

**Review Article**

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Advanced Surgical Approaches to Frontal Bandeau and Sinus Fracture Management

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Introduction to Frontal Bandeau in Craniofacial Reconstruction

The frontal bandeau is a pivotal anatomical structure in craniofacial reconstruction, particularly concerning its role in both aesthetic and functional outcomes. Surgical manipulation and positioning of the supraorbital bar and forehead are critical, as they significantly impact the upper facial balance. Common surgical interventions include the resection of a compromised frontal bandeau and its replacement with parietal cranial bone. This approach not only enhances the aesthetic contour of the upper face but also ensures the precise alignment of frontozygomatic sutures, thereby anchoring the facial structure effectively. The term “frontal bar” is often used synonymously with the frontal bandeau in reconstructive contexts, highlighting the