Review Article

# Access Osteotomy in the Maxillofacial Skeleton

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## Abstract

Surgical accesses for the facial skeleton are based on the concept of modular osteotomies. Various techniques and combination of osteotomies facilitate access to the most inaccessible tumors of craniomaxillofacial region. Most appropriate surgical access is determined by considering size, location, extension of the tumor, and experience of the surgical team. These are primarily used for tumors in the nasopharynx or the skull base. The aim of this paper is to review surgical accesses that aid in removal of inaccessible tumors of craniomaxillofacial region with series of cases operated in the Department of Oral and Maxillofacial Surgery, Armed Forces Medical College, Pune, India, between July 2008 and June 2010. The surgical approaches constituted of transfacial, transoral, lip-split mandibulotomy and modified osteotomy of the orbital rim in cases of juvenile nasoangiofibroma, squamous cell carcinoma of the base of the tongue, orbital floor tumour respectively. Only 3 cases (33.33%) reported with postoperative paresthesia of the infraorbital region and mandibular symphysis region which resolved in 6 months. None of the patients presented with occlusal discrepancy, neuromotor deficit or sign of recurrence in the follow up period of one year.

**Keywords:** Juvenile angiofibroma, Le Fort I osteotomy, mandibulotomy, squamous cell carcinoma, transfacial approach

## Introduction

Craniofacial skeleton can be regarded as an osteoplastic structure as its excellent blood supply allows mobilization and replacement of bone fragment either pedicled on their soft tissues or as free segments. The management of malignant tumors requires resection of the primary tumors with negative margins and accessibility to these pose a great challenge to the surgeon. Von Langenbeck in 1859 was the first to access a tumor in the nasopharynx using a horizontal osteotomy at the level of the fracture line later described as Le Fort I in 1901.

There is a multitude of surgical accesses for the facial skeleton based on the concept of modular osteotomies that are primarily used for the removal of tumors from nasopharynx or the skull base.[1] The surgical approaches involving the disarticulation of the craniofacial skeleton aimed at providing increased and more direct exposure of both the pathology and the surrounding structures while avoiding the need to resect the uninvolved structures. Three-dimensional access to skull base tumors is obtained by wide soft-tissue exposure and selective osteotomy and removal of parts of the facial skeleton.[2] Location and extension of the tumor and the experience of the surgical team are important factors when choosing the appropriate surgical approach. The most frequently used surgical routes through the maxilla include transpalatal, Le Fort I maxillotomy, medial maxillotomy, facial translocation, infratemporal, intranasal endoscopic approaches, and midfacial degloving.[3] The aim of this paper is to review the surgical access used to aid in the removal of inaccessible tumors of the craniomaxillofacial region performed in Armed Forces Medical College (AFMC), Pune.

## Materials and Methods

In this study, 6 cases of benign and malignant tumors of the craniomaxillofacial region surgically removed through the access osteotomies of midface and mandible in the Department of Oral and Maxillofacial Surgery, AFMC, Pune, India, between July 2008 and June 2010 have been reviewed. Among the 6 cases, there were 4 cases of Juvenile nasopharyngeal angiofibroma (JNA) of which 1 was a recurrent case; 1 case of squamous cell carcinoma of the

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base of the tongue; and 1 case of orbital floor tumor. Out of the 6 patients, 4 (66.67%) were male, and 2 (33.33%) were female. The age range of the patients varied between 19 and 49 years with a mean average age of the patients being 34 years [Table 1]. All cases were operated by a team comprising maxillofacial surgeons, oncosurgeons, and otorhinolaryngologists.

All patients were evaluated with a complete medical history, clinical and radiological examination which included a complete oncological and otorhinolaryngological examination. Computed tomography scans and magnetic resonance imaging were taken for all patients to assess the exact anatomical location of the lesion [Figure 1]. Angiography and preoperative embolization were performed 24–72 h before surgery in all JNA cases.

