Breach of Posterior Wall of Frontal Sinus: Management with Preservation of the Sinus

Jacob L. Freeman and Ken R. Winston

Key words
- Breach of frontal sinus
- Complications
- Cranialization of frontal sinus
- Frontal sinus fracture
- Management of frontal sinus fracture
- Posterior wall of frontal sinus
- Rhinorrhea

Abbreviations and Acronyms
CSF: Cerebrospinal fluid
NF: Nasofrontal

From the Departments of Neurosurgery of The University of Colorado Denver School of Medicine, Denver Health Medical Center, Denver Colorado, University Hospital, Aurora Colorado, and Children's Hospital Colorado, Aurora, Colorado, USA

To whom correspondence should be addressed: Jacob L. Freeman, M.D. [E-mail: Jacob.freeman@ucdenver.edu]

Citation: World Neurosurg. (2015). http://dx.doi.org/10.1016/j.wneu.2014.12.023

Journal homepage: www.WORLDNEUROSURGERY.org

Available online: www.sciencedirect.com

OBJECTIVE: **To analyze outcomes after the management of mild (<1 mm) and moderately severe (>1 mm and <5 mm) breaches of the posterior wall of the frontal sinus with a goal of maintaining or restoring the functional status of the sinus.**

METHODS: **A retrospective analysis of prospectively accrued data was performed on patients with mild and moderately severe breaches of the posterior wall of their frontal sinus who were managed with the intent to preserve the frontal sinus. Data on presenting features, pathology, details on breaches of the posterior wall, management, outcome, and complications were collected from medical records and neuroimages.**

RESULTS: **Forty-two cases met inclusion criteria. Diagnostic categories included trauma in 34 cases, infection in 3, and other categories in another 5 cases. Five presented with cerebrospinal fluid rhinorrhea, and 26 had radiographic evidence of obstruction of a nasofrontal duct at time of presentation. Fifteen patients were managed without surgical intervention, and 27 underwent surgery. No complications occurred in the patients managed without surgery and 4 postoperative cerebrospinal leaks that were managed successfully with a period of drainage occurred in the surgical group. No patient developed meningitis or mucocele.**

CONCLUSIONS: **Many patients with mild to moderately severe breaches of the posterior wall of the frontal sinus can be managed safely and effectively by techniques that preserve the anatomy and function of the frontal sinus.**

INTRODUCTION

Breaches of the posterior wall of the frontal sinus can result from trauma, infection, neoplasia, or erosion from pressure. In addition, the frontal sinus may be breached iatrogenically or by intention in the course of gaining intracranial surgical exposure. Aggressive surgical methods commonly are used to manage breaches of the posterior wall that are moderately or severely displaced, comminuted, associated with cerebrospinal fluid (CSF) rhinorrhea, have nasofrontal (NF) duct compromise, or are filled with purulence (2, 5, 9, 10, 14, 29, 31, 32). Neurosurgeons deal with many categories of breach of the posterior wall of the frontal sinus, yet most publications on this subject are in the otolaryngological, plastic surgical, and oral maxillofacial literature, with relatively few found in neurosurgical journals (1, 2, 4-8, 10, 12-16, 21, 22, 24-27, 29-34, 36, 39-43, 48).

For decades, cranialization and/or obliteration has been used commonly for most significant breaches of the posterior wall of the frontal sinus (9, 13-15, 22, 24, 26). Several authors have stressed the nearly mandatory requirement for cranialization and/or obliteration in patients with CSF rhinorrhea, NF duct compromise, or fractures of the posterior wall that are appreciably comminuted or displaced (13, 15, 31, 32). Most surgeons are uncomfortable with nonsurgical management for all except the most minor breaches because of fear of persistent CSF rhinorrhea, meningitis, brain abscess, mucocele, or combinations thereof. Although many surgeons agree on the need for aggressive surgical management, usually cranialization or obliteration for severely disrupted or shattered frontal sinuses, there remains a large group of patients with mild to moderately severe posterior wall disruptions, from multiple etiologies, that is often, but inconsistently, grouped managerially in published reports with those having severe breaches, particularly if there is fracture displacement greater than one wall thickness, posterior wall comminution, CSF rhinorrhea, or compromise of the NF ducts (2, 5, 13, 29).

This report reviews the outcomes and complication rates in a consecutively encountered series of patients with mild to moderately severe frontal sinus breaches, all of whom were managed with a consistent goal of maintaining or restoring the functional status of the frontal sinus with satisfactory cosmetic outcome and without compromising safety. Multiple etiologies for breaches of the posterior wall of the frontal sinus that come to neurosurgical attention are included in this report because of their similarities in therapeutic decision-making and management.

