Original Article

Zygomaticomaxillary "lateral swing" osteotomy for augmentation of midface deficiency

ABSTRACT

Introduction: Various surgical modalities have been proposed for the augmentation of midface deficiency without correction of the occlusal component. They include autogenous bone and cartilage grafts, alloplastic materials, and osteotomies. We propose an innovative osteotomy technique for augmentation of the midface including the infraorbital rims, the zygoma, the anterior maxillae, and the paranasal areas without advancing the dental-bearing segment.

Materials and Methods: This procedure was carried out on a 21-year-old male patient who had a deficiency of the anterior maxillae including the infraorbital rims. His occlusion was in Class I molar relation. The surgical exposure was carried out through a midface degloving approach. This bilateral osteotomy encompasses the anterior maxillae and the zygoma; the osteotomy line running superiorly from the medial aspect of the infra-orbital rim to the root of the frontal process of maxilla. Inferiorly, the line runs above the apices of the maxillary teeth laterally underneath the zygomatic buttress, separating part of the zygomaticomaxillary suture posteriorly. Medially, the osteotomy line runs parallel to the piriform aperture. The osteotomy is pedicled on the zygomaticotemporal suture. A greenstick fracture at the zygomatic arch pedicled the osteotomized segment to the zygomatic process of the temporal bone. The entire segment was swung laterally outward, effectively separating part of the zygomaticomaxillary suture posteriorly. Fixation was achieved with a single 2-mm L-shaped, 4-hole plate with gap at the zygomatic buttress region.

Results: This osteotomy technique resulted in fullness of the anterior maxillae and infraorbital rims, with increased anterior and lateral projection of the zygoma.

Conclusion: The zygomaticomaxillary "lateral swing" osteotomy is a reliable and stable technique for total midface augmentation not requiring occlusion correction.

Keywords: Maxillomalar osteotomy, midface augmentation, midface deficiency, zygomaticomaxillary osteotomy

INTRODUCTION

The zygomaticomaxillary complex is important for facial projection in the anterior as well as lateral dimensions. A prominent zygomatic region bestows fullness and definition to the face. Along with the shadows of the nasolabial region, the malar complex accentuates the facial features. We propose an osteotomy technique for augmentation of the midface including the infraorbital rims, the zygoma, and the anterior maxilla without advancing the dental-bearing segment. This is a modification of the "sandwich osteotomy" technique of Mommaerts *et al*.[1] and a technique proposed by Van Sickels and Tiner[2] for correction of zygomatic deficiency. The zygomaticomaxillary "lateral swing" osteotomy technique proposed by us incorporates elements from both these designs.

Thomas Zachariah, R. S. Neelakandan, Aparna Murugan

Department of Oral and Maxillofacial Surgery, Meenakshi Ammal Dental College and General Hospital, Meenakshi Academy of Higher Education and Research (Deemed to be University), Chennai, Tamil Nadu, India

Address for correspondence: Dr. Thomas Zachariah, Department of Oral and Maxillofacial Surgery, Meenakshi Ammal Dental College and General Hospital, Meenakshi Academy of Higher Education and Research (Deemed to be University), Alapakkam Main Road, Maduravoyal, Chennai - 600 095, Tamil Nadu, India.
E-mail: thomas.zach@gmail.com

Received: 21-06-2018, **Revised:** 24-07-2018, **Accepted:** 14-05-2019, **Published:** 12-11-2019

Access this article online

Website: www.njms.in

DOI: 10.4103/njms.NJMS_53_18

Quick Response Code

How to cite this article: Zachariah T, Neelakandan RS, Murugan A. Zygomaticomaxillary "lateral swing" osteotomy for augmentation of midface deficiency. Natl J Maxillofac Surg 2019;10:146-52.

Van Sickels and Tiner[2] first proposed an osteotomy technique for augmentation of the zygoma and the infraorbital region along with a LeFort I osteotomy. Bone cuts were made along the floor of the orbit, laterally on the zygoma, and along the anterior aspect of the maxilla just lateral to the piriform aperture. They left a 5-mm lateral strut of bone near the piriform aperture to allow stabilization of the midface complex. After releasing the pterygoid plate, the lateral walls of the nose and midline structures, the midface, and the maxilla were mobilized. Microplates and miniplates were placed at the piriform fossa and laterally at the zygoma for stabilization. The maxilla was fixed with microplates and miniplates.