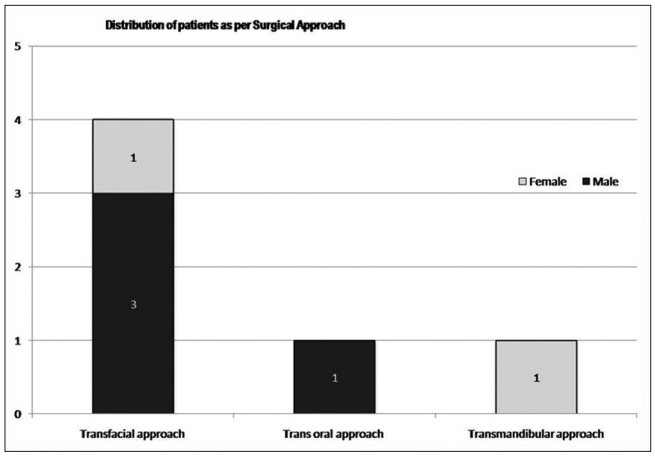
## Surgical technique

All cases were operated under general anesthesia through oral endotracheal intubation except in the case of squamous cell carcinoma of the base of the tongue where a nasal intubation was used. The specific approaches for individual cases are as shown in Table 1. Prefabricated acrylic splints were made for all cases undergoing maxillary and mandibular swing.

**Table 1: Specific approaches for individual cases**

| Type of surgical procedure | Number of patients | Sex (year) | Diagnosis |
|---|---|---|---|
| Transfacial approach with maxillary swing | 2 | Male (19 yrs and 32 yrs) | JNA of nasopharynx left side |
| Transfacial approach with maxillary swing | 1 | Male (23 yrs) | Recurrent JNA of nasopharynx, left side |
| Transfacial approach with osteotomy of the infraorbital rim | 1 | Female (39 yrs) | Orbital floor tumor, right side |
| Transoral approach with Le Fort I osteotomy | 1 | Male (49 yrs) | JNA of nasopharynx, left side |
| Lip split mandibular osteotomy with mandibular swing | 1 | Female (45 yrs) | Squamous cell carcinoma of the base of the tongue, right side |

JNA = Juvenile nasopharyngeal angiofibroma




In facial translocation approach, a standard Weber–Fergusson (WF) incision was given with a lateral Diffenbach extension along the lower eyelid curving inferiorly at the lateral canthus within a natural skin crease as close as possible (1–2 mm) to the lower eyelashes [Figure 2]. Subperiosteal dissection was kept to a minimum to retain a maximum blood supply to the bone segments that are to be osteotomized. Intraorally, the incision was taken vertically through the alveolar mucosa between the upper central incisors and extended palatally in the midline and curving laterally from the junction of the hard and soft palate behind the maxillary tuberosity [Figure 3].

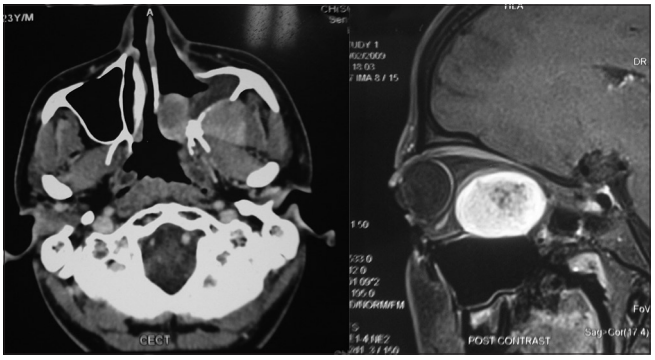



**Figure 1:** Contrast enhanced location of lesions

**Figure 2:** Facial translocation approach

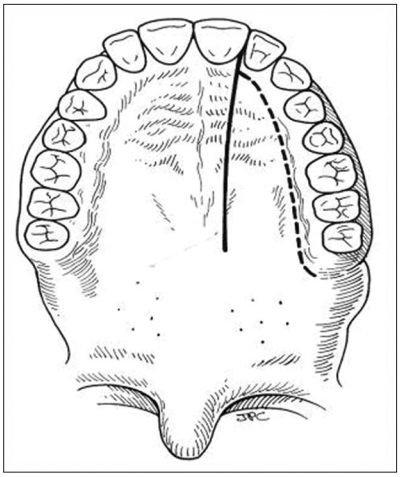


**Figure 3:** Intraoral incision extended palatally in the midline and curving laterally

For the purpose of achieving accurate anatomical reduction of the out fractured segments, low-profile titanium miniplates were adapted, and pilot holes were made in the region of the anterior maxilla, frontal process of the maxilla, and lateral orbital rim.

