Evaluation of facial nerve function following surgical approaches for maxillofacial trauma

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Purpose: The aim of this study was to report facial nerve injury following extraoral surgical approaches for the treatment of maxillofacial trauma, using the House–Brackmann facial nerve grading system (HBFNGS) as a means of classifying and measuring the degree and type of injury.

Materials and Methods: The sample comprised 100 consecutive cases of various maxillofacial trauma in which extraoral surgical approaches were used. Variety of surgical approaches such as coronal, preauricular, endaural, retromandibular, and submandibular approach and its modifications were used based on the anatomic location of the fracture and the accessibility required for its reduction and fixation. Facial nerve function of all patients was evaluated preoperatively and 24 hours after surgery. Patients who presented postoperative facial nerve injury were likewise examined using the HBFNGS at 24 hours, 1 week, 1 month, 3 months, and 6 months. Results: Of the 100 patients, temporofacial branch involvement was seen in 11 cases, whereas cervicofacial branch involvement was seen in 6 cases. Complete recovery of the temporofacial branches was seen in a period of 3–4 months; whereas cervicofacial branches recovered in 5–6 months postoperatively. Conclusion: The frequency of facial nerve injury was related to various surgical approaches in maxillofacial trauma. Facial nerve impairment was found to be temporary in all cases, although the recovery of cervicofacial branches took a longer time. Moreover, there is a need to standardize the reporting of facial nerve recovery.

Keywords: Facial nerve, House–Brackmann facial nerve grading system, maxillofacial trauma

INTRODUCTION

A myriad of surgical approaches have been designed in the management of maxillofacial trauma, predominated by intraoral approaches. Multiple/comminuted fractures due to high-velocity trauma necessitate various extraoral approaches for adequate reduction and fixation. Various extraoral approaches have been designed over the years to provide adequate access to treat various traumatic afflictions of the maxillofacial region. The facial nerve is at risk during these surgical procedures and it is difficult to provide adequate exposure without causing injury. Facial nerve impairment following various surgical approaches to the maxillofacial region range from 0% to 48%. The measurement of facial nerve function in a consistent, reliable manner is an important but elusive goal due to the inherent complexity of facial nerve physiology. Not only does the nerve control multiple motor regions of the face but also it controls special functions such as lacrimation, salivation, and taste. The major problem in evaluating the results of facial nerve injury lies in the subjective methods of assessment and reporting. The House–Brackmann facial nerve grading system (HBFNGS) was introduced in 1983 for clinical use and was modified by Brackmann in 1985. The HBFNGS is a gross subjective scale that considers overall facial function and assigns patients to six categories on the basis of their degree of facial nerve dysfunction. This system intentionally takes into account facial expression at rest and in motion as well as the presence of secondary defects. The literature shows rates of interobserver reliability of 93% among the different evaluators.
The aim of this prospective study was to evaluate the facial nerve injury following extraoral surgical approaches to the maxillofacial skeleton in trauma patients, using the HBFNGS as a means of classifying and measuring the degree and type of injury.

MATERIALS AND METHODS

The sample comprised 100 consecutive cases reported to a center for various maxillofacial trauma in which extraoral surgical approaches [Figure 1] were used. The study included 88 male and 12 female patients. The mean age of the patients was 28.75 years (range 16–68 years). The study was conducted between January 2008 and January 2010 at a tertiary care service hospital.

The cases involved fractures of zygomatic complex, mandibular fractures (body, angle, ramus, and condyle), frontal bone fractures, combined frontal bone and nasoorbitoethmoidal (NOE) fractures, and cases of panfacial trauma. Variety of surgical approaches such as coronal, preauricular, endaural, retromandibular, and submandibular approach and its modifications were used based on the anatomic location of the fracture and the accessibility required for its reduction and fixation [Table 1 and Graph 1].

Patients were evaluated immediately postoperatively to assess the involvement of the peripheral branches of the facial nerve. Facial nerve involvement was classified as involving the five peripheral branches of facial nerve [Table 2] and graded in severity according to the HBFNGS scale [Table 3]. Patients who presented with postoperative facial nerve injury were similarly examined using the HBFNGS, at 1 week, 1 month, 3 months, and 6 months to assess the degree of improvement or deterioration [Table 4]. Facial nerve function of all patients was evaluated by the same set of examiners preoperatively, postoperatively, and during the follow-up period.