The zygomatic "sandwich" osteotomy (ZSO) pedicled on the zygomatic arch for malar augmentation was originally proposed by Mommaerts *et al.* and popularized in a series of publications.[1,3,4] A vertical osteotomy, through both the anterior and posterior walls of the maxillary sinus, was performed using a thin reciprocating saw blade. The osteotomy cut was stopped about 4 mm below the infraorbital rim. An oblique horizontal bone cut was made proceeding anteromedially from the junction of the zygomatic arch and body, transecting the sinus walls beneath the orbital floor, and joining the vertical osteotomy at its superior end. The bone cuts were completed with small chisels. A 1-cm-wide osteotome or a superior ramus separator was used to open the vertical osteotomy by mainly outward pressure. The fulcrum was located at the zygomaticomaxillary buttress. A greenstick fracture occurred at the temporozygomatic suture. A hydroxyapatite block was carved to a trapezoid of desired width and "sandwiched" into the vertical osteotomy space. They also combined the ZSO with a LeFort I osteotomy if required. Fixation was achieved with miniplates separately for the zygomatic osteotomy and the LeFort I osteotomy.

MATERIALS AND METHODS

A 21-year-old patient presented to the Department of Oral and Maxillofacial Surgery with a complaint of flatness and retrusion of the middle third of the face. On examination, he had midface deficiency with retrusion of the anterior maxillae including the infraorbital rims with a decreased bizygomatic width. His occlusion was in Class I molar relation [Figure 1a-d].

A decision was made to augment his midface without disturbing the occlusion as it was in Class I molar relation. An osteotomy technique rather than onlay grafts was planned as the patient did not desire grafting from a second surgical site or alloplasts. The surgical approach to perform the zygomaticomaxillary "lateral swing" osteotomy technique

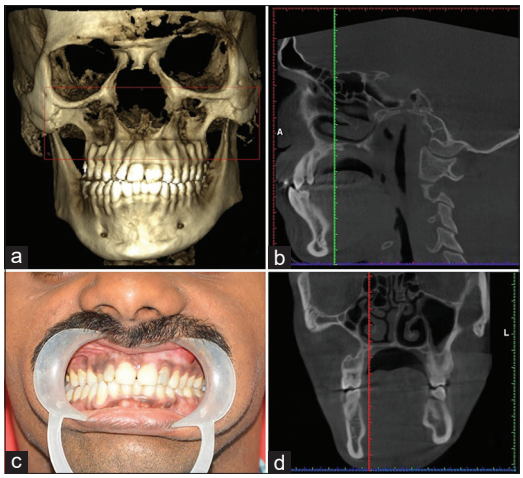

Figure 1: (a-d) Computed tomography images and occlusion of the patient

was the midface degloving approach[5] as it allows excellent exposure to the entire midfacial region including the zygoma, the infraorbital rims, the maxillae, and the paranasal areas bilaterally.

The patient was orally intubated (to allow for endonasal dissection and the elevation of the flap). The midface degloving approach was performed with a maxillary vestibular incision and three intranasal incisions that included (1) bilateral intercartilaginous, (2) complete transfixion, and (3) bilateral piriform aperture incisions.

An intercartilaginous incision [Figure 2a] is initiated at the inferior border of the upper lateral cartilage, beginning at the lateral end and extending medially curved into the membranous septum anteriorly to meet the transfixion incision. Laterally, the incision must be sufficient so that it extends to the piriform aperture. A complete transfixion incision [Figure 2b] is used to separate the membranous septum/columella from the cartilaginous septum and converges with the intercartilaginous incision. Dissection through the intercartilaginous incision [Figure 3a] allows access to the nasal dorsum and releases soft tissue from the underlying bony structures. The beaks of the scissors pass below the lower lateral cartilage but above the upper lateral cartilages. Tissues around the piriform fossa are released as well. Finally, a standard sublabial incision [Figure 3b] in the maxillary vestibule is made approximately 3–5 mm superior to the mucogingival junction. The periosteum along with the facial soft-tissue envelope and the lower lateral nasal cartilages can then be degloved or "peeled off" [Figure 3c] over the underlying nasal structures to expose the entire midfacial skeleton from one zygoma to the other, the zygomatic buttresses, the infraorbital rims, the anterior maxillae, and the piriform aperture [Figure 3d].

