



Maxillary Tuberosity Fracture During Extraction of Maxillary Posterior Teeth



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Abstract

Objective: Maxillary tuberosity fractures are common in oral surgical practice. The bone density at the maxillary tuberosity is the lowest. In patients with enlarged maxillary sinus, the alveolar process fractures may occur during extraction of the molar teeth. The aim was to assess whether maxillary tuberosity fracture during the extraction of maxillary posterior teeth was a common complication through a systematic review.

Materials and Methods: Three electronic databases (PUBMED, Research Gate, and Google Scholar) were searched. Of the 12805 abstracts reviewed for inclusion. These 12805 references were assessed based on the abstracts and titles; these were reduced to 47 relevant manuscripts of which 21 studies were included in this systematic review.

Results: 47 manuscripts were identified as eligible based on the abstracts and titles searched for full-text and analyzed for inclusion. 21 manuscripts were relevant for inclusion in qualitative analysis.

Conclusion: A proper pre-operative clinical and radiological examination is essential to prevent such a complication. If it is thought that there is a high risk of tuberosity fracture during extraction from the pre-operative evaluation, then surgical removal of the tooth is recommended.

Keywords: Maxillary tuberosity fracture; Third molar extraction complication; Tuberosity fracture during extraction

Introduction

Maxillary tuberosity fractures are common in oral surgical practice. It most commonly occurs during the extraction of maxillary molars. The bone density at the maxillary tuberosity is the lowest and hence the tuberosity bone allows easy luxation of the tooth but is also highly susceptible to fracture even under lower applied forces [1,2]. Fractures of the maxillary alveolar process occur most commonly in the maxillary anterior and premolar regions in young adults. In patients with enlarged maxillary sinus, the alveolar process fractures may occur during extraction of the molar teeth [1]. Maxillary tuberosity is an important structure to maintain the stability of maxillary dentures. In cases with large fractures of the maxillary tuberosity, the fractured bone has to be salvaged by maintaining it in place and aided in healing [3]. A correct preoperative clinical and radiographic evaluation along with sound anatomical knowledge might help to reduce and prevent such complications of extraction [1]. The aim was to assess whether maxillary tuberosity fracture during extraction of maxillary teeth was a common complication through a systematic review. The objectives were to determine which maxillary tooth

extraction commonly resulted in maxillary tuberosity fracture and also whether maxillary tuberosity fracture during extraction of maxillary teeth was associated with any other complication.

Methods

This manuscript followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Protocols (PRISMA - P) for reporting a systematic review.

The PICO question was:

- i. Population:** Patients with maxillary tuberosity fracture during extraction of maxillary teeth
- ii. Intervention:** Extraction or Surgical removal of maxillary teeth
- iii. Comparison:** Extraction or Surgical removal of maxillary teeth with and without maxillary tuberosity fracture
- iv. Outcomes:** Maxillary tuberosity fracture with or without complications

Inclusion and Exclusion Criteria

Studies were limited to Case reports, Prospective and Retrospective cohort studies reporting the presence of maxillary tuberosity fracture during extraction of maxillary teeth. The population included patients who presented for the extraction of the maxillary teeth between January 2000 and February 2021. Studies in the English language were only included and studies in languages other than English were excluded. Studies on animals and cadavers were excluded. There were no restrictions on the type of clinical setting. Studies at all levels of healthcare

settings (such as primary, secondary, and tertiary healthcare) and those conducted in the community were included for maximum representation.

Search methods for identification of studies

Three electronic databases (PUBMED, Research Gate, and Google Scholar) were searched using the strategies reported in Table 1. The search was performed on March 25th, 2021, with 12805 abstracts reviewed for inclusion, and 21 studies were included in this systematic review (Table 1 & Figure 1).