Osteotomy cuts were made using fine reciprocating saw with copious saline irrigation. The nasal mucosa was elevated to permit the osteotomy of the nasal floor. Protection to the nasolacrimal duct was ensured as the osteotomy was done from the piriform fossa to infraorbital rim. The osteotomy was extended to the lateral orbital wall just below the frontozygomatic suture. Sectioning of the zygomatic arch was carried out at the junction between body and arch. Finally, the osteotomy was completed through the floor of the orbit immediately posterior to the infra orbital rim. A unilateral pterygomaxillary disjunction was performed in osteotomized module at the intended side. The maxilla and the zygomatic complex were outfractured pedicled to the soft tissue of the cheek. The infraorbital nerve is sectioned whenever found preventing an adequate lateral movement. Excellent exposure of the soft palate and nasopharynx could be achieved, and the tumor was excised and submitted for histological analysis [Figure 4]. Electrocoagulation was judiciously used to achieve hemostasis and a clear operating field.

In the transmandibular approach, a full thickness vertical incision was placed in the midline to divide the lower lip and chin. The incision was curved downward from the midpoint of the submental fold to the level of hyoid bone and curved upward to the mastoid process. Skin flap was raised in subplatysmal plane, and sternomastoid and posterior belly of digastric was retracted medially. The carotid sheath was exposed at the level of carotid bifurcation, and internal jugular vein and vagus nerve were identified. The involved submandibular gland was also removed [Figure 5]. Intraorally, incision was made through labial and attached mucosa. A full-thickness flap was raised adjacent to the planned osteotomy site approximately one tooth width on either side. Before osteotomy of mandible, titanium miniplates were adapted, and holes were made to aid in reapproximation. Paramedian mandibulotomy osteotomy cuts were placed in the mandible with reciprocating saw. Following division of the mandible, intraoral dissection was extended along the floor of the mouth lateral to submandibular duct dividing the oral mucosa and mylohyoid muscle. An adequate cuff of mucosa was left intact in the lingual aspect of mandible for wound closure. The hemimandible was retracted laterally, and excellent access was achieved to the floor of the mouth, base of tongue, tonsillar fossa, soft palate, and oropharynx [Figure 6]. Tumor was excised with safe margins, and the specimen was preserved for the purpose of histopathological study.

A similar transfacial approach was carried out in the case of orbital floor tumor. Osteotomy was done superiorly in the infraorbital rim with two limiting osteotomy cuts on the medial and lateral aspect. The inferior osteotomy cut was placed 2 mm superior to the infraorbital foramen, thus creating a window to achieve access for removal of the tumor [Figure 7]. Titanium mini plates were adapted, and holes were made for reapproximation before downfracturing the osteotomized segments [Figure 8].

A conventional Le Fort I osteotomy of maxilla was done with intraoral vestibular incision and osteotomy cuts were placed in the Le Fort I level and pterygomaxillary disjunction was done in one case of JNA. Maxilla was downfractured, and removal of the tumor was carried out [Figure 9]. The downfractured maxilla was rigidly fixed in the preosteotomized position using titanium miniplates and screws, both in the pyriform region and the zygomatic buttress region followed by surgical wound closure. Temporary intermaxillary fixation was done before rigid fixation to prevent postoperative occlusal discrepancies.

In procedures where outfracturing of the osteotomized modules done, prefabricated acrylic palatal splints were used to avoid tilting of the segments. Occlusion was achieved with intermaxillary fixations using the IMF screws/arch bars. The osteotomized segments were rigidly fixed using the prelocated pilot holes with titanium mini-plates and screws. Intermaxillary fixation was released, and occlusion was verified. Finally, the surgical wounds were primarily closed. All patients were kept under nasogastric tube feed for the next three postoperative days. Postoperative recovery and healing were uneventful in all cases.

## Results

Out of 4 cases of juvenile nasoangiofibroma, 3 cases (75%) were operated through transfacial approach with maxillary swing, and 1 case (25%) was operated through a transoral approach using a Le Fort I osteotomy. One case of orbital floor tumor was approached through transfacial approach with an osteotomy on the infraorbital rim only. One case of squamous cell carcinoma of the base of the tongue was approached with a lip-split mandibular osteotomy and mandibular swing.

Excessive or uncontrollable blood loss was not encountered in any of the cases; hence, perioperative transfusion of blood or blood substitutes was not required. Out of the 3 cases who underwent maxillary swing through transfacial approach, 2 cases (66.66%) reported with postoperative paresthesia of the infraorbital region on the operated side. Patient who had undergone mandibular swing approach also developed paresthesia of the lower lip on the operated side. There was no occlusal discrepancy or neuromotor deficit elicited in any of the patient.