After careful reflection of the orbital periosteum, the osteotomy starts at the medial aspect of the orbital floor, 2 mm posterior to the infraorbital rim, lateral to lacrimal fossa [Figure 4a]. Care must be taken to avoid injury to the nasolacrimal duct at the medial aspect of the orbit. The cut extends laterally, running across the orbital floor parallel to the infraorbital rim, to the root of the frontal process of the zygomatic bone [Figure 4b]. Extreme caution must be exercised to avoid injury to the infraorbital nerve as the cuts are made at the infraorbital foramen. The cut is extended posteriorly and downward across the zygomaticomaxillary suture behind the zygomatic bone [Figure 4c]. It then runs inferiorly along the zygomaticomaxillary suture to take a right-angled turn medially at the zygomatic buttress to emerge at the anterior surface of the maxilla [Figure 4d]. The cut then runs medially and horizontally above the root apices of the maxillary teeth, parallel to the superior infraorbital cut [Figure 4b]. Above the root apex of the maxillary first premolar, the cut turns upward, running lateral and parallel to the piriform aperture to join the medial orbital floor cut superiorly [Figure 4a]. Care must be exercised to avoid injury to roots of the maxillary teeth. After the bone cuts are made, the osteotomy is meticulously completed with chisels and the entire segment in unison swung laterally with a greenstick fracture at the zygomatic arch, pedicled at the

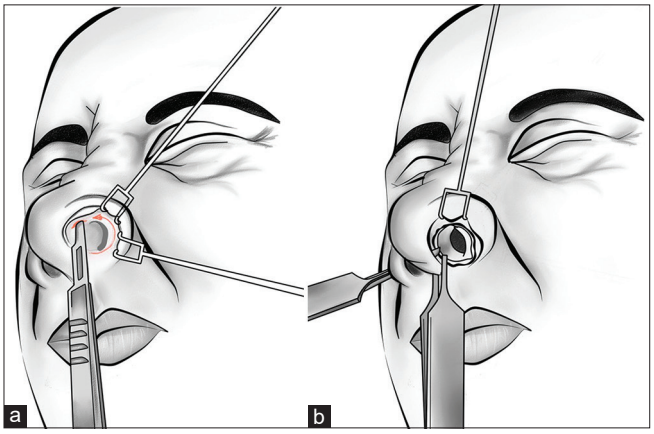

Figure 2: (a) An intercartilaginous incision is initiated at the inferior border of the upper lateral cartilage, beginning at the lateral end and extending medially curved into the membranous septum anteriorly to meet the transfixion incision. (b) Complete transfixion incision is used to separate the membranous septum/columella from the cartilaginous septum and converges with the intercartilaginous incision

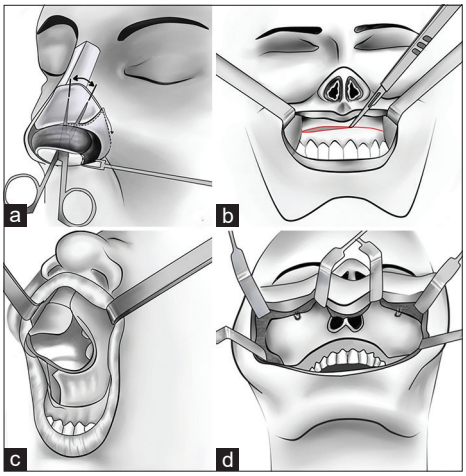

Figure 3: (a) Dissection through the intercartilaginous incision allows access to the nasal dorsum and releases soft tissue from the underlying bony structures. (b) A standard maxillary vestibular incision made approximately 3–5 mm superior to the mucogingival junction. (c) The periosteum along with the facial soft-tissue envelope and the lower lateral nasal cartilages can then be degloved or "peeled off" over the underlying nasal structures. (d) Exposure of the entire midfacial skeleton from one zygoma to the other