For analysis of the data, absolute and percentage distributions were obtained. Fisher’s exact test (using the approximation of Katz) was used to compare the relative risk of facial nerve involvement. The program used for obtaining the statistical calculations was SPSS (Statistical Package for Social Science; SPSS Inc, Chicago, IL) Version 13.0 for Windows. A P value of ≤ 0.05 was taken as significant.

RESULTS

Hundred cases of maxillofacial trauma in which extraoral approaches were used were evaluated postoperatively for involvement of peripheral branches of facial nerve.

Trauma involving the zygomatic complex formed the predominant number of the cases in the study [56%]. Coronal approach was used in all these cases to reduce and stabilize these fractures. Involvement of temporal branch was seen in 6 of the 56 cases immediately postoperatively (10.7%). Four of the cases were in grade III and 02 cases had grade II involvement immediately postoperatively. Zygomatic branch involvement [Figure 2] was seen in 3 of the cases (5.3%). There was grade III involvement in 2 cases and grade IV involvements in 1 case each in immediate postoperative period. Combined involvement of the temporal

![Figure 1: Various surgical approaches for maxillofacial trauma](image1)

![Graph 1: Distribution of surgical approaches based on the anatomic location of the fracture](image2)

| Fracture location          | No | Coronal | Approach | Retromandibular | Preauricular | Endaural | Multiple approaches |
|----------------------------|----|---------|----------|-----------------|--------------|----------|---------------------|
| Zygomatic complex fractures| 56 | 56      | -        | -               | -            | -        | -                   |
| Mandibular fractures (body, angle, ramus, condyle) | 36 | -       | 12       | 20              | 03           | 01       |                     |
| Frontal bone fractures,    | 03 | 03      | -        | -               | -            | -        | -                   |
| Frontal bone + NOE fractures| 02 | 02      | -        | -               | -            | -        | -                   |
| Panfacial trauma           | 03 | -       | -        | 20              | 03           | 01       | 03                  |
| Total                     | 100| 61      | 12       | 20              | 03           | 01       | 03                  |

*Fisher’s exact test, Relative risk = 0.6087*
and zygomatic branches was seen in 2 cases (3.5%) and was classified as involving the zygomatic branch. Isolated frontal bone fractures (3%), combined frontal bone and NOE fractures (2%) were also treated using coronal approach. There were no signs of postoperative facial nerve involvement in any of these five cases.

In cases of mandibular angle and body fractures (12%), submandibular approach and its modifications were used. Involvement of the marginal mandibular nerve [Figure 3] was seen in 2 of the 12 cases (16.6%). There were grade II and III involvements in 1 case each immediately post surgery. Condylar fractures were treated using retromandibular approach in 20 of the 24 cases (20%). There was grade III involvement of the marginal mandibular nerve in two of the cases (10%) and buccal branch in one of the cases (5%). Four cases of high condylar fractures in which preauricular (Rowe’s modification) and endaural approaches were used showed no facial nerve involvement. Combined coronal and retromandibular approaches were used in all three cases of panfacial fractures. Grade III involvement of the marginal mandibular nerve and the zygomatic branch was noticed in one case each.

A significant association was found between various surgical approaches used to access the maxillofacial fractures and the risk of facial nerve involvement (relative risk 0.6087). A two-sided P value of 0.0479 was obtained which was considered statistically significant.

There was gradual recovery of function of these branches during a period of 5–6 months postoperatively. Cases of temporal and zygomatic branch involvement (11 cases) showed a gradual recovery during a period of 3–4 months [Figure 4] characterized by symmetric wrinkling of the forehead and closure of the upper eyelid with minimal effort. Complete recovery of the marginal mandibular nerve [Figure 5] was noticed in all the cases during a period of 5–6 months postoperatively characterized by a symmetric smile. One of the cases in which the buccal branch was involved showed a complete recovery in a period of 3 months.

**DISCUSSION**

High-velocity injuries in the maxillofacial region necessitate various surgical approaches to be combined to adequately reduce and stabilize these fractures. Preparation of a surgical approach that allows a suitable exposure of the surgical field with a minimum risk of damage to the facial nerve representing a great challenge, as it requires meticulous surgical dissection, a thorough knowledge, and a precise awareness of the regional anatomy. The surgery in maxillofacial trauma is complicated by gross facial edema with distortion of anatomic landmarks; loss of surgical planes and underlying hematoma/neurological deficit that may increase the incidence of postoperative facial nerve complications. Moreover, the gross anatomic variations and the multiple innervations patterns of the peripheral branches of the facial nerve put these branches at risk during surgery.