One out of the four operated cases of juvenile nasoangiofibroma underwent postoperative radiotherapy. Similarly, the same was with the operated case of squamous cell carcinoma of the base of the tongue. A follow-up period of 6 months to 1 year showed satisfactory esthetic results with the resolution of the paresthesia with no clinical or radiological sign of recurrence in any of the cases.

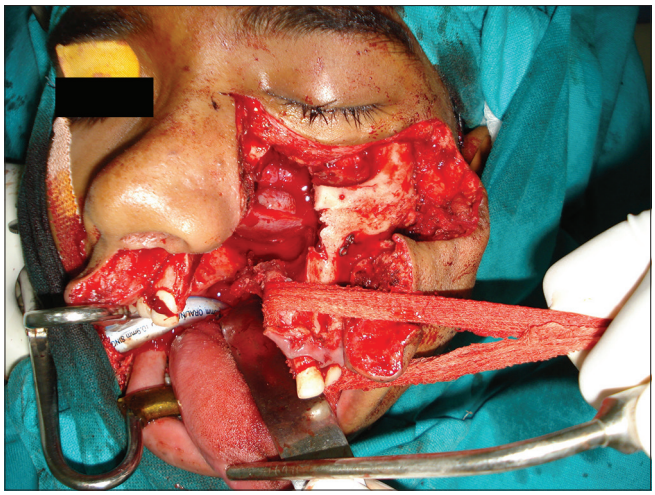


**Figure 4:** Outfractured maxilla providing excellent exposure of the soft palate and nasopharynx

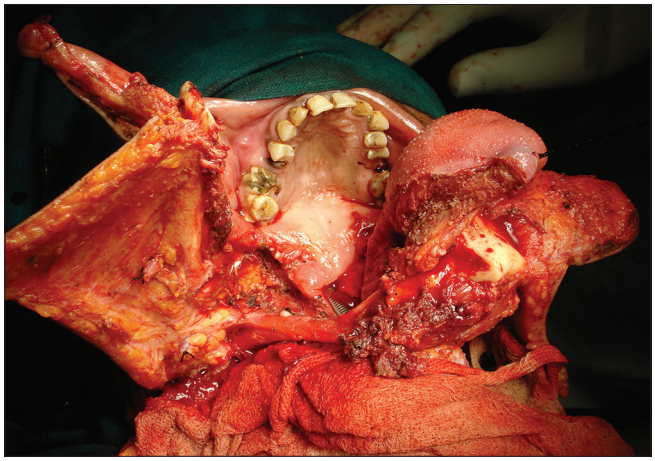


**Figure 6:** Hemimandible retracted laterally providing excellent access

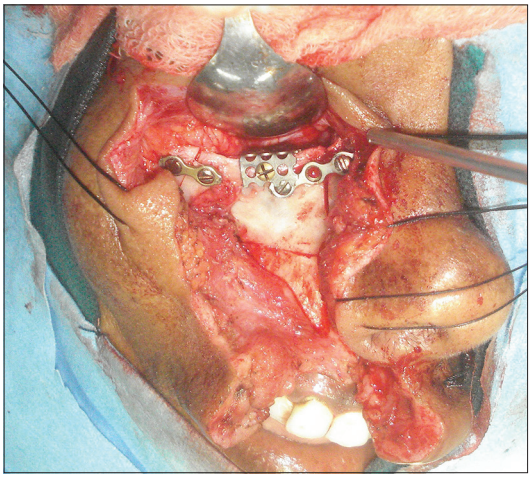


**Figure 8:** Access window reapproximation done with titanium plates and screws

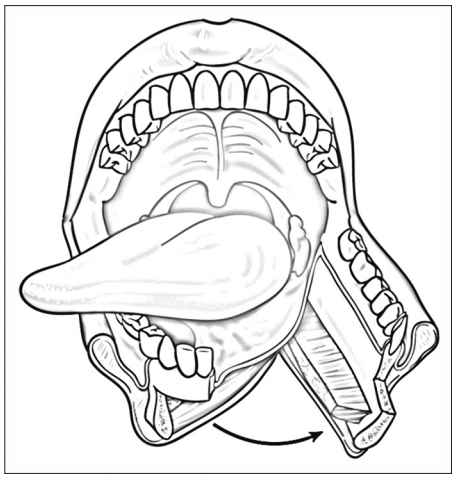


**Figure 5:** Transmandibular approach

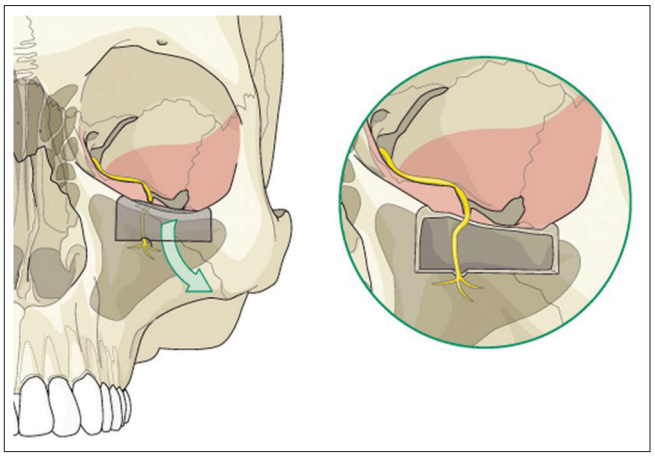


**Figure 7:** Modified osteotomy with medial and lateral cuts

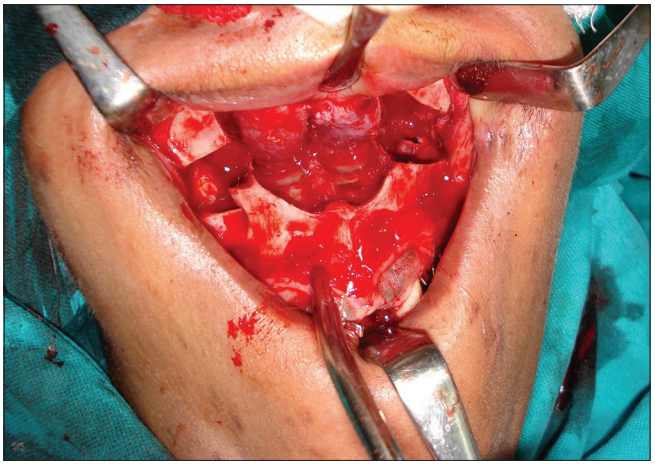


**Figure 9:** Le Fort I osteotomy of maxilla

## Discussion

Surgical exposure and accessibility play an important role in the removal of any oral or oropharyngeal tumor. A variety of procedures have been described to approach tumors of the oral cavity and oropharynx which include transoral resection, lateral pharyngotomy, median (transhyoid) pharyngotomy, submental approach, median and paramedian mandibulotomy with paralingual extension; modified mandibular swing procedure, lateral mandibulotomy, lateral segmental mandibulectomy,

medial labiomandibular glossotomy, visor flap approach, lower cheek flap, and mandibular lingual releasing approach.[4]

