

Case Report
Trauma

‘Stylo-mandibular complex’ fracture from a maxillofacial surgeon’s perspective – review of the literature and proposal of a management algorithm

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Abstract. The incidence of fractures of styloid process, either in isolation or association with mandibular fractures, is rare, and frequently overlooked. When present, they pose clinical dilemma in diagnosis and management. Proper management of styloid fractures is essential, not just to alleviate the patients’ symptoms, but also to prevent potential complications like post-traumatic styloid syndrome and injury to adjacent vital structures. This article features a review of literature on ‘styloid fracture concomitant with mandibular fracture’ along with a case report. The article explores the biomechanics resulting in styloid fracture especially when co-existing with mandibular fractures. The article also enumerates the clinical features of this unusual clinical phenomenon and aims at rationalizing the need for its medical or surgical management. A simple protocol for the management of ‘stylo-mandibular complex’ fracture has been proposed.

Key words: styloid process fracture; mandibular angle fracture; stylo-mandibular complex fracture; biomechanics.

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Fractures of the styloid process are uncommon in occurrence as well as presentation to a maxillofacial surgical unit.^{1–6} More infrequent, is the incidence of styloid fracture concomitant with mandibular fractures (styloid-mandibular fracture complex).^{7–11} Parenthetically, reports of

isolated styloid fracture detailing their management are found in Otolaryngology literature^{12–16} while in contrast there is extremely sparse discussion on management of styloid fractures occurring along with mandibular fractures.^{8–11} Hence there is often a clinical dilemma regarding the

course of management in the following aspects: (1) whether the styloid fracture requires treatment or not, (2) if yes, the choice of treatment needed-surgical or pharmacological, (3) the type of anaesthesia needed for surgical treatment, (4) the time of surgical treatment; simultaneous

with mandibular fracture or later and finally (5) whether the surgical management of styloid process is within the purview of the maxillofacial surgeon.

The purpose of this paper is to clarify the aforementioned queries. The article also aims at exploring the biomechanics involved in such combined fractures and to analyze the treatment probabilities. It is also an attempt to compare and contrast the differences if any, in surgical management of 'isolated styloid' fracture with the combined 'stylo-mandible complex' fracture.

Review of literature

Incidence

Reports of trauma to the styloid process are found sporadically in maxillofacial literature. A case of styloid process fracture following administration of local anaesthesia during a minor surgical procedure has been documented.⁴ Proof of styloid fracture in cases of death by hanging or strangulation have also been recorded in forensic medicine.¹⁷

Though the styloid process has well established anatomical association with the mandible,⁴ the biomechanics of styloid fracture in association with mandibular fractures (styloid-mandibular fracture complex) and their clinical implications are discussed with less clarity.^{4,9,10} The mandibular fractures previously documented with styloid fractures are parasymphysis,^{9,11} body, angle⁷ and the mandibular condyle.^{8,9}

Surgical anatomy and embryology

The styloid process is a cylindrical extension arising from the tympanic part of the temporal bone with a pointed tip. It is a part of the stylohyoid apparatus whose other components are stylohyoid ligament and hyoid bone. The spatial orientation of the styloid process is in an oblique fashion – anteromedially and inferiorly, occupying the retropharyngeal space.¹⁸ Three osseous structures of significance lie in close proximity to the styloid process; the mandible, hyoid and atlas.¹⁹ It is also closely associated with lingual and auriculo-temporal nerves anteriorly, the carotid space containing the internal jugular vein, internal carotid artery, sympathetic chain and cranial nerves 9–12 posteriorly (Fig. 1).^{3,19} The process gives attachment to 3 muscles (stylohyoid, styloglossus, stylopharyngeus) and 2 ligaments (stylo-mandibular and stylohyoid).³ The stylo-mandibular ligament extending from the