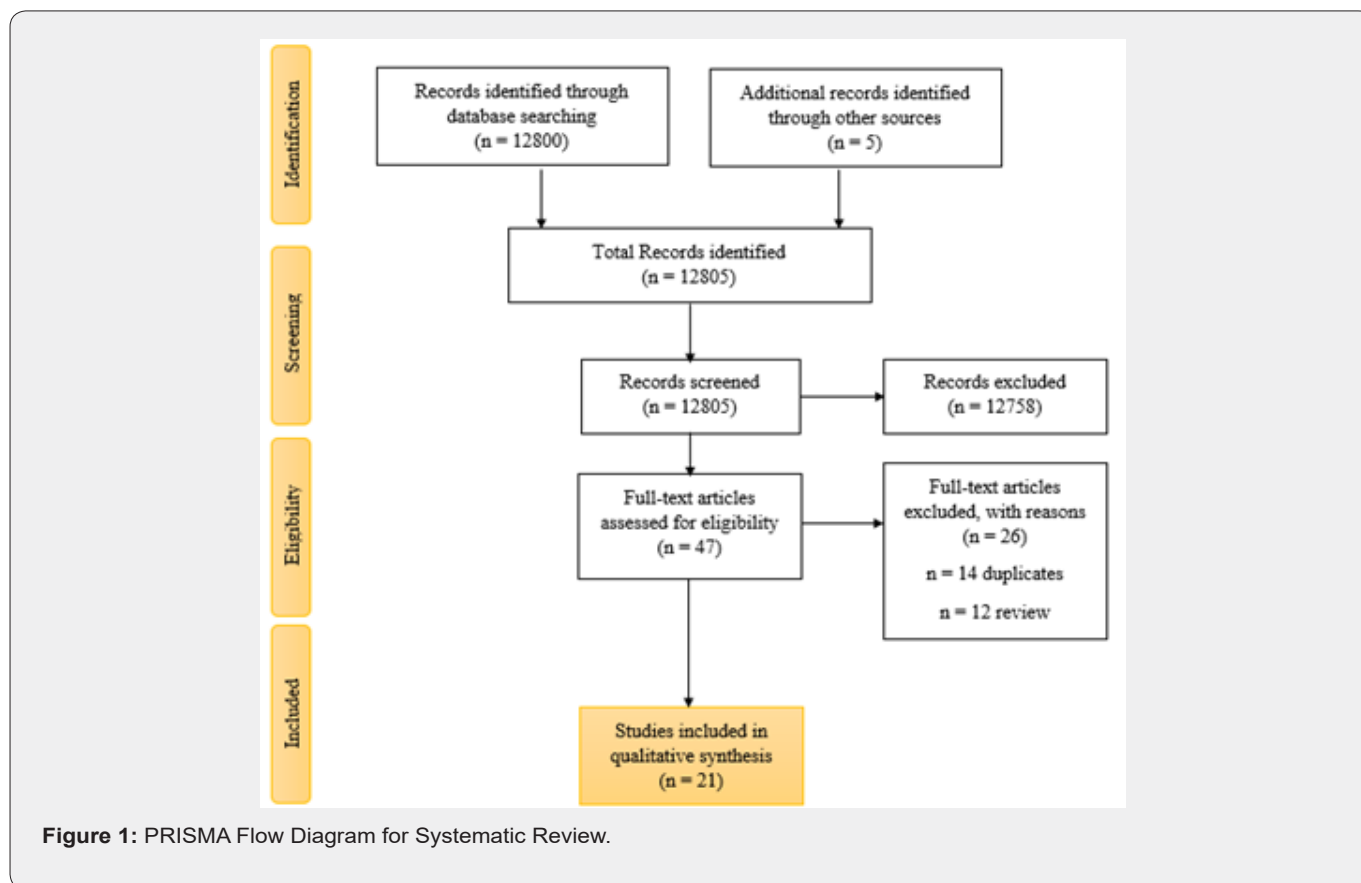


Figure 1: PRISMA Flow Diagram for Systematic Review.

Table 1: Search Strategy.

Search terms
"Maxillary tuberosity fracture during extraction"
"Maxillary tuberosity fracture after extraction"
"Maxillary tuberosity fracture following extraction"
"Extraction of maxillary tooth with tuberosity fracture"
"Extraction of maxillary tooth and tuberosity fracture"

Data collection and analysis – Selection of studies

Abstracts were initially reviewed to determine if the full-text article should be obtained. If the article fulfilled the criteria or if the authors were unable to decide regarding inclusion, a full-text article was obtained and evaluated (Figure 1).