The term "transfacial" has been employed to describe any procedure that mobilizes the midface through a facial incision irrespective of the extent of midface disassembly employed.[5] These approaches improve surgical access to nasal cavity, maxillary, ethmoid and sphenoid sinuses, soft palate, nasopharynx, infratemporal, and parapharyngeal space and may be extended to provide access to the anterior and middle cranial fossa, cavernous sinus, craniocervical junction, and upper cervical vertebrae.[2] The most commonly used transfacial approach to midface for the resection of maxillary tumors is the WF incision. The major limitation for using the WF incision is that it does not improve access when the tumor involves the posterior aspect of maxilla and/or the pterygoid plates.[1]

To avoid an unesthetic scar, Altemir described that incision to be placed along the philtrum carrying the lip extension with a slight step away and placing a chevron in vermilion portion of the incision. The superior extent of the lip incision should be performed into the nasal sill and then extended out along the base of the ala in a cephalad direction. The lateral nasal incision should be placed in the nasal side wall at the junction of nasal subunit. Then, the incision may be extended laterally inferior to the lower eyelid in one of the creases or extended superiorly into a lynch extension.[1]

In our case of orbital floor tumor, the need for an extensive osteotomy and outfracturing of the entire maxilla on the ipsilateral side was avoided using a modification and osteotomizing only the infraorbital rim similar to a trapdoor [Figure 7]. No difficulty in removal of the tumor mass was encountered. In addition, we observed that when the principles of wound closure are strictly adhered and meticulously done even a midline incision would yield an esthetically acceptable scar.