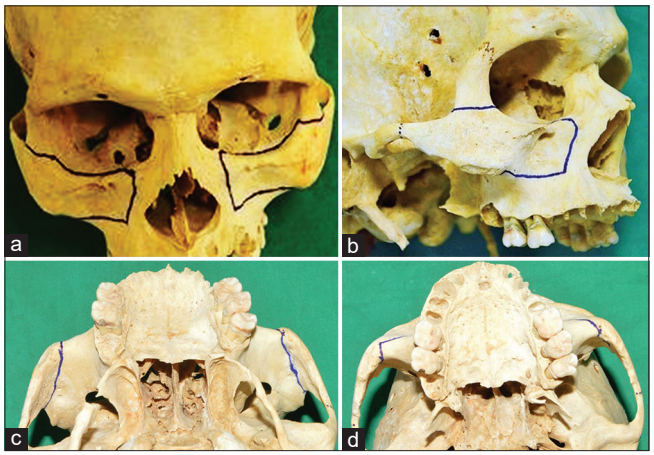

Figure 4: (a) The osteotomy starts at the orbital floor, 2–3 mm posterior to the infraorbital rim, lateral to lacrimal fossa. (b) The cut extends laterally, running across the orbital floor parallel to the infraorbital rim, to the root of the frontal process of the zygomatic bone. (c) The cut is extended posteriorly and downward across the zygomaticomaxillary suture behind the zygomatic bone. (d) The cut then runs inferiorly along the zygomaticomaxillary suture to take a right-angled turn medially at the zygomatic buttress to emerge at the anterior surface of the maxilla

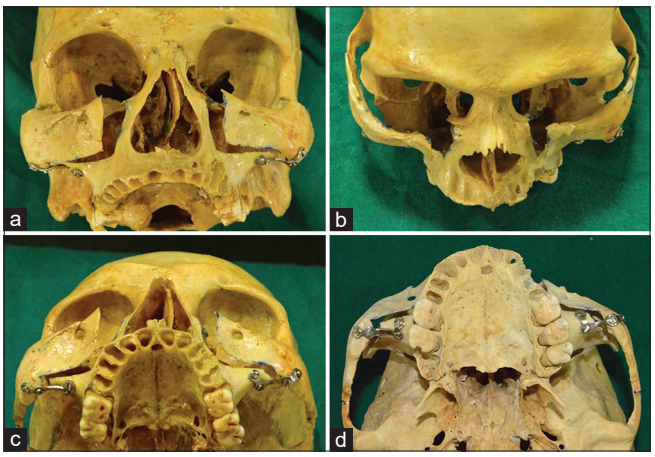

Figure 5: (a and b) After the bone cuts are made, the entire segment is swung outward with a greenstick fracture at the zygomatic arch, pedicled at the zygomatic process of the temporal bone. (c and d) A Smith spreader applied at the thick bone of the zygomatic buttress which acts as the fulcrum for the "lateral swing" osteotomy prevents any inadvertent fracture of the osteotomy segment

zygomatic process of the temporal bone [Figure 5a-d]. This effectively separates part of the zygomaticomaxillary suture posteriorly. A Smith spreader applied at the thick bone of the zygomatic buttress, which acts as the fulcrum for the "lateral swing" osteotomy, prevents any inadvertent fracture of the osteotomy segment near the thin anterior maxilla. During outfracture of the infraorbital rims, meticulous care must be taken to gently free the infraorbital nerve from the infraorbital rims as they are advanced [Figure 6a and b]. Fixation is achieved with a single 2-mm L-shaped, 4-hole plate with gap at the zygomatic buttress region [Figure 6c and d]. Intra-operative photographs show the exposure, osteotomy cuts, and fixation [Figures 7a and b]. Meticulous closure of the intranasal incisions as well as layered closure of the vestibular incision should be carried out.

RESULTS

Postoperatively, the patient had appreciable fullness of the anterior maxillae, the infraorbital rims, and the zygoma anteriorly as well as laterally. The results were fairly stable 6 months postoperatively [Figures 8 and 9].

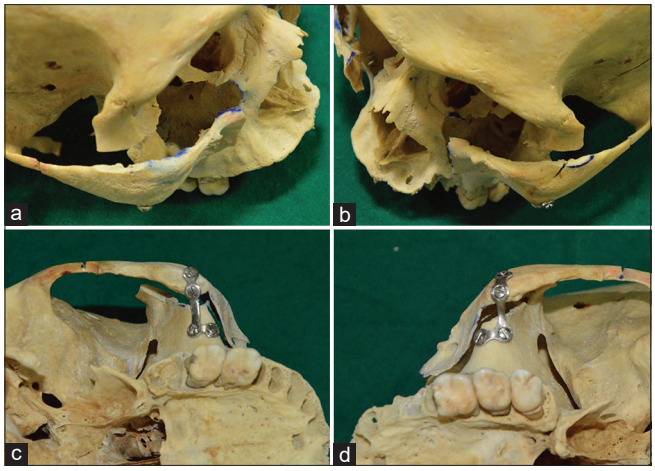

Figure 6: (a and b) Anterolateral projection of the zygoma, infraorbital rim, and anterior maxilla achieved. (c and d) Fixation is achieved with a single 2-mm L-shaped, 4-hole plate with gap at the zygomatic buttress region