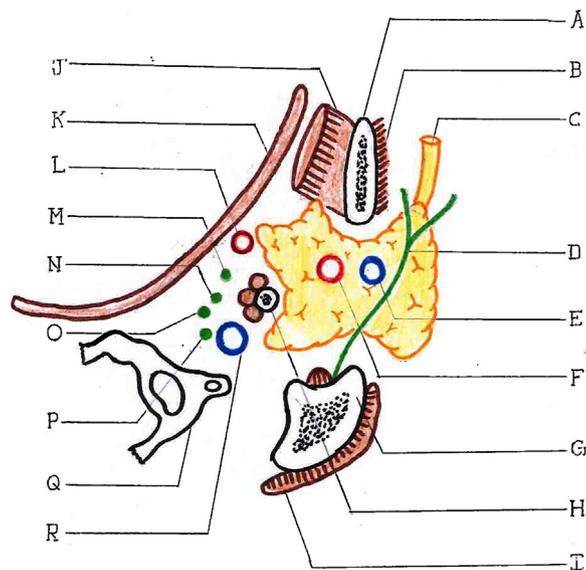


Fig. 1. Relationship of styloid process to vital structures. (A) Ramus of mandible. (B) Masseter. (C) Parotid duct. (D) Facial nerve and its branches. (E) Retromandibular vein. (F) External carotid artery. (G) Mastoid process. (H) Styloid process with its muscles. (I) Sternocleidomastoid. (J) Medial pterygoid. (K) Superior constrictor. (L) Internal carotid artery. (M) Glossopharyngeal nerve. (N) Vagus nerve. (O) Hypoglossal nerve. (P) Accessory nerve. (Q) Transverse process of atlas. (R) Internal jugular vein.

styloid process to the angle of the mandible serves to limit the excessive protrusive movement of mandible.

The styloid process originates from the Reichert's cartilage of the second branchial arch and gets ossified completely by 5–8 years.²⁰ The time period of Ossification and fusion varies with the 3 mechanisms of ossification including reactive hyperplasia, reactive metaplasia or developmental.²¹

Biomechanics of styloid fracture

The styloid process is a relatively well-protected structure, directed away from extrinsic traumatic forces; with its tip oriented medially and adequately draped by soft tissue which lends to the rarity of its fracture and displacement. However, fracture of the styloid has been proposed to occur due to the following biomechanics: (1) intrinsic trauma arising/originating from muscles attached to the styloid apparatus,^{4,11} and (2) extrinsic trauma to a comparatively weaker or trauma-prone styloid.

Intrinsic trauma may be inflicted due to un co-ordinated muscle spasms during strained swallowing patterns, epileptic seizures, laughter, singing, excessive coughing,^{16,22} and even sudden movement during administration of inferior alveolar nerve block⁴ and dental extraction.² The extrinsic trauma could be a direct blow to the styloid region or trauma to the anterior

mandible resulting in posterior displacement of the mandible which indirectly impacts the styloid process⁴ (Fig. 2A). The styloid process becomes trauma-prone when it gets weakened in the following aspects: (1) structural variation – thinner in cross section, longer,^{1,7} or multidirectionally curved,⁷ (2) spatial variation – tip oriented laterally,⁷ and (3) pathological alteration-infection (enthesitis).²⁰ Nevertheless, of all the factors mentioned, the propensity for the styloid process to fracture increases with its elongation.⁷

Length of styloid

The normal length of the styloid process spans a wide range 2.5–4.77 cm,^{23,24} varying according to age, ethnicity, sex,²⁵ and ossification.²⁶ It increases with age²⁷ due to calcification. Though some studies mention that length is independent of sex.²⁵ Kishore et al. found that the average length of styloid process in women was found to be higher than in men.²⁸ Length has also been shown to increase due to increased weight on head.²⁹

The actual length of the styloid refers to the length of the osseous styloid process and the ossified ligaments³⁰ and is measured on the posterior aspect from the base to the tip.³ After an extensive anatomic study, Eagle stated that a styloid process longer than 30 mm may be termed as elongated styloid process (ESP) which is clinically significant.³¹