Coronal approach was used in 64% of cases in this study, which puts the temporal branch of facial nerve at considerable risk. Involvement of temporal branch was seen in 6 of the 64 cases (9.3%), seen as asymmetric wrinkling of the forehead. Zygomatic branch involvement was seen in 3 of the cases (4.7%) characterized by inability to tightly close the upper eyelid. Combined involvement of the temporal and zygomatic branches was seen in 2 cases (3.1%). The temporal nerve lies deep to the temporoparietal fascia, and dissection in a subgaleal plane avoids the risk of injury to this branch of the facial nerve. However, over the zygomatic arch, this nerve lies in a condensation of superficial fascia, temporalis fascia, and periosteum and may be injured by any dissection technique that attempts to violate the integrity of this region. The temporal branch lies within this area of tissue condensation, on average 2 cm from the anterior concavity of the external auditory canal (range, 0.8–3.5 cm).

In all our cases to prevent any injury to the nerve concerned, the temporal fascia was incised 1 cm above the zygomatic arch root and the dissection over the zygomatic arch strictly kept in a subperiosteal plane, so that the temporal and zygomatic branches were kept in the elevated flap for protection. The zygomatic branch traverses below the zygomatic arch and ascends upward over the body of the zygoma to supply the orbital slips of the orbicularis occuli muscle. Compression/inadvertent transection

| Table 2: Assessment of motor response of facial nerve branches |
|---------------------------------------------------------------|
| Temporal branch | Ability to raise the eyebrow or wrinkle the forehead |
| Zygomatic branch | Ability to close the eyelid completely |
| Buccal branch | Blow the cheek and assess the degree of asymmetry |
| Marginal mandibular branch | Ability to smile and grin showing the teeth. Assess the degree of drooping and asymmetry of the lower lip |
| Cervical branch | Ability to taut the platysma muscle |

| Table 3: House-Brackmann facial nerve grading system measurements |
|---------------------------------------------------------------|
| Grade | Temporal | Zygomatic | Buccal | Marginal mandibular |
|---|---|---|---|---|
| I Normal | - | - | - | - |
| II Mild dysfunction | 2 | - | - | 1 |
| III Moderate dysfunction | 4 | 3 | 1 | 3 |
| IV Moderately severe dysfunction | - | 02 | - | 1 |
| V Severe dysfunction | - | - | - | - |
| VI Total paralysis | - | - | - | - |
| Total | 6 | 5 | 1 | 5 |

Table 4: Recovery of facial nerve function

| Grade | Temporal branch involvement | Zygomatic branch involvement | Buccal branch involvement | Marginal mandibular branch involvement | Cervical branch involvement |
|---|---|---|---|---|---|
| Postop | 6 | 5 | 1 | 5 | Nil |
| 1 week | 6 | 5 | 1 | 5 | Nil |
| 1 month | 4 | 2 | 1 | 3 | Nil |
| 3 months | Nil | Nil | Nil | 2 | Nil |
| 6 months | Nil | Nil | Nil | Nil | Nil |
of the zygomatic nerve or excessive stripping of the tissues along the inferior border of the zygomatic arch can result in temporary/permanent damage to this branch. In cases with temporal and zygomatic nerve injury, there was gradual improvement and return to function over a period of 3 months. Based on our results, we state that the main cause of facial nerve injury in our series was compression and/or stretching of nerve fibres, which resulted in neuropaadiaia and was caused by excessive or heavy handed retraction.

The marginal mandibular and the buccal branch of the facial nerve are at considerable risk when using extraoral approaches to access the mandibular fractures. Submandibular approach was used in all the cases of angle and body fractures (12 cases). Transient marginal mandibular involvement was seen in 2 of the 12 cases (16.66%). Condylar fractures were treated using retromandibular approach in 20 of the 24 cases. There was grade III involvement of the marginal mandibular nerve in two cases and buccal branch in one of the case. Marginal mandibular involvement was also seen in one of the three cases of panfacial trauma treated through retromandibular approach.