Figure 8: (a and b) Preoperative and 6-month postoperative frontal clinical comparisons showing increased bizygomatic width

DISCUSSION

Various surgical modalities have been proposed for the augmentation of midface hypoplasia apart from conventional orthognathic surgery. They include autogenous bone and cartilage grafts, alloplastic materials, and osteotomies. The advantages and disadvantages of bone grafts, cartilage grafts, and alloplasts are summarized in Tables 1 and 2.[6]

Conventionally, autologous tissue has been the gold standard for midface augmentation. Bone grafts rather than cartilage grafts have been used for craniofacial bone defects.[7] Bone graft is not ideal for the orbitozygomatic region, as it is very difficult to carve a complex shape out of hard bone to get an accurate fit without palpable edges and irregularity.[8] As an onlay graft, there is an increased risk of bony resorption.[9] Calvarial bone, which is membranous in origin, has been shown to be most resistant to resorption. Membranous bone maintains its volume to a significantly greater extent than

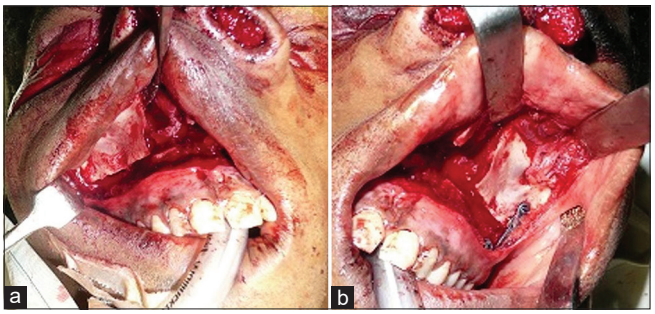

Figure 7: (a and b) Intraoperative photograph showing osteotomy cuts and fixation

Figure 9: (a-d) Preoperative (left) and 6-month postoperative (right) lateral clinical comparisons showing increased fullness at the infraorbital rims and anterior maxillae

endochondral bone when autografted in the craniofacial region. There is an increased resorption of endochondral bone grafts when compared to membranous grafts, and cranial donor sites are preferable for maxillofacial recipient areas due to the proximity of the donor site.[10] According to Staffenberg and Kawamoto,[11] lesser degrees of flattening of the malar eminence may be camouflaged with various alloplastic implants or autogenous tissue, but their choice for camouflage was split calvarial bone.

Costochondral graft has also been used for midface reconstruction. Costal osteocartilage has many advantages. First, the shape and thickness of the costal osteocartilage make it a suitable material for performing inferior orbital augmentation. Second, costal osteocartilage is adequate in volume and easy to harvest. Third, it can be harvested simultaneously during dissection of the facial skeleton, which reduces operating time.[12] Some authors consider cartilage as the graft of choice for orbitozygomatic reconstruction owing to its ease of carving a complex graft shape.[9] There is always a concern of bone resorption; however, Kim *et al*.[13] and others reported that costal bone grafted on the facial area maintained its volume even after a 17-year follow-up of their case.

Table 1: Comparison of bone and cartilage grafts

Graft materials	Advantages	Disadvantages
Bone (calvarial)	Least resorption among bone grafts (due to membranous origin) Ideal for large reconstruction	Difficulty with shaping and carving Palpable edges and irregularity Donor-site morbidity
Rib cartilage	Ease of carving and shaping Less resorption than bone owing to relative avascularity and decreased oxygen demand	Useful only for smaller reconstructions Donor-site morbidity

Perfect adaptation of the graft to the orbitozygomatic contour and with a smooth bevel is often difficult to achieve. The onlays must be symmetrically tailored, and adequate fixation is necessary to prevent dislocation and asymmetry. The nature of the onlay provides its own specific problems. An infected wound promotes resorption of auto-, homo- and heterografts. Remodeling and resulting asymmetry can also occur without apparent infection.[1] Although alloplastic implants have been advocated for volume and contour restoration of complex bony defects, they carry significant risks of infection,[7,14,15] slippage,[7,8,14] and extrusion.[8,14]

Freihofer and Borstlap[16] compared onlay grafting with osteotomy for the reconstruction of the zygomatic area. They compared the long-term results of onlay grafting with split ribs or calvarial grafts with osteotomy techniques. They found that the long-term results achieved in cases treated with onlay techniques were esthetically inferior to the cases treated by osteotomy.