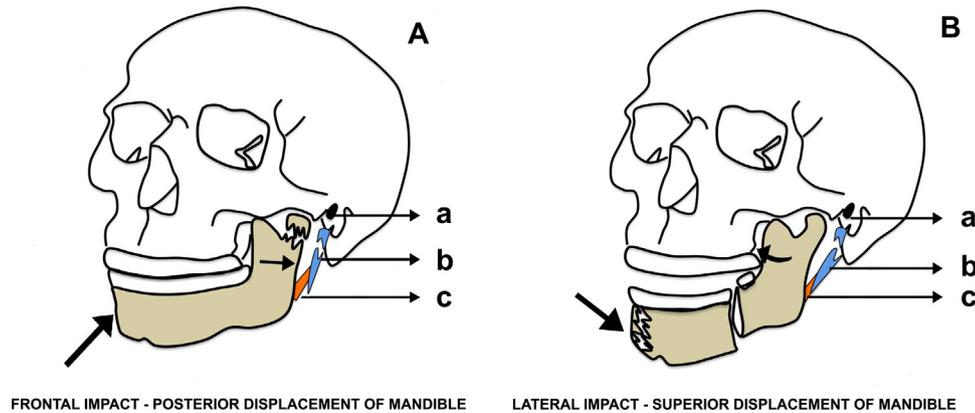


Fig. 2. Pictorial representation of styloid fracture biomechanics. (A) Styloid fracture with mandibular condyle fracture. (B) Styloid fracture with mandibular body and angle fracture. (a) External acoustic meatus, (b) styloid process, (c) styломandibular ligament.

The length has been studied by a number of methods including cadaveric dissections,²⁴ dry skulls,²⁷ and radiographic assessment.³² Though anatomic studies provide accurate measurements, they do not offer much of clinical correlation as radiographs/CT obtained from patients with elongated styloid and positive clinical symptoms.

Goldstein and Scopp gave a practical assessment of the styloid length relative to the mandible concerned and named a styloid 'elongated', when its length is more than 1/3rd that of ramal height.³² ESP graded by Verma is also a useful guide to assess the styloid.²⁸ The incidence of elongated styloid is 4–19 percent,^{33,34} and it is interesting to note that elongation is common in women and the elderly, especially the third to fourth decade.^{25,28}

An elongated styloid is known to cause numerous clinical conditions like eagles syndrome due to its compressive effect on adjacent vital structures. Symptoms of Eagle's syndrome include pain in the oropharyngeal region, face, and neck, dysphagia, frequent episodes of syncope and globus pharyngeus.³ In addition there are reports of elongated styloid causing ischaemic attack³⁵ and difficult intubation.^{36–39} A case of mental nerve paresthesia has also been reported in a patient with elongated styloid which got relieved with its excision.⁴⁰

Clinical presentation of styloid fractures

A fractured styloid is akin to an elongated styloid especially when it is displaced. Therefore the symptoms of styloid fractures resemble an elongated styloid process¹¹ and include a spectrum of clinical features; dysphagia,¹⁰ pain in the pharyngeal, tonsillar, preauricular and retromandibular region which characteristically

increases while turning the head to the side of trauma, restricted mandibular movements, trismus, burning pain in the neck, diffuse facial pain, otalgia,⁷ sensation of foreign body and clicking in the pharynx, headache, ocular pain, tinnitus and temporomandibular joint pain.¹ The symptoms vary according to the length, position, displacement of the styloid process and presence of pathological factors (infection, fibrosis) associated with the styloid.¹

The fracture of styloid may eventually lead to development of Traumatic Eagle syndrome¹ which is characterized by all the clinical features of eagle syndrome following fracture/surgery of styloid process. Fracture induced fibrosis or infection has been attributed to this phenomenon. Further, the displaced fracture fragment can impinge on adjacent vital structures to produce consequences like glossopharyngeal neuralgia, atypical facial pain.⁷

Differential diagnosis to a styloid fracture includes third molar pain, TMJ disorders, foreign body in the throat, inflammation involving the submandibular salivary gland, tonsils and mastoid, myofascial pain dysfunction syndrome, sphenopalatine and glossopharyngeal neuralgias and pharyngeal tumour.¹

The clinical diagnosis of styloid fracture is always confirmed by ideal imaging which includes orthopantomogram, computerized tomogram scans,⁴¹ conventional radiographs in lateral and posteroanterior view.^{7,42} On plain radiographs, it is important to precisely differentiate the fractured styloid from the normal styloid which sometimes appear segmented due to syndesmosis or synchondrosis of stylohyoid ligaments.¹⁹ CT scans are useful in providing accurate measurement of the styloid as well as spatial orientation of fractured fragment in relation to vital structures.

Management of styloid fracture

The patient management is planned according to the severity of clinical presentation.

Complaints of pain and dysphagia¹⁰ arising out of a styloid fracture may be managed (1) symptomatically/conservatively with heat, soft diet and rest; immobilization with cervical collar and/or IMF (observation), or (2) medically with muscle relaxants, NSAIDs, steroids and carbamazepine or local anaesthetic injections.^{2,4,5,9,10} Loco-regional administration of local anaesthetic solutions are very effective; local infiltration of hydrocortisone with bupivacaine was found to be effective by Blythe³ while glossopharyngeal nerve block⁴³ also proves to be an adequate reliever of symptoms.