Results

Results of the search

The initial search strategy yielded 12805 unduplicated references including case reports, prospective and retrospective studies. These 12805 references were assessed based on the abstracts and titles; these were reduced to 47 relevant manuscripts. Of those 12758 references excluded, the main reasons for exclusion were: Teeth extraction with different

complications, different etiology for maxillary tuberosity fracture, papers in other languages, abstract/conference proceedings, and editorial/opinion.

Qualitative analysis

All the 47 manuscripts identified as eligible based on the abstracts and titles were searched for full-text and analyzed for inclusion. 21 manuscripts were relevant for inclusion in qualitative analysis.

Characteristics of the participants and interventions

Table 2 provides detailed overview of patient demographics and study characteristics of the included studies. A total of 192 patients in all included studies were comprised in this systematic review.

Table 2: Case reports.

Author	Place & year	Title	Type of study	Number of cases (Incidence rate in %)	Tooth extracted	Age & gender of the patient	Complications	Management
Shah et al. [4]	United Kingdom, 2005	An extraction complicated by lateral and medial pterygoid tethering of a fractured maxillary tuberosity	Case report	1	Attempted extraction of maxillary right second molar	50-years Female	<ul style="list-style-type: none"> aemorrhage oro-antral communication Fractured maxillary tuberosity with the pyramidal process of the palatine bone and a small portion of the lateral pterygoid plate with attached fibres of lateral pterygoid and medial pterygoid 	<ul style="list-style-type: none"> The area of bleeding was arrested with an absorbable haemostatic agent and sutures A stainless-steel clip was used to seal the artery and the application of bipolar diathermy controlled the muscle bleeding.
Polat et al. [5]	Turkey, 2007	Maxillary Tuberosity Fracture Associated with First Molar Extraction: A Case Report	Case report	1	Attempted extraction of maxillary right first molar	28-years Female	<ul style="list-style-type: none"> Maxillary right tuberosity fracture including three molar teeth Oro-antral communication bleeding from right nostril 	<ul style="list-style-type: none"> The tuberosity and all molar teeth were repositioned to their original location and fixed by an arch bar After the 2-month -maxillary right first molar -treated by root canal treatment and apical resection of mesio-buccal root

Altug et al. [6]	Turkey, 2009	Extraction of upper first molar resulting in fracture of maxillary tuberosity	Case report	1	Extraction of maxillary right first molar	22-years Male	<ul style="list-style-type: none"> • Haemorrhage • Fracture segment including all three right maxillary molars with the tuberosity • Oro-antral communication 	<ul style="list-style-type: none"> • Surgical site sutured
Bertram et al. [7]	Australia, 2010	Maxillary tuberosity fracture: a life-threatening haemorrhage following simple exodontia	Case report	1	Extraction of the left maxillary second molar tooth	20-years Male	<ul style="list-style-type: none"> • Epistaxis and severe, pulsatile haemorrhage intraorally from the area of the left maxilla - arterial haemorrhage • Haemorrhagic shock - tachycardia, hypotension and slightly confused. • Acute blood volume loss of 750 mL to 1500 mL • Large portion of the left posterior maxilla missing • Large oro-antral communication 	<ul style="list-style-type: none"> • Haemostasis was achieved by packing the defect, the left antrum and left nose with ribbon gauze • Second operation - to remove the packing and close the large oro-antral communication
Hadziabdic et al. [8]	Bosnia and Herzegovina, 2011	Maxillary tuberosity fracture as a post-operative complication - Case study	Case report	1	Attempted extraction of the left maxillary second molar tooth	Female	<ul style="list-style-type: none"> • Haematoma with the 2cm diameter in the area of the lower edge of the mandible • Enlarged left palatine alveolar ridge • Mucosa in the tuberosity area - slight colour change 	<ul style="list-style-type: none"> • Sutures were placed over the left maxillary second molar tooth to immobilize it • Cold compression wraps • After 3 months -surgical extraction of left maxillary second molar tooth and left maxillary second premolar tooth
Venkateshwar et al. [9]	India, 2011	Complications of exodontia: A retrospective study	Retrospective study	112 (of 22330 extractions in 14975 healthy patient) (0.5%)	-	-	<ul style="list-style-type: none"> • Fractured maxillary tuberosity 	-

