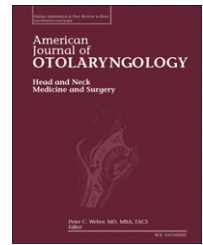


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Spontaneous ventilation of the frontal sinus after fractures involving the frontal recess[☆]

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ABSTRACT

Purpose: Frontal sinus fractures (FSF) have potentially catastrophic consequences due to frontal recess (FR) obstruction and proximity to the brain and orbit. Lack of follow-up and ability to predict which type of fractures predispose to complications has biased surgeons toward definitive interventions such as sinus obliteration and cranialization. These procedures carry inherent risk and may be unnecessary in a subset of patients. This study seeks to better characterize spontaneous ventilation in subjects with FSFs, including those involving the FR.

Materials and methods: Review of a prospectively maintained trauma database between 2009 and 2013 at a level 1 trauma center. Patients with frontal sinus fractures with follow-up imaging (>6 weeks) available were included. The medical records and imaging were reviewed for evidence of spontaneous ventilation of the frontal sinus.

Results: Nineteen patients sustained frontal sinus fractures in the study period with mean imaging interval of 67.4 weeks (range, 6–188.4 weeks). Injury mechanisms included fall (32%), assault (31%), motor vehicle accident (17%), pedestrian-versus-automobile (12%), and gunshot wound (8%). 8/19 patients (42%) sustained FSFs involving the FR and 7/8 (87.5%) spontaneously ventilated by time of interval imaging. The one patient with persistent radiographic sinus opacification was associated with a naso orbital ethmoid and medial orbital blowout fracture. 6/19 patients (32%) sustained FSF sparing the FR, and all spontaneously ventilated by the time of interval imaging. 5/19 patients (26%) underwent surgical intervention.

Conclusions: An expectant, sinus-preserving approach to acute FSFs involving the FR is safe and effective. Etiology of re-ventilation failure may be due to tissue obstruction, rather than the frontal recess fracture itself.

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Abbreviations: FSF, frontal sinus fracture; FR, frontal recess; NOE, naso orbital ethmoid; CSF, cerebrospinal fluid; CT, computerized tomography; AT, anterior table; PT, posterior table; MVA, motor vehicle accident.

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1. Introduction

Frontal sinus fractures account for 5–15% of all maxillofacial injuries [1]. Despite the relative infrequency, these fractures have potentially catastrophic consequences given the proximity to the brain and orbit. Serious complications of frontal sinus fractures include cerebrospinal fluid (CSF) leak, meningitis, encephalitis, brain abscess and occlusion of the drainage pathway [2,3]. Anatomic obstruction of the frontal sinus drainage pathway, also known as the nasofrontal outflow tract and the frontal recess (FR), can lead to potentially devastating late complications such as persistent sinusitis, mucocele, and mucopyocele long after initial evaluation [3,4].

Lack of patient follow-up and an inability to accurately predict which type and pattern of fracture predisposes patients to complications has historically biased surgeons toward expeditious, non-specific, and definitive interventions such as frontal sinus obliteration or cranialization [5,6]. These surgical interventions each carry inherent risk and may be unnecessary in a portion of patients that may achieve spontaneous ventilation of the frontal sinus. Failed ventilation of the frontal sinus manifests as persistent opacification of the sinus on computerized tomography (CT) and may portend the development of a frontal mucocele.

Various treatment algorithms for the management of frontal sinus fractures have been proposed but vary widely and lack consensus [7]. Furthermore, the degree and nature of FR injury as it relates to the anticipated complications have not been clearly defined, yet remain a critical variable in the decision to pursue surgical intervention. Ideally, through characterization of fracture patterns on high-resolution CT, management of FR fractures may be refined such that surgical interventions are considered only for fracture patterns associated with a failure to ventilate the frontal sinus. Expectant management or interval imaging has been advocated as a reasonable alternative treatment strategy for a limited subset of these patients [2,8,9].

In addition, present-day frontal sinus fracture patterns may no longer reflect those seen in prior studies. With the advent and mandated adoption of the airbag injury mechanisms have evolved from high-impact injuries associated with automobiles to lower-energy means such as assault [5,10,11]. Prior data are limited as frontal sinus fractures are relatively rare and trauma patients are associated with low rates of follow-up [2,12]. Therefore, ideally, patients that could benefit from conservative management are identified at the time of initial evaluation.

The present study seeks to better characterize the rates of spontaneous ventilation in subjects with fractures of the frontal sinus including those that involve the FR as seen on interval imaging.

2. Materials and methods

The University of California, San Diego Hillcrest Medical Center is a level-1 trauma center that prospectively maintains a database of admitted patients. After institutional review board approval, a 5-year review from January 2009 to December 2013

was performed on all patients who had sustained a skull-base fracture, which includes all frontal sinus fractures. The complete medical records and initial high-resolution (1-mm) CT findings were reviewed to identify patients with acute frontal sinus fractures. Associated facial fractures, demographic data, injury mechanisms and frontal sinus interventions were recorded. All patients were evaluated at the time of admission and treated by either the plastic surgery or otolaryngology services. Conservative management involved monitoring for complications while inpatient and return precautions upon discharge.

Patients who had sustained acute frontal sinus fracture and received a CT scan 6 weeks or longer after date of injury were subsequently selected for review. This interval was selected based on expected time for clearance of intrasinus traumatic hemorrhage if present, based on endoscopic frontal sinus surgery literature [13]. Follow-up scans for any indication that included the frontal sinus and FR were selected, including dedicated brain CT imaging (3-mm cuts). Two otolaryngologists (ASD, AJ) reviewed these CT-scans. Location of the frontal sinus fracture on admission was characterized as involving the anterior table, posterior table and/or the FR.

Follow-up CT scans were reviewed and frontal sinus re-ventilation was operationalized into either spontaneous re-ventilation of the sinus or persistent opacification (Fig. 1). Review of the medical record was performed and clinical symptoms were recorded (Fig. 2).

2.1. Statistical analysis

For statistical analysis, the chi-square test was used for discrete variables, and t-test was used for continuous variables. A value of $p < 0.05$ was considered significant.

3. Results

A total of 669 adult trauma patients who sustained acute traumatic skull-base fractures (ICD-9 801.00–801.99), which include frontal sinus fractures, were identified during the study period. A total of 102 patients (15%) had suffered acute traumatic frontal sinus fractures involving at least one-subsite (anterior table, posterior table, or FR). Of patients with frontal sinus fractures, 19 (31.6%) patients had at least 6-week (67.4 ± 56.7 weeks; range 6–188.43 weeks) interval imaging available. Compared to subjects without interval imaging available, age of subjects with follow-up scans was not significantly different (42.8 ± 16.9 vs 38.5 ± 18.7 ; $p = .21$), and was equally as likely to have sustained the injury through an assault (47% vs 31%; $p = .18$), fall (26% vs 32%; $p = .60$), motor vehicle accident (MVA) (11% vs 17%; $p = .50$) and gunshot wound to the head (16% vs 8%; $p = .27$). However 12% of patients in the group without interval imaging had suffered a pedestrian vs. auto accident, whereas no patient in the group with interval imaging available sustained an injury with this mechanism.

3.1. Concomitant injuries

18 of 19 patients had concomitant maxillofacial (79%), ocular (84%), or intracranial injuries (74%).

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