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ORIGINAL ARTICLE

Vertically unstable fractured mandibular segment with attached genial tubercles as a parameter for difficulty during intubation for general anaesthesia—substantiation with computed tomographic (CT) scan evidence

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Abstract

Purpose To study and evaluate the anatomic alterations in the suprahyoid musculature, the hyoid bone, and the laryngeal inlet in patients with vertically unstable fractured mandibular segment with attached genial tubercles using computer tomography for substantiation of the clinical evidence and hypothesis of difficulty during intubation for general anaesthesia.

Materials and method Random sampling methodology was used to enrol patients with mandibular bilateral parasymphysis fracture qualifying for the classification of vertically unstable fractured mandibular segment with attached genial tubercles for group A patients. Patients with unilateral parasymphysis fracture with vertically stable mandibular segment were included in group B. Forty patients with parasymphysis fracture and no other associated facial fracture/injury were evaluated prospectively by comparing their pre-operative computer tomography (CT) images with post-operative CT images taken after the reduction of the fracture. Parameters evaluated were variation in the radiologic anatomy of the laryngeal inlet shape and alteration in the suprahyoid musculature after open reduction and internal fixation of the fracture when compared with pre-operative CT images.

Results The following were the results/observations from this study among group A patients: (1) The distance between the genial tubercles and the hyoid was found to be reduced. (2) Dorsal bodily movement of the hyoid was observed suggesting loss of anterior hyoid support. (3) The posttraumatic changes in the shape of the laryngeal inlet were observed in cases with vertically unstable bilateral parasymphysis fracture. (4) Restoration of morphology of the laryngeal inlet and anterior-posterior distance between genium and hyoid after reduction.

Conclusion Computer tomographic findings confirm that the displacement of fractured mandible and resultant displacement of the genial musculature have their effect on the laryngeal morphology. These posttraumatic changes in cases with dorsally displaced vertically unstable fractured mandibular segment with attached genial tubercles should be considered as a vital parameter for assessing difficulty during intubation.

Keywords Mandibular fracture · General anaesthesia · Difficult intubation · Computed tomography (CT) · Laryngeal inlet · Hyoid bone

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Introduction

Genial attachment to the suprahyoid musculature in addition to its contribution towards the muscle control for the mandibular dynamics also provides support to the hyoid for the maintenance of its spatial position in the inframandibular region. The genial muscular attachments add to the anterior support to the hyoid and thereby providing positional stability to the various anatomic structures in the region. Disruption of the genial support may have its effects on the spatial orientation of the hyoid and associated anatomic structures including the laryngeal inlet.

Vertically unstable fractured mandibular segment with attached genial tubercles and its associated musculature has a tendency to displace in the inferior and backward direction as genial tubercles of the mandible give attachment to genioglossus and the geniohyoid muscles and in turn aid in supporting the tongue and hyoid bone in its anatomical position [1]. Tissue prolapse adds to the intubation difficulty in patients with postero-inferiorly displaced vertically unstable fractured mandibular segment as there will be disruption of the hyoid and laryngeal inlet along with the associated anatomic structures [2–4].

This study critically evaluates the anatomic alterations in the suprahyoid musculature, hyoid bone, and laryngeal inlet in patients with bilateral mandibular parasymphysis fracture with attached genial tubercles using computed tomography (CT) scan for the substantiation with clinical evidence and hypothesis of difficulty during intubation for general anaesthesia in such patients as discussed in the previous study [3]. The consequences of dorsal and inferior displacement of the genial apparatus due to unfavourable mandibular fracture on the spatial orientation of hyoid and its effects on the laryngeal inlet using a comparative pre-operative and post-operative CT analysis have been discussed in this study.