MATERIALS AND METHODS

All patients encountered by the senior author (K.R.W.) between August 1, 1998, and January 1, 2014, who had breach of the

posterior wall of the frontal sinus of 5 mm or less, regardless of cause, are the basis for this investigation. Fractures were divided into 4 groups: nondisplaced, displaced less than 1 mm (mild), displaced 1–5 mm with or without comminution (moderate), and displaced greater than 5 mm with or without comminution (severe). Severe, comminuted fractures were treated surgically with a cranialization operation that does not preserve the function of the sinus. These patients were therefore excluded from the study. Additional exclusion criteria included breach of the frontal sinus that did not involve the posterior wall and death within 7 days of presentation. Patients with surgical osteotomies crossing the frontal sinus were included, as were patients having sinus breaches related to sinusitis, subdural, or epidural empyema, and Pott puffy tumor. The radiographic appearance of the NF duct did not affect the categorization of these fractures in the current study. Hospital records and neuroimaging were reviewed. This study was done with approval of the Colorado Multi-Institutional Review Board.

Description of Technique

Fractures of the posterior wall of the frontal sinus with no displacement or with displacement of less than 1 wall thickness, including those with suspicious or definite CSF rhinorrhea, were managed nonoperatively. Minimally displaced posterior wall fractures, with or without comminution, in patients who required surgical intervention for other cranial or intracranial pathologies such as depressed fractures of the cranial vault or intracranial hematomas were surgically ignored. Persistent CSF rhinorrhea lasting more than approximately 24 hours, if not controlled by bed tilt, was managed with lumbar or ventricular drainage, and antibiotics were administered during the course of drainage.

Moderately depressed and comminuted fractures of the posterior wall with displacement of bony fragments greater than one wall thickness, including patients with definite or presumed disruption of dura, as evidenced by subdural air or by CSF rhinorrhea, were managed through a bicoronal scalp incision and bifrontal craniotomy. Mucosa that was disrupted, loose, or folded was removed. Loose bony fragments of the posterior wall were repositioned and aligned to reestablish normal sinus anatomy. When possible the fragments were wedged in place but some required metal plates and screws.

The NF duct was explored with a probe for patency in all patients undergoing surgery in whom there was radiographic evidence of compromise and in all patients with sinusitis. If found to be compromised, the duct was expanded with a small osteotome, bone impactor, or both to reestablish a functional drainage pathway.

The dura was inspected in all surgical cases, and lacerations and durotomies were repaired with running 4-0 polyglycolate suture when the dural edges could be identified and brought together. In patients with tenuous dural approximation, a free strip of periosteum was harvested and either sewn snugly over the damaged dura with 4-0 polyglycolate suture or simply placed over the area of attenuated dura and tacked in place with sutures to prevent displacement during irrigation, and the frontal bone flap was replaced. Free periosteal flaps were placed along the floor of the frontal fossa when secure, watertight closure was not possible. All patients with purulence within a frontal sinus underwent surgery to drain and irrigate the sinus and to remove any associated infection in epidural, subdural, or intracerebral locations. All contaminated bone, including free flaps, were scrubbed with either a bacitracin or providone iodine solution and returned to their normal anatomical locations (49).

In patients in whom both anterior and posterior walls of the frontal sinus were surgically breached, typically by an osteotomy crossing the upper or mid-portion of the frontal sinuses during elective craniotomy to address intracranial pathology, the disrupted mucosa was removed from the sinus within the free bone flap, the sinuses irrigated, and the NF ducts were ignored. At time of closure, all frontal bone flaps were seated snugly to obliterate the kerf crossing the sinus.

A subgaleal drain was inserted in each patient and removed 1–2 days later. Intravenous antibiotics were administered preoperatively in nonemergent cases for 24–48 hours after surgery in clean and clean-contaminated cases. Longer courses of antibiotics were administered in patients with persistent CSF rhinorrhea, frontal sinusitis, or epidural or subdural abscess.

RESULTS

Forty-two patients, 33 male and 9 female, with breaches of the posterior wall of the frontal sinus met criteria for inclusion. The diagnostic categories and associated intracranial pathologies are summarized in Table 1. The age range was 6–79 years with a median of 27 years; 15 patients were younger than 18 years of age. More males were affected than females (77%), and the great majority of posterior wall breaches (81%) were traumatic in origin. The mechanism of posterior wall breaches was attributable to trauma in 34 patients, iatrogenic breach during craniotomy to address cranial, or intracranial pathology in 7 and posterior wall erosion from arteriovenous malformation in 1 (Table 2). Twenty-three patients, including those cases with infection and neoplasia, had disruptions of dura, but only 5 of these presented with CSF rhinorrhea (Table 3).

Thirty-four patients sustained breaches of their anterior and posterior walls, and 8 had isolated posterior wall breaches. The posterior wall breaches were not displaced in 22 patients, displaced less than one posterior wall thickness in 11, and between one wall thickness and 5 mm in another 9. The NF duct appeared on computed tomography imaging to be patent in 16 patients and was possibly compromised or indeterminate in 26. Five patients had CSF rhinorrhea on presentation, and 1 patient sustained a complex fracture extending from the posterior wall of the frontal sinus, across the middle fossa, and into the petrous temporal bone resulting in CSF otorrhea. This patient's CSF leak was managed successfully with lumbar drainage. Twenty-nine of the 34 patients with trauma sustained concomitant intracranial injuries as evidenced by pneumocephalus, intracranial hemorrhage, bullet tract, large intracerebral hemorrhage, and cerebral contusion.

Twenty-seven patients underwent surgical intervention, and the remaining 15 were managed without surgery. Five of these operations were done solely to address issues confined to the frontal sinus and