Biljana Evrosimovska et al. [10]	Macedonia, 2012	Fracture of the Maxillary Tuberosity: A Case Report	Case report	1	Attempted extraction of maxillary right third molar	45-years Female	<ul style="list-style-type: none"> Fracture at the area of right maxillary tuberosity, expanding to the space between second and third maxillary molar oroantral communication 	<ul style="list-style-type: none"> Surgical removal of the fractured tuberosity together with extraction of maxillary right third and second molars and suturing
Pourmand et al. [11]	Switzerland, 2013	The most common complications after wisdom-tooth removal: part 2: a retrospective study of 1,562 cases in the maxilla	Retrospective study	6 (of 1,562 maxillary third molars) (0.38%)	Extraction of maxillary third molar	-	<ul style="list-style-type: none"> Fractured maxillary tuberosity 	-
Thirumurugan et al. [12]	India, 2013	Maxillary tuberosity fracture and subconjunctival hemorrhage following extraction of maxillary third molar	Case report	1	Attempted extraction of left maxillary third molar	52-years Male	<ul style="list-style-type: none"> Peri-orbital and subconjunctival ecchymosis of left eye Hematoma of left maxillary tuberosity region and buccal mucosa 	<ul style="list-style-type: none"> Surgical extraction of left maxillary third molar and retaining the tuberosity with the periosteum
Azenha et al. [13]	Brazil, 2013	Accidents and complications associated to third molar surgeries performed by dentistry students	Retrospective study	4 (of 210 third molars) (1.9%)	Extraction of third molar		<ul style="list-style-type: none"> Fractured maxillary tuberosity 	<ul style="list-style-type: none"> Bone fragment attached to third molar was removed
Sebastiani et al. [14]	Brazil, 2014	Intraoperative accidents associated with surgical removal of third molars	Retrospective study	8 (of 164 maxillary third molars) (2.8%)	Extraction of maxillary third molar	-	<ul style="list-style-type: none"> Fractured maxillary tuberosity 	-
Ülkem Cilasun et al. [15]	Turkey, 2015	Is maxillary tuberosity fracture possible while upper first premolar extraction? : Case report	Case report	1	Extraction of maxillary right first premolar	52-years Male	<ul style="list-style-type: none"> Hematoma of right posterior maxillary region Fracture of maxilla – extending from the maxillary right first premolar region extending beyond the right maxillary tuberosity 	<ul style="list-style-type: none"> Fracture stabilized with titanium plate and screws After 4 months – surgical removal of maxillary right molars

Baba et al. [16]	Japan, 2016	Maxillary tuberosity fracture and ophthalmologic complications following removal of maxillary third molar	Case report	1	Extraction of left maxillary third molar	35-years Female	<ul style="list-style-type: none"> Excessive haemorrhage Maxillary tuberosity fracture Bleeding from the left nasal cavity Swelling and ecchymosis of the left cheek and buccal mucosa Trismus slight intra-orbital haematoma via the inferior orbital fissure as well as with extension in the maxillary sinus and adjacent spaces such as buccal, masticator, pterygomaxillary and infratemporal spaces Slight diplopia of left eye in lateral gaze 	<ul style="list-style-type: none"> Haemostatic agent was inserted in the extraction socket and the wound was sutured tightly Nasal packing Vacuum-formed splint - to cover the surgical site for oozing
Olborska et al. [17]	Poland, 2017	Iatrogenic fracture of the maxillary tuberosity –a case report	Case report	1	Attempted extraction of left maxillary third molar	Male	<ul style="list-style-type: none"> Anterior tamponade of the nose due to massive epistaxis Fracture of the maxillary tuberosity along with a part of alveolar process up to the region of maxillary left first premolar Oedema of the left cheek Haematoma of the buccal mucosa around 4 to 5 cm in diameter Haematoma from the tuberosity region up to vestibular mucosa in the region of tooth 23 Haematoma was on the palatal mucosa of the left side 	<ul style="list-style-type: none"> Surgical removal of maxillary left third molar with preservation of maxillary tuberosity