Material and methods

A prospective randomised study was conducted after obtaining an ethical clearance from our institutional ethical committee (IEC/RAC). To prevent bias in the sampling among our study cohort, random sampling methodology was used to enrol patients with mandibular bilateral parasymphysis fracture qualifying for the classification of vertically unstable fractured mandibular segment with attached genial tubercles in group A and group B patients diagnosed with unilateral parasymphysis fracture with favourable fractured mandibular segment. Forty systemically healthy patients with parasymphysis fracture and no other associated mandibular/facial fracture and head injury were evaluated prospectively by comparing their pre-operative CT images with post-operative CT images taken after open reduction and internal fixation (ORIF) of the fracture.

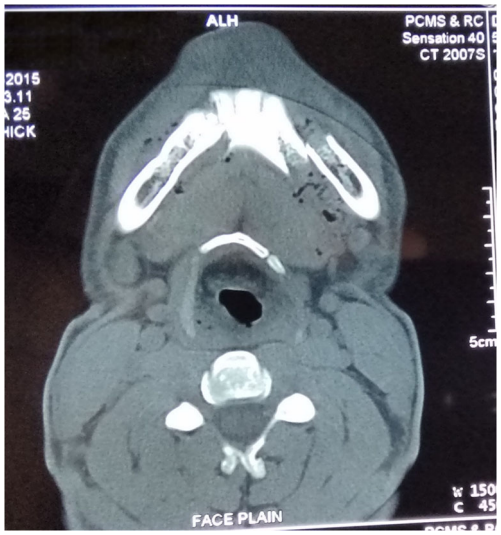

Fig. 1 Pre-operative computed tomographic (CT) image, axial section showing bilateral parasymphysis fracture of the mandible with displaced hyoid apparatus and reduction in the size of laryngeal inlet

Parameters evaluated were variations in the radiologic anatomy of the laryngeal inlet shape and the alteration in the suprahyoid musculature after ORIF of the fracture comparing with pre-operative and post-operative CT images (Figs. 1, 2, 3, and 4) Sectional data of CT scan can illustrate all the regions of the mandible in three planes—axial, coronal, and sagittal planes. Besides identifying the fracture, it is more accurate to determine the degree of fragment displacement with CT scan than with a plain radiography. Multi-section CT scan (Siemens, India) was obtained with following exposure parameter of 400 mAS, 120 kV with scan time of 15.35 s and 4-s delay to procedure, and the slice thickness of 1 mm. ORIF

Fig. 2 Post-operative computed tomographic (CT) image, axial section showing reduced parasymphysis fracture of the mandible with restoration in the size of laryngeal inlet and hyoid anatomy

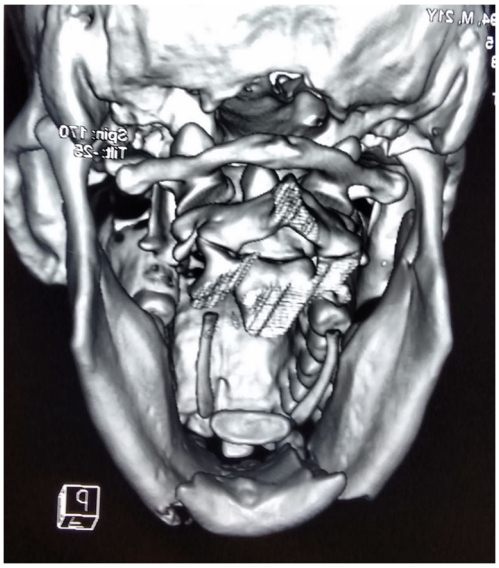

Fig. 3 Reconstructed three dimensional (3D) image showing decrease in the distance between the genium and the hyoid bone with bilateral mandibular parasymphysis fracture

was performed by a single qualified operator and intubation was performed by a single qualified blinded anesthesiologist for all the study population. The anesthesiologist routinely performed intubation for maxillofacial trauma patients in our maxillofacial trauma unit. The anaesthetist graded the degree of intubation difficulty using Intubation Difficulty Scale (IDS) (Table 1) based on parameters like number of intubation attempts and operators for assistance, number of alternative techniques used, Cormack's glottis exposure score, lifting