Poor response to medical management is an indication for surgical management which involves excision of the fractured distal fragment.^{16,44} In addition, surgery is mandatory when the tip is in close proximity to vital structures such as carotid arteries, the internal jugular vein, the facial, glossopharyngeal, vagus and hypoglossal nerve.¹⁸ Surgical excision is mainly by 2 approaches: intra oral and extra oral. Intra-oral approach includes two methods, the anterior pillar approach or the transpharyngeal where the styloid is accessed through the tonsillar fossa. This may be done under LA.³ Special equipments like Kerrison's punch offer precise and safer resection of the styloid tip as compared to the usual armamentarium of bone nibblers and artery forceps.⁴⁵ Extra oral delivery of the distal fragment is performed by one of the 3 approaches; cervical,⁴⁶ submandibular^{3,47} or preauricular.⁴⁷ In a study done by Smith, trans-oral approach was found to be better.¹ It offers numerous benefits like ease and

rapidity of surgical access, avoidance of external scar and earlier post-op healing. Nevertheless, when the fractured segment is of larger dimension, extra oral approach is preferred.

Case report

A 36-year-old female presented to our outpatient department with complaints of pain in the left angle and right lower border of the mandible following alleged assault. The patient also expressed concern over pain in the pharynx with dysphagia, restricted mouth opening (22 mm), pain on turning the head to the left side and numbness over the chin region. On clinical examination, a diffuse swelling in the left angle region was noted with no deviation of mandible. Tenderness was elicited on palpation in the angle, mastoid and preauricular region on the left side and body of the mandible on the right side. There was no pain, crepitus or clicking in the ipsilateral temporomandibular joint. Intraoral examination revealed deranged occlusion and interfragmentary mobility was felt between the two premolars on the right mandible

and between the second and third molar on the left mandible. Following clinical evaluation, a provisional diagnosis of mandibular Lt angle Rt body fracture was done. However, imaging with orthopantomogram (Fig. 3A) and CT scan revealed a displaced left angle and right body fracture, along with a fractured left styloid process. The patient was taken up for fracture management under GA; the mandibular fractures were reduced and fixed using two 2 mm stainless steel mini-plates at the parasymphyseal region and a single 2 mm mini plate positioned along the external oblique ridge with 2×8 mm screws at the angle region (Fig. 3B). The post-op recovery was uneventful with restoration of normal occlusion and mouth opening and recovery of sensation over the chin. The patient also had relief of dysphagia and pain in the preauricular region.

Discussion

The occurrence of styloid-mandibular fracture complex is a rarity. Nevertheless, the otherwise protected styloid process becomes trauma-prone, when it is elongated or abnormally angulated. The critical

length that categorizes a styloid process as 'elongated' is variable according to the sample selected and the method of study. Therefore, for the case discussed, radiographic assessment of styloid was done based on the criteria proposed by Goldstein and Scopp³² because it is a more patient-specific and practical evaluation, relative to the mandible concerned. The styloid process was thus classified as an elongated styloid with 'partial calcification' and was confirmed by CT scans. The length of the styloid process was measured to be 3.6 cm which explains its susceptibility to trauma.

The general biomechanics elucidating 'styloid-mandible complex' fracture refers to a posteriorly directed force to the styloid.^{4,7} However, this case projects a new dimension; a direct force at the contralateral (R) body region has resulted in a contre-coup fracture at the (L) angle, due to the presence of impacted molar. Ideally this should have resulted in dissipation or termination of force propagation posteriorly. However, here the unfavourable fracture line at the angle has led to superior displacement of mandibular angle which probably exerted a pull through