Osteotomy to augment the midface obviates all the disadvantages of autogenous or alloplastic grafting. Various modifications of the zygomatic "sandwich" osteotomy for esthetic enhancement of the zygoma have been published. Jones and Ching[17] proposed an inferior osteotomy cut at a LeFort I level, a vertical cut lateral to the infraorbital nerve including the infraorbital margin, and a superior cut inside the infraorbital margin to include the body of the zygoma. Their technique was essentially similar to Mommaerts' osteotomy except that the horizontal cut involved the infraorbital margin. Layoun *et al*.[18] modified Mommaerts technique to propose a malar osteotomy with graft interpositioning. The vertical osteotomy was performed from the maxillomalar buttress, cutting off both the anterior and posterior sinus walls, stopping 10 mm outside the infraorbital nerve and 10 mm below the

Table 2: Comparison of different alloplastic materials

Materials	Advantages	Disadvantages
Silicone (vulcanized dimethylsiloxane polymer)	Adaptable nonporous rubber Resistant to enzymatic breakdown and autoclaving No tissue immunogenicity	Do not allow for tissue ingrowth and incite the capsular formation Implant may be easily displaced in the immediate postoperative period May be prone to deformation over time from tissue contraction
e-PTFE (Gore-Tex)	Pore sizes of 10-30 μm allow for a small amount of tissue ingrowth that helps in stabilization Easily accepted by well-vascularized tissue No tissue toxicity or immunogenicity Implant removal not difficult as minimal tissue ingrowth	Not adequately rigid
High-density porous polyethylene (Medpor)	The pore size of 125-250 μm allows a high degree of tissue ingrowth resulting in rapid implant stabilization Reduced incidence of implant infection owing to adequate vascularization of the implant–soft-tissue interface Easily carvable and moldable	Implant removal difficult owing to a high degree of tissue ingrowth

e-PTFE: Expanded polytetrafluoroethylene

infraorbital rim. Su *et al*.[19] changed the vertical osteotomy line of Mommaerts to a moderately oblique L-shaped one on the zygomaxillary suture to maintain closure of the maxillary sinus. They used natural coral as interpositional graft material with rigid fixation. According to them, since the elasticity of the expanded zygoma was not reliable all the time, the bone substitute was placed into the osteotomy gap to prevent interposition shift and nonunion. In our technique, interposition with a graft material after osteotomy was avoided owing to risk of migration of graft into the antrum. Layoun *et al*.[18] reported coral graft migration into the antrum after a similar malar osteotomy procedure despite rigid fixation.

Our osteotomy technique bestows fullness and projection to the maxillary and zygomatic regions in the anterior as well as lateral dimensions. Osteotomy lends more stability than onlay grafting with more predictable long-term results. We had fairly stable posteropative results with this technique. In order to minimize the risk of injury to the infraorbital nerve in this technique, the osteotomy cuts with the bur at the infraorbital rim are done only through the cortical bone. Once all the bony cuts are over, gentle tapping with fine sharp osteotomes (3 or 4 mm) at the infraorbital rim is carried out through the cancellous bone and all around the margins of the infraorbital foramen to complete the osteotomy, while continuously protecting the nerve with a broad end of a periosteal elevator. Once this is done, the bony segments can be gently sleeved over the nerve. Caution must also be exercised to prevent herniation of the periorbital fat present behind the orbital septum as the osteotomy runs along the orbital floor. As long as the dissection of the periorbita is in a subperiosteal plane subperiosteal without violating the integrity of the orbital septum, any orbital complication can be avoided. During elevation of the osteotomized segment at the anterior maxilla near the piriform aperture, extreme care must be taken to prevent fracture of the bone which is very thin at these regions. The complications associated with the midface degloving approach are nasal cartilage distortion, nasal vestibule stenosis, and oronasal communication,[5] which can be avoided with careful dissection around the cartilages and meticulous re-approximation of the nasal mucosa. A layered watertight closure of the vestibular incision in our technique minimizes any sinus-related complication.