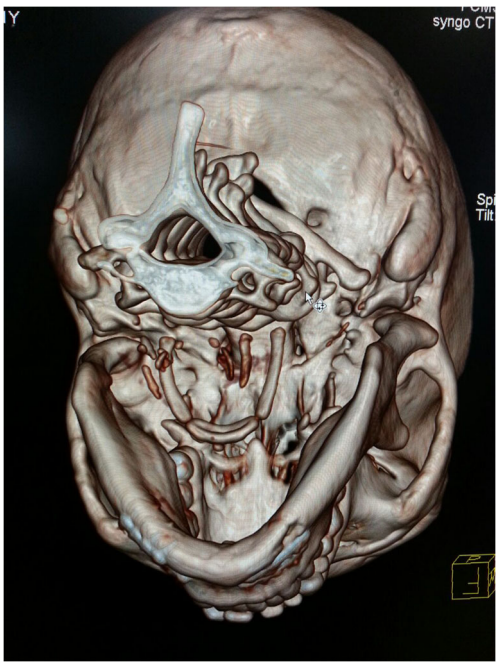

Fig. 4 Reconstructed three dimensional (3D) image showing restoration in the distance between the genium and the hyoid bone after open reduction and internal fixation (ORIF)

Table 1 Intubation Difficulty Scale (IDS) to assess the degree of difficulty

Intubation Difficulty Scale (IDS) score	Degree of difficulty
0	Easy
$0 < IDS \leq 5$	Slight difficulty
$IDS < 5$	Moderate To major difficulty
$IDS = \infty$	Impossible intubation

force required during laryngoscopy, and necessity for laryngeal pressure for all the 40 patients from both the groups after induction of general anaesthesia (GA) drugs for muscle relaxation. Clinical parameters like obesity and short neck which adds to intubation difficulty were ruled out.

Results

The results obtained which were evaluated by two different radiologists who were blinded showed that there was an alteration in the distance between the hyoid and the genial tubercle with loss of hyoid apparatus support due to the disruption of musculature and a significant alteration in the laryngeal inlet shape which was restored after ORIF which was evident in the pre-operative and post-operative CT images.

Both the radiologists reported that out of 20 patients, 18 patients had significant alteration in the laryngeal inlet shape due to the dorsal displacement of hyoid apparatus and suprahyoid musculature pre-operatively in group A (Table 2). Chi-square test revealed a value of 0.00 and the probability of variance among the radiologists' opinion was 1.000. The observational findings by the radiologists have been summarised (Table 3).

The anaesthetist graded the difficulty of nasoendotracheal according to the IDS score. He observed that in group A, $n = 18$ (90%) patients had "moderate to major difficulty" and $n = 2$ (10%) patients had "slight difficulty" during intubation. Among group B patients, $n = 19$ (95%) had "easy" intubation whereas $n = 1$ (5%) patient, "slightly difficult" intubation which was encountered due to decreased hyoid-mental distance and soft tissue oedema.

Discussion

Trauma patients in maxillofacial surgery have peculiar necessities for general anaesthesia as the work field is shared by both the surgeon and anaesthetist which demands an understanding for each other's needs for the operative procedure. In most instances, nasotracheal intubation is the most suitable method of administering general anaesthesia for surgical

Table 2 Data observed by two radiologists on the change in the laryngeal inlet shape and dorsal displacement of the hyoid apparatus with loss of anterior support in the pre-operative and post-operative computed tomography (CT) image

Anatomic changes in the CT scan	Group A		Group B	
	Pre-operative CT	Post-operative CT	Pre-operative CT	Post-operative CT
Radiologist 1	18	0	0	0
Radiologist 2	18	0	0	0

procedures involving the oral cavity as the dental occlusion needs to be evaluated intraoperatively.

