal and distal segments is measured. I prefer to use specialized, extreme plates manufactured by the KLS Company. These plates are pre-bent to approximate different advancements from 7 to 15 mm and are 2 mm thick, making them extremely stiff and resistant to postoperative bending (Fig. 3). Screws of 2 mm diameter are used to get maximal bone grip. Proper placement of these plates is critical to avoid a poor occlusal result. Typically, the medial and lateral buttresses represent the strongest bone available for fixation and it is here that the best application of the rigid fixation can be made (Figs. 2 and 3). The plates need to be precisely bent to the contours of the maxilla to ensure occlusal stability, when using the pre-contoured plates this usually requires only minor adjustments. Two plates per side are utilized. At this point, if there is any doubt regarding the integrity of the previous alveolar bone graft, it is wise to expose the area and re-graft it from above. If there are very large turbinates, they can be trimmed at this point. If an impaction is contemplated in the vertical dimension, it may be necessary to remove a segment of septum to

**FIGURE 3** Skull model with medial buttress fixation with “extreme,” 2 mm thick, pre-contoured plating system.
prevent it from warping during the impaction, causing postoperative airway obstruction. Once these maneuvers have been completed, the patient is taken completely out of maxillary fixation and, with the mandible in centric relation, with gentle posterior pressure, the occlusion is checked. The occlusion should fit passively into the occlusal splint. If it does not, it indicates that either the plates were not bent precisely, causing torque on the maxilla, or the condyles were not seated at the time the patient was put into maxillary fixation. In either case, reapplying the intermaxillary fixation is required, with removal of all hardware. All bony interferences should be resected, and the plates contoured to fit precisely against the bone. If the occlusion is acceptable at the end of the rigid fixation phase of the procedure, the patient is put into simple 8 oz elastics with slight anterior maxillary pull, the occlusal splint is wired to the orthodontic wire. If the patient has had an impaction, a cinching suture is placed along the base of the nose to prevent widening of the ala. These wounds are irrigated with antibiotic solution and closed with resorbable sutures.

Postoperatively, the patient is extubated in the operating room and put into an upright position with ice packs. Intravenous steroids are continued for two days after surgery. The patient is put immediately on a clear liquid diet and then advanced to a soft diet as tolerated. The hip drain is removed within one to two days, depending on the amount of drainage, and the patient is discharged. At the first week’s postoperative appointment, the patient is shown how to change the rubber bands and is allowed to remove them to eat. The occlusal splint is removed after two weeks. A soft diet is instituted for six weeks. A follow-up orthodontic appointment is made within four weeks of the surgery.

Potential problems with the surgery include relapse of the maxilla to a variable degree. This can be prevented by continuing to have slight anterior pull on the light elastics or consideration can be given to a reverse pull face gear to exert tension on the maxilla. Care should be taken not to exert too much pull on the maxilla during the early healing period, since it is possible, through continuous movement and elastic tension, to actually begin to dislodge the fixation. After maxillary stability has been achieved, finishing orthodontics is instituted. If prosthetic rehabilitation for missing teeth is necessary, I recommend waiting at least 9 to 12 months after the surgery to allow full healing of the surgical site. After that time, the orthodontist, prosthodontist, and implant surgeon can decide the best strategy for final rehabilitation of the dentition (Figs. 1, 4, and 5). If postoperative velopharyngeal incompetence is detected the patient is monitored by the Speech and Language Pathologist for six months. If no improvement is forthcoming a pharyngoplasty is performed.

**SURGERY FOR SECONDARY NASAL DEFORMITIES**

Final nasal reconstruction is typically done when skeletal maturity has been achieved. I prefer to wait to do the definitive rhinoplasty until after the maxilla is in its proper alignment. If a maxillary advancement is performed I wait 9 to 12 months before rhinoplasty. My approach to cleft nasal reconstruction includes consideration of both functional and the aesthetic needs of the patient. Computerized imaging is often utilized to help the patient visualize the idealized final appearance and to explore the patient’s expectations preoperatively (3,4). Most patients with cleft lip and palate will have some degree of nasal airway obstruction (10–12). This is typically caused by nasal septal deviation, including the vomer, perpendicular plate of ethmoid, and the cartilaginous septum. Often, there will be compensatory turbinate hypertrophy contributing to the overall nasal airway obstruction. In addition, the nasal inlet may be obstructed by inspiratory collapse either at the lower lateral cartilage level or alar valve level. All these sites need to be taken into consideration. This surgery is carried out under general anesthesia and an open rhinoplasty approach is used in all cases (13).