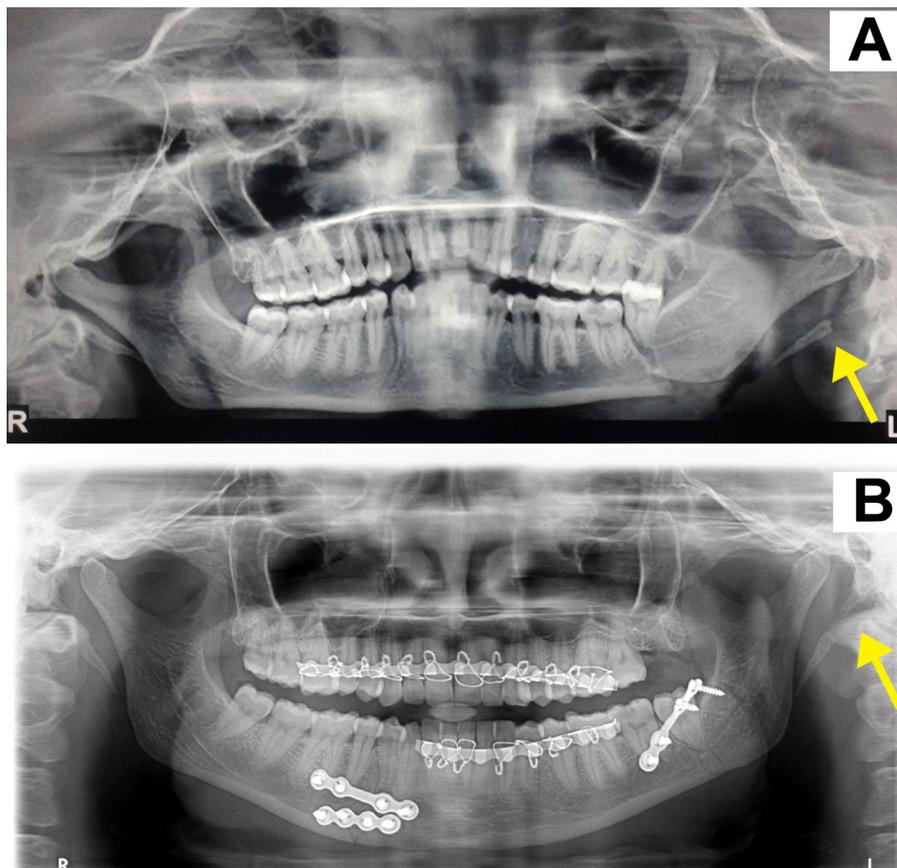


Fig. 3. Orthopantomogram of patient. (A) Preoperative OPG demonstrating fracture of left angle, left styloid (arrow) and right body. (B) Immediate postoperative OPG showing ORIF mandible and spontaneous reduction of styloid (arrow).

the stylo-mandibular ligament leading to styloid fracture (Fig. 2B). The role of the stylo-mandibular ligament in the pathogenesis of styloid fracture is uncertain. There is lacuna in literature on the applied anatomy of 'styloid-mandibular complex' and needs exploration.

A clinical diagnosis of 'styloid fracture co existing with mandibular fracture' is challenging because of signs and symptoms which overlap that of mandibular angle fracture alone. The clinical confirmation of styloid fracture is generally made by positive palpation of the fracture fragment at the tonsillar fossa. However in this case, it was not palpable although the patient exhibited most of the clinical features of styloid fractures like dysphagia, swelling in retromandibular region, chin numbness and preauricular pain on jaw movements; all of which are common to a mandibular angle fracture and hence clinical diagnosis was misleading. The styloid fracture was evidenced only on OPG and CT. The inability to appreciate the fracture fragment at the tonsillar fossa was probably due to the inferior displacement of the fracture segment.

A diagnosis of 'styloid-alone' fracture evokes minimal confusion or contradictions in terms of management.^{4,5} However, when it is 'styloid-mandible complex' fracture, there is ambiguity. There is no

classification of styloid fractures or guidelines based on which treatment may be planned. For practical purposes, SP fractures can be categorized as either displaced or undisplaced. Undisplaced fractures do not require treatment. However they need to be maintained in the undisplaced position to prevent potential displacement during jaw movements and injury to adjacent vital structures.² A displaced styloid fracture may be of different types; the fractured fragment may be inferior, medial or posterior depending on the impact. The degree and direction of displacement determine the clinical severity as well as the surgical treatment.

Literature review shows 'IMF alone' or 'ORIF followed by IMF'^{7,8} as one of the treatment options for management of similar styloid-mandibular angle fracture. However this modality not only compromises the airway and nutrition of the patient for 4-6 weeks, the non-rigid fixation of the angle fracture could also lead to unfavourable healing. Further, the restitution of styloid position is not guaranteed.