A bilateral parasymphysis fracture with genial attachments is displaced in an inferior and backward direction along with the tongue via its musculature anteriorly. The muscular instability causes a loss of control over tongue and the hyoid bone which can cause oropharyngeal obstruction in supine position. Genioglossus and the geniohyoid muscles attached on the genial tubercle help in supporting the anatomic position of the tongue and hyoid bone. Muscle attachments which act to place dynamic vectors of force on the mandible when in continuity allow for proper mandibular function but when there is discontinuity such as unfavourable mandible fractures can potentially disrupt appropriate fracture healing [2].

In the previous study conducted by Bhargava D et al. to assess the difficulty in nasoendotracheal intubation in patients with inferior and backward displacement of unfavourable fractured mandible using genial tubercle and genial muscles as reference landmarks, they have observed that there is alteration in the anteroposterior airway due to collapse of suprahyoid musculature. They assessed the difficulty encountered during intubation in favourable and unfavourable mandibular fracture and concluded that vertically unstable mandibular fracture with genial attachments increases the degree of difficulty during intubation. The patients had higher Cormack grade in which additional force is required for glottis exposure during laryngoscopy. The study concluded that displaced mandibular fracture with genial attachment is a vital parameter for assessing difficulty during intubation [3]. In this study, 2 patients with favourable bilateral mandibular fracture did not show much alterations in the laryngeal inlet shape and associated anatomic structures. The CT findings in the present study shows the variation in radiologic anatomy of the laryngeal inlet shape and alteration in the suprahyoid musculature after ORIF correlates with the difficulty during intubation for general anaesthesia.

Kellman RM et al. have observed that airway obstruction in maxillofacial injuries is caused by tongue base or maxillary prolapse, pharyngeal oedema, or haematoma. Tongue retraction should be done using a suture or towel clamp followed by securing a definitive airway in bilateral mandibular body fracture as there is high risk for tongue prolapse [4]. Functional and structural disruption of the oral cavity, larynx, and pharynx can cause not only airway difficulty but also dysphagia as the individual musculature performs its function to maintain the normal anatomy and physiology [5].

A retrospective review on airway management in maxillofacial trauma patients by Saraswat V observed that mandible was commonly involved in maxillofacial injury. Nasoendotracheal intubation is commonly preferred by maxillofacial surgeons as they can use occlusion as key to reduce facial fractures. He had also mentioned that nasal or oral intubation does not pose problem if there is absence of gross disruption in the normal anatomic structures [6]. There may be varying degree of difficulty during the intubation procedure in different fracture patterns as discussed in the presented study.

Hutchinson et al. have put forward six situations associated with maxillofacial trauma which can affect the airway which includes bilateral fracture of mandible causing backward displacement of the tongue and soft tissue oedema of the head and neck [7–9]. Similar observations were made by Kellman et al. in their study [5]. Walls RM has reviewed on management of the difficult airway in a trauma patient with short

Table 3 Observational changes in the computed tomography (CT) scan summarised by the radiologist

S. No.	Observational changes observed by the radiologist
1	The distance between the genial tubercles and the hyoid was found to be reduced
2	Dorsal bodily movement of the hyoid was observed suggesting loss of anterior hyoid support
3	The posttraumatic changes in the shape of the laryngeal inlet were observed in cases with vertically unstable bilateral parasymphysis fracture
4	Restoration of morphology of the laryngeal inlet and anterior-posterior distance between the genium and hyoid after reduction.

neck; retruded mandible will pose difficulty for intubation as the tongue has to be pushed out of line. They further mentioned that intubation in patient with upper airway compromise is a rule rather than an exception [10] which has been observed from our previous study [3] and the present CT corelation.

Conclusion

Vertically unstable bilateral fractured mandibular segment with attached genial tubercles with genial musculature is a vital parameter for surgery under general anaesthesia as it poses difficulty during intubation even in the presence of adequate muscle relaxation. The reason for this difficulty in intubation has been substantiated with CT study.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval Obtained. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from the patients involved in this study.

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