**Unilateral Cleft Nasal Deformity**

The unilateral deformity has several characteristic components that must be considered during preoperative planning and surgical repair. These include nasal tip deviation toward normal side, posterior displacement of cleft side dome, alar buckling on cleft side, medial
crus retro displacement on the cleft side, septum and collumellar deviation toward the cleft side, and buckling of the lateral crura on the cleft side (Fig. 6). The unilateral cleft reconstruction involves a stair step collumellar incision and a rim incision, with exposure of the entire nasal pyramid (10,11). It is very important to be able to visualize the anatomy fully. The nasal septum is resected from between the two medial crura of the lower lateral footplates with mucosal flaps elevated on either side. At least 1.5 cm of dorsal septum should be kept intact. Often, the caudal septum is grossly deviated and must be resected. The deviated portions of the septum are completely resected, to be used as autologous
cartilage grafts. If the perpendicular plate of ethmoid and vomer are involved, they should also be resected at that time. Once this has been accomplished, the mucoperichondrial flaps are sutured to each other using resorbable sutures. A conservative inferior turbinectomy is advocated to prevent nasal crusting or drying. Once the nasal airway has been established, the height of the dorsum is set and, if necessary, rasping is done to take down any dorsal irregularities or humps. Care is taken to create junction tunnels between the upper lateral cartilages and the septum. Next, the bony vault is addressed. If the dorsum has been taken down or if the dorsum is wide, lateral osteotomies are carried out with a 2 mm osteotome to close the open roof deformity and to decrease the nasal width. Next, the mid-vault is addressed. If there is significant dorsal septal deviation, this can be camouflaged with spreader grafts (13). These are placed on the concave side and should extend across the nasal valve (Fig. 6). They are secured with resorbable suture. Next, the nasal tip is addressed. The nasal tip deformities can be quite severe and include asymmetry, hypoplasia of the cartilages, and displacement of the cartilages. The cephalic margin of the both lower lateral cartilages are usually trimmed in order to provide a more refined nasal tip and then over-grafting is carried out, on the cleft side, to make up for any cartilage deficiencies (Fig. 6). A columellar strut graft should be utilized if the caudal septum has been removed (Fig. 6). The strut graft is sutured to the medial crura of the lower lateral footplates with resorbable sutures. Finally, a variation of several types of tip grafts can be used to give tip definition. These include shield grafts and stacked Peck-type grafts (14). Packing is not used and the external incision is closed with synthetic sutures. If the alae are wide or
asymmetric, they are addressed at this point. These should be addressed with either alar reduction, going along the floor of the nose, or, more commonly, by repositioning the cleft side ala. Typically, the ala tends to be displaced laterally. In order to reconstruct the floor of nose, a Y to V advancement of the lateral ala is done. This can be done with an 11 scalpel and matched to the contralateral side without much difficulty. Adhesive strips are applied, along with a thermoplastic dressing. The patient is discharged on oral antibiotics and pain medication, they are allowed to shower. We have found that a short course of postoperative steroids can also be quite helpful in reducing swelling. All permanent sutures are removed at one week as is the splint, saline drops are started to help clear out the airway.