In our case, the position of the fractured styloid was confirmed by CT as safe, and ORIF of the mandibular fracture was done using semi-rigid fixation with mini plates. Surprisingly, the restoration of the bony anatomy at the angle region appears to have restituted the normal anatomy of the mandibular angle as well as position of

the styloid. This raises doubts regarding the mode of treatment that advocates aggressive excision of fractured styloid fragment as well as the conservative management of the mandible fracture by immobilization.

The need for immobilization or potential of a styloid to get displaced may be tested by an OPG taken with open mouth; if it reveals a change in position of fractured styloid fragment, it indicates possibility of displacement and hence, injury to adjacent structures and therefore MMF would be helpful in restricting movements. On the contrary, lack of displacement negates need for MMF. A simple protocol to manage 'styloid-mandible complex' fracture is proposed in (Fig. 4). Irrespective of the treatment modality, patients must be under observation and reviewed periodically to identify development of traumatic styloid syndrome which may manifest in various forms.¹ Specific guidelines to management of fractured 'styloid-mandibular complex' is not yet established; especially regarding the choice of treatment modality and the time of surgery; whether the styloid needs to be addressed simultaneously with angle fracture or later. This case report is a significant addition to the already existing but meagre literature. A prospective analysis of numerous such cases might help in arriving at a definite consensus.

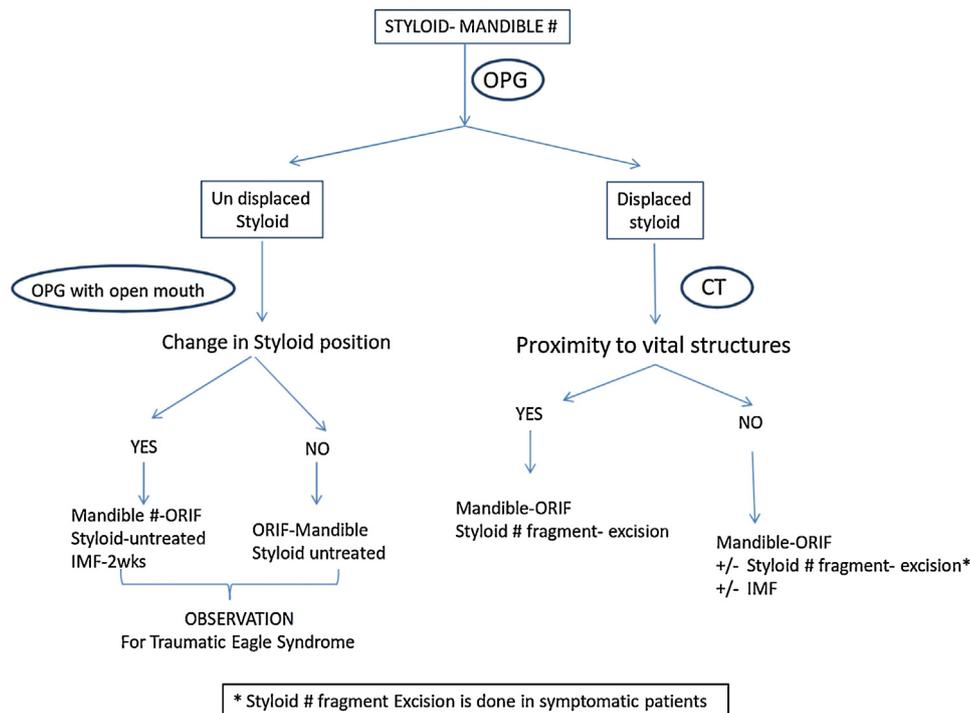


Fig. 4. Treatment algorithm for 'stylo-mandibular complex' fracture.

In conclusion, fracture of styloid process may be found in association with mandibular fractures in cases of direct or indirect trauma to the mandibular body, angle or condyle region. It is mandatory to treat these fractures either pharmacologically or surgically on the basis of severity of clinical features. Hence, careful radiographic assessment of the styloid region is essential in mandibular fractures to avoid overlooking styloid fractures. Clinical features of dysphagia and glossopharyngeal neuralgia associated with mandibular fracture, should alert a surgeon regarding the possibility of styloid fracture. Surgery must be considered when the fractured fragment is in close proximity to vital structures. The patients need to be followed up to identify and treat or prevent potential complications like post-traumatic styloid syndrome.

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Conflict of interest

None.

Ethical clearance

Not required.

Patient consent

Informed consent has been obtained for Fig. 3 explaining their right to privacy, which has been waived.

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