Proper case selection is vital before utilizing this osteotomy technique. The patient must demonstrate midface deficiency of the anterior maxillae, the infraorbital rim, the zygoma, and the paranasal areas without occlusal discrepancy.

CONCLUSION

The zygomaticomaxillary "lateral swing" osteotomy is a novel, versatile, and stable technique for esthetic augmentation of the midface including the infraorbital rims, the zygoma, the anterior maxilla, and the paranasal areas, not requiring occlusal correction. It accentuates anterior as well as lateral facial fullness.

Declaration of patient consent

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

Acknowledgments

Line diagrams courtesy of Dr. Vidya Devi, MDS (OMFS). E-mail: vidya.devi.vuyyuru@gmail.com.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Mommaerts MY, Abeloos JV, De Clercq CA, Neyt LF. The 'sandwich' zygomatic osteotomy: Technique, indications and clinical results. J Craniomaxillofac Surg 1995;23:12-9.
2. Van Sickels JE, Tiner BD. A combined le fort I and bilateral zygomatic osteotomy for management of midface and maxillary deficiency. J Oral Maxillofac Surg 1994;52:327-31.
3. Mommaerts MY, Nadjmi N, Abeloos JV, Neyt LF. Six year's experience with the zygomatic "sandwich" osteotomy for correction of malar deficiency. J Oral Maxillofac Surg 1999;57:8-13.
4. Bettens RM, Mommaerts MY, Sykes JM. Aesthetic malar recontouring: The zygomatic sandwich osteotomy. Facial Plast Surg Clin North Am 2002;10:265-77.
5. Kitagawa Y, Baur D, King S, Helman JI. The role of midfacial degloving approach for maxillary cysts and tumors. J Oral Maxillofac Surg 2003;61:1418-22.
6. Soares DJ, Silver WE. Midface skeletal enhancement. Facial Plast Surg Clin North Am 2015;23:185-93.
7. Toth BA, Ellis DS, Stewart WB. Computer-designed prostheses for orbitocranial reconstruction. Plast Reconstr Surg 1988;81:315-24.
8. Binder WJ, Kaye A. Reconstruction of posttraumatic and congenital facial deformities with three-dimensional computer-assisted custom-designed implants. Plast Reconstr Surg 1994;94:775-85.
9. Lee SJ, Lee HP, Tse KM, Cheong EC, Lim SP. Computer-aided design and rapid prototyping-assisted contouring of costal cartilage graft for facial reconstructive surgery. Craniomaxillofac Trauma Reconstr 2012;5:75-82.
10. Zins JE, Whitaker LA. Membranous versus endochondral bone: Implications for craniofacial reconstruction. Plast Reconstr Surg 1983;72:778-85.
11. Staffenberg AD, Kawamoto HK Jr. Revisional surgery for midface fractures: Malocclusion and malposition. Operat Tech Plast Reconstr

Surg 1998;5:302-11.
12. Song H, Park MC, Lee IJ, Park DH. Correction of infraorbital and malar deficiency using costal osteochondral graft along with orthognathic surgery in crouzon syndrome. J Craniofac Surg 2014;25:e449-51.
13. Kim T, Han J, Lee Y. Onlay rib bone graft in elevation of reconstructed auricle: 17 years of experience. Arch Plast Surg 2013;40:209-13.
14. Cuzalina LA, Hlavacek MR. Complications of facial implants. Oral Maxillofac Surg Clin North Am 2009;21:91-104, vi-vii.
15. Miyasaka M, Tanaka R, Hanai U, Yamazaki A, Iida M, Akamatsu T. A case of chronic infection 28 years after silicone orbital implant. Tokai J Exp Clin Med 2008;33:35-8.
16. Freihofer PM, Borstlap WA. Reconstruction of the zygomatic area. A comparison between osteotomy and onlay techniques. J Craniomaxillofac Surg 1989;17:243-8.
17. Jones RH, Ching M. Intraoral zygomatic osteotomy for correction of malar deficiency. J Oral Maxillofac Surg 1995;53:483-5.
18. Layoun W, Guyot L, Richard O, Gola R. Augmentation of cheek bone contour using malar osteotomy. Aesthetic Plast Surg 2003;27:269-74.
19. Su R, Gui L, Liu J, Niu F, Chen Y, Wang M. Unilateral zygomatic hypoplasia correction by L-shaped zygomatic osteotomy with natural coral. J Craniofac Surg 2015;26:914-7.