Bilateral Cleft Nasal Deformity

The bilateral deformity is quite different from the unilateral cleft deformity (Fig. 7). The bilateral deformity includes a foreshortened nasal tip, a short columella, bifid but symmetric tip cartilages, a wide nasal dorsum, and low alar domes, buckling of the lateral crura, and variable degrees of septal displacement (10,12). If the columella is adequate, the incisions can be made with a stair step design. In most adolescent patients there has already been surgery to lengthen the perceived lack of columellar length. If the columella is short, the bilateral lip reconstruction scars can be harvested as small forked-flaps to lengthen the columella. Alternatively, wide undermining of the skin envelope will often preclude the need for columellar flaps if adequate structural support is provided. The rest of the exposure is standard external rhinoplasty exposure (13). If there is a component of airway obstruction, this can be addressed in the same fashion as in the unilateral deformity. Often, there is fibro fatty tissue between the splayed medial crura, which should be removed to give maximal tip refinement. The lateral crura are then mobilized from the soft tissues with sharp scissor dissection. Next, the nasal dorsum is set. This can include taking down any type of hump or doing lateral osteotomies to decrease the overall nasal width. If the dorsum is adequate but too wide, lateral osteotomies via a pyriform aperture approach using a 2 mm osteotome are
carried out. If necessary, the nasal dorsum can be augmented with either on lay septal grafts or, more commonly, with extended alar spreader grafts that are placed above the level of the dorsal septum to give dorsal definition (Fig. 7) (13). These are sutured onto the dorsal septum and to each other with resorbable sutures. The upper lateral cartilages are then suspended to each other. The nasal tip then needs to be lengthened. This can be done through a combination of techniques, depending on the severity of the deformity. The medial crura are sutured to each other, as are the footplates, essentially walking length up the nasal columella. If this is not adequate or if the nose is extremely short, tip projection and length must be added. If adequate septal cartilage is available, this is ideal. This can be done by a series of shield grafts placed with the wide end downward and also along the nasal columella to essentially extend the tip downward and forward, (14). It is important that these grafts all be secured to each other and to the underlying dorsum with resorbable suture. A columella strut graft can be quite helpful to secure this construct (Fig. 7). Wide undermining of the nasal skin is advocated in order to have adequate soft tissue length to cover the grafts. Occasionally, septal cartilage is not present or is inadequate. A conchal graft can serve as an excellent substitute. The perichondrium is left on one side of the graft and the graft is trimmed to resemble an L-strut. It is then sutured to the underlying medial crura and nasal tip, leaving graft projecting to extend the tip. Conchal grafts can also be stacked on this construct in order to increase tip projection and length. All intranasal incisions are closed with resorbable sutures and the external incisions with non-dissolvable sutures. The ala will often need to be adjusted and a Y to V alar advancement medially
is an excellent maneuver to decrease alar width. Postoperative care is the same as with an unilateral deformity.

**Adjuvant Techniques**

Adjuvant techniques are sometimes helpful to achieve the best final aesthetic result. Occasionally, the cleft patient with maxillary hypoplasia will have an imbalance in chin position or size. Genioplasty can be useful in achieving an optimal aesthetic result and is done at the time of maxillary advancement (Figs. 2 and 5) (15). Lip revision is often necessary and can be done at the time of rhinoplasty. With some patients there is an imbalance between the upper and lower lip or paranasal flatness despite a Class I occlusal relationship after maxillary advancement. In those cases, a dermal fat graft can be a valuable adjuvant measure (Figs. 5 and 7). Typically, the dermal fat graft is harvested from the suprapubic area. If the lip is to be augmented, a small incision is made on either side of the defect along the free border of the lip and deep subcutaneous dissection is carried out with sharp scissors. An adequate tunnel must be created and should be in the shape of the graft. The graft is trimmed to fit, leaving plenty of dermis to adhere to and pulled through the subcutaneous tunnel (Fig. 8). If the paranasal areas or sub nasal areas are still inadequate despite normal bony projection, the dermal fat graft is tunneled through the Y to V incisions for augmentation. Approximately 30% resorption can be expected, so these grafts should be made somewhat larger than anticipated in order to allow for shrinkage.

**CONCLUSION**

Surgery of the midface and nose are valuable tools in completing reconstruction for adolescents and adults with bilateral cleft lip and palate. Often, these are the last surgeries needed for their reconstruction. Careful preoperative planning, computerized imaging, and a team approach to both the orthognathic and aesthetic surgery can yield gratifying results.
REFERENCES