An alternative approach to maxillary tumors can be done performed with use of the midface degloving technique.[6] The technique incorporates the use of vestibular and intranasal incisions to lift or "deglove" the facial skin from the facial skeleton, improving the access to the maxillary tumor. The transoral approach with Le Fort I osteotomy pioneered by Archer and Utley is particularly used in the removal of juvenile nasopharyngeal angiofibroma and provides excellent exposure for tumors that invade the ethmoid roof, superior septum, cribriform plate, and sphenoid sinus area.[7] Because of the restricted mobilization imposed by the vascular supply to the downfractured maxilla and restriction of the lateral access imposed by the presence of pterygoid plates, it poses limited role in the removal of tumors in the midface and skull base such as chondromas and structural abnormalities of the craniocervical junction.[2] Therefore, the Le Fort I osteotomy provides adequate access to the tumors of nasopharynx with no postoperative disfigurement if properly planned and executed and also there is no need for an extraoral incision.

Salins described a trans naso-orbito-maxillary approach using a combination of Le Fort I osteotomy with mandibulotomy as a relatively simple and versatile technique for the removal of extensive anterior and middle skull base tumors.[8]

Transmandibular approach provides access to the floor of the mouth; tongue particularly the mid and posterior thirds, tonsillar fossa, soft palate, oropharynx, pterygomandibular region, pterygoid space, infratemporal fossa, and parapharyngeal space.[9] Attia & co-workers in 1984[12] modified this technique to increase the access to the parapharygeal space, infratemporal fossa and pterygomaxillary region up to the skull base using a secondary osteotomy of the mandibular ramus above the level of lingula. Other modifications by various authors include lateral osteotomies with inverted "L" or "C" osteotomy of mandible in the angle and ramal region through a cervical approach without division of lower lip.[2] The use of two osteotomies allows for superior and lateral displacement of the mandibular segment without disturbing temporomandibular joint and provides excellent access to tumors with deep, superior, and medial parapharyngeal extension.[10]

A combination of the WF approach with a lip-splitting mandibulotomy approach referred to as the posterior maxillary approach are useful in the removal of large tumor that extends anteriorly, superiorly, and posteriorly with extension toward the pterygoid plates or the infratemporal fossa.[1]

The mandibular lingual releasing approach described by Slaughter (1951) and McGregor (1994)[1] as pull-through technique has shown to produce postoperative complications such as restriction of the tongue movements, speech, and swallowing disturbance. The indication of the pull-through approach is only when both the primary tumor and the lymphatics need to be removed as a single-block specimen.[7]

The visor flap can be used as an alternative to the pull-through technique for resection of tumors involving the anterior oral cavity. The drawback of this technique is the sacrifice of the mental nerve, leading to anesthesia of the lip and chin. This can be avoided by placing osteotomies distal to the mental foramen have been described. Kolokythas and Eisele described the use of a lingual splint to assist in three-dimensional control of the segmented mandible and interocclusal elastics to correct postoperative occlusal changes after mandibular osteotomies.[9]

Adequate soft-tissue closure is as important for a successful outcome as the type of osteotomy and fixation method applied. Geir and Morten reported with a special reference to radionecrotic complications and recommended the extraction of the incisors for easier and safer tissue adaptation, especially when flaps are used for coverage, and the osteotomy site will be included in the radiation field.[11]

## Conclusion

Surgical access is the primary difficulty in resection of inaccessible tumors of craniofacial region. Multiple techniques

and combination of osteotomies have been employed to facilitate the access of these tumors. The most appropriate surgical approach must be determined considering size and location of the tumor, extension to adjacent structures, and experience of the surgical team. In our study, various time-tested approaches such as the transfacial maxillary swing, lip-split mandibulotomy, and Le Fort I proved to be successful in providing excellent access to most of the inaccessible tumor of the craniomaxillofacial region and are also versatile and flexible allowing a greater degree of modifications whenever required yielding good results. Any technique of access osteotomy can be done with good esthetic and functional results with proper preop planning, instrumentation, and regular follow-up.

## 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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Nil.

## Conflicts of interest

There are no conflicts of interest.

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