Injury to the marginal mandibular nerve results in a significant cosmetic deformity. The deformity is caused by interruption of nerve fibers to the depressor anguli oris and the depressor labii inferioris that results in flattening and inversion of the ipsilateral lower lip and the inability to move the lip downward and laterally. In 5 cases (14.2%), we have noticed transient involvement of the marginal mandibular nerve. Mehra P\textsuperscript{8} comparing the results of intraoral and extraoral approaches to mandibular angle fractures have described transient facial nerve weakness in 13 of the 57 patients (23%) in the extraoral group with clinical recovery within 7 months of injury. Various authors\textsuperscript{9,10} have reported an incidence of 10–11% transient facial nerve injury following retromandibular, postparotid approach to the condylar fractures with a gradual improvement and return to function over a period of 6 months. Our results are comparable to the above two studies. However, unlike the temporofacial divisions the recovery in the cervical branches took an average of 5–6 months in this study. The delay in recovery in cases of marginal mandibular nerve injury was due to the excessive compression/stretching of nerve fibers and due to the fact that the ramification and cross innervations were less in cases of marginal mandibular nerve unlike the temporofacial divisions of the facial nerve.

Marginal mandibular branch may have two or more rami at the
the most widely accepted method, because it is clinically useful, a major pitfall. HBFNGS has emerged over the past two decades as with facial nerve paralysis after maxillofacial surgery has been a

level of the angle of the mandible. Posterior to the facial artery, the nerve runs in an arc 1 cm or less below the inferior border of the mandible in 19% of cases. However, other investigators noted the marginal mandibular nerve well below the inferior border of the mandible in almost every instance in fresh cadaver specimens and clinical dissections. They observed some branches as low as 3–4 cm below the lower border of the mandible. Both these reports recommended cervical incisions several centimeters below the inferior border of the mandible. So it is prudent that the submandibular incision be placed well below the anatomical limits of this nerve. In angle fractures with gross upward displacement of the proximal fragment, care has to be taken to locate the incision at least 2 cm below the actual anatomic border of the mandible while avoiding injury to the marginal mandibular nerve. Moreover, meticulous dissection and incision in the deep fascia at the level of the skin incision, blunt dissection around the region of facial artery/vein, combined with gentle handling of the flaps can result in significant decrease in morbidity to the marginal mandibular nerve. In cases of retromandibular approach, it is necessary to do a careful dissection over the parotidomasseteric fascia in approaching cleavage plane between the parotid and the massester. Excessive retraction of the parotid should be avoided to limit the postoperative facial nerve injury.

Based on our results, we can state that the main cause of facial nerve injury in our series was compression and/or stretching of nerve fibers, which resulted in neuropaenia, and was caused by excessive or heavy handed retraction. However, there were significant differences in the time of recovery of various branches of facial nerve. This was particularly noticeable in relation to marginal mandibular nerve which took an average of 5–6 months for complete recovery.

The lack of uniformity in reporting facial nerve recovery in patients with facial nerve paralysis after maxillofacial surgery has been a major pitfall. HBFNGS has emerged over the past two decades as the most widely accepted method, because it is clinically useful, not time-consuming, accurate, and easy to use. HBFNGS clearly describes functions of the forehead, eye, nasolabial fold, and mouth, and it is capable of assessing and communicating variable facial functions. However, we found a number of limitations of HBFNGS that are also reported in the literature. One major criticism is that being a gross scale, it cannot be used to distinguish subtle differences in facial nerve dysfunction. Nonetheless, the HBFNGS is limited by reducing facial function to a single figure. This shortcoming is most noticeable in the assessment of patients who have involvement of more than one branch of the facial nerve with varying severity. In such situations, the assignment of the HBFNGS rests on the random judgment of the grader, depending on which portion of the face is deemed more significant; the emphasis is often laid on the ability to close the eyes. Two of our cases where two branches were involved (temporal and zygomatic) were categorized as zygomatic branch involvement because the function of this branch was considered more important.

In short, this study was a modest attempt to evaluate the frequency of facial nerve injury following various surgical approaches to treat maxillofacial trauma cases. Facial nerve impairment was shown to be of a temporary nature in all the cases. However, due to myriad of surgical approaches to the maxillofacial region and variations that may occur in the subjective assessment, there is a need to standardize the reporting of facial nerve recovery.

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