Tay et al. [18]	Malaysia, 2018	Dentoalveolar fracture: A complication of extraction of upper left first molar	Case report	1	Attempted extraction of maxillary left first molar	25-years Male	<ul style="list-style-type: none"> • Facial asymmetry • Swelling of left side of face • Fracture of left maxilla involving the left maxillary first, second, third molar and maxillary tuberosity • laceration on the buccal gingiva adjacent to the maxillary left first molar 	<ul style="list-style-type: none"> • Fragment stabilized by intermaxillary fixation using arch bars • After 2 months - surgical removal of maxillary left first molar
Naik et al. [19]	India, 2018	Fractures of maxillary tuberosity during extraction of maxillary molar- a case report and review	Case report	1	Attempted extraction of left maxillary second molar	-	<ul style="list-style-type: none"> • Mobility in relation to the left maxillary tuberosity region • Mild swelling with tenderness in the left malar region. • Laceration on the palatal mucosa • maxillary right tuberosity fracture including three molar teeth 	<ul style="list-style-type: none"> • The tuberosity and third molar tooth were repositioned to their original location • Maxillary left second molar tooth fragments were extracted surgically • Fractured tuberosity fragments were fixed with 1.5 mm 2 - holed miniplate secured with 2 screws • Lacerations were sutured
Abdul Salik et al. [20]	India, 2019	Study of complications of surgical removal of maxillary third molar	Retrospective study	19 (of 230 patients) (31.66%)	Extraction of maxillary third molar	-	<ul style="list-style-type: none"> • Fractured maxillary tuberosity 	-
Sayed et al. [21]	Oman, 2019	Complications of Third Molar Extraction. A retrospective study from a tertiary healthcare centre in Oman	Retrospective study	6 (of 491 maxillary third molars) (1.2%)	Extraction of maxillary third molar	-	<ul style="list-style-type: none"> • Fractured maxillary tuberosity 	-
Khatoon et al. [22]	India, 2020	A Retrospective study to assess the complications of surgical removal of maxillary third molar	Retrospective study	11 (of 100 maxillary third molars) (36.67%)	Extraction of maxillary third molar	-	<ul style="list-style-type: none"> • Fractured maxillary tuberosity 	-

Tsolov et al. [23]	Bulgaria, 2020	Case report: fracture of the maxillary tuberosity during tooth extraction and subsequent treatment	Case report	1	Attempted extraction of right maxillary second molar	43-years Female	<ul style="list-style-type: none"> Fractured maxillary tuberosity with a dental pin in the maxillary sinus Mobility of the entire right maxillary tuberosity 	<ul style="list-style-type: none"> Surgical removal of maxillary right second molar with the maxillary tuberosity
Paul et al. [24]	India, 2021	Assessment of the complications encountered during and after surgical removal of maxillary third molar: An observational study	Prospective study	13 (of 120 patients) (34.2%)	Extraction of maxillary third molar	-	<ul style="list-style-type: none"> Fractured maxillary tuberosity 	-

Results of individual studies

Table 2 summarizes the results reported from the included studies divided by author, place and year, title, type of study, number of cases with incidence rate, tooth extracted, age and gender of the patient, complications and management. The complication encounter in each study was assessed and the management done was tabulated.

Tooth extracted

11 studies reported maxillary tuberosity fracture following maxillary third molar extraction, 5 studies reported following maxillary second molar extraction, 3 studies following maxillary first molar extraction, 1 study reported tuberosity fracture following maxillary premolar extraction and one study did not report the tooth/teeth involved.

Complications and management

Table 2 summarizes the various complications reported in the studies. The incidence rate of maxillary tuberosity in this review ranged between 0.38 - 36.67%. Maxillary tuberosity fracture was the primary outcome and the associated complications reported in the studies included haemorrhage, edema, fractured alveolus, gingival laceration, oro-antral communication, fractured pyramidal process of palatine bone, epistaxis, tachycardia, hypotension, blood loss, maxillary defect, peri-orbital and subconjunctival ecchymosis, diplopia, and facial asymmetry. Each of these complications were managed by varied methods by various authors such as arterial ligation, diathermy for bleeding control etc.

Discussion

The maxillary sinus is the largest paranasal air sinus. It develops during the 3rd and 4th months of intrauterine life [3]. In

adults it lies about half inch beneath the level of floor of the nose. Its size varies greatly amongst different individuals [3]. The maxillary sinus enlarges into the alveolar process after the eruption of the permanent maxillary first molar [3]. This extension may weaken the walls of the sinus [3]. Chugh et al [4] found that the bone density at the maxilla was the lowest at the maxillary tuberosity region for both alveolar and basal, cortical and cancellous bones than that at other sites. The presence of least density might be due to the absence of direct mechanical forces in the tuberosity region [4]. The density was found to be 888 Hounsfield unit (HU) in the buccal alveolar cortical bone, 970 HU in the palatal alveolar cortical bone, 362 HU in the alveolar cancellous bone, 933 HU in the buccal basal cortical bone and 411 HU in the basal cancellous bone [4]. The possible etiologic factors for maxillary tuberosity fracture during extraction of maxillary teeth are: a large maxillary sinus extending into the maxillary tuberosity, resorption of the maxillary alveolar process bringing the antral lining close to the oral mucoperiosteum, unerupted maxillary third molar, isolated tooth, tooth with divergent roots, tooth with more roots, tooth with curved roots, tooth with dental anomalies, ankylosed tooth, tooth with hypercementosis, tooth with chronic periapical infection, cyst, multiple extractions [1].

The incidence rate of maxillary tuberosity is varied. The incidence rate of maxillary tuberosity fracture during extraction in cases reported by various authors included in this review ranged between 0.38 - 36.67%. Fractures of maxillary tuberosity pose a serious problem for surgical and prosthetic rehabilitation [5]. The tuberosity fracture can be observed clinical during the extraction and also can be diagnosed radiographically [3,5]. The fracture can be noted by crepitus on palpation from either the buccal or palatal aspect or both or mobility of the posterior maxillary alveolus [3,5]. There may be other clinical signs like hematoma or any soft tissue lacerations near the fracture [5]. There may be an

associated oro-antral communication that depends on the size of the tuberosity fracture [5]. In this review, 5 studies reported oro-antral communication following tuberosity fracture. Sometimes a tuberosity fracture may be unrecognised until the extracted tooth is examined [3]. In such cases the tuberosity bone may be fused with the extracted tooth and this may have an extension of the maxillary sinus with its mucosal lining [3]. In such cases the extraction site has to be carefully examined for an oro-antral communication and its extent [3]. The tuberosity fracture can be categorised as mild, moderate and severe based on the size of the fracture [6-25].

If the fractured tuberosity is small or if the tooth intended for extraction is infected at the time of fracture, then the fragment should not be left in situ because the fractured complex might not heal due to the persisting infection [1]. But some authors consider immobilization of the fractured fragment using a splint for 3 - 5 weeks and surgical extraction of the tooth at the end of the splinting period [3]. When a large bony fragment is present then one of the following measures can be used: surgical removal of the tooth by root sectioning; detaching the fractured maxillary tuberosity from the roots of the tooth, stabilizing the fractured segment using rigid fixation technique for 4 - 6 weeks and then the tooth can be surgically removed at a later date, the large fragment can be removed and the soft tissue can be sutured back with airtight closure if the fragment is already detached from the maxilla [1]. Bone marrow stromal cells from the maxillary tuberosity can be reliable, accessible and easy-to-harvest intraoral sources of osteoprogenitor cells for bone tissue engineering as an alternative to the iliac crest bone marrow, hence the preservation of maxillary tuberosity during tooth extraction is of great importance [26].

Conclusion

Since the density of the bone at the maxillary tuberosity is relative less and the extension of the maxillary sinus into the alveolar region weakens it further, care should be taken to avoid tuberosity fracture during teeth extraction. Also, the patients must be informed about this potential risk during extraction and its complications prior to extraction of maxillary teeth, especially the molars. A proper pre-operative clinical and radiological examination is essential to prevent such a complication. If it is thought that there is a high risk of tuberosity fracture during extraction from the pre-operative evaluation, then surgical removal of the tooth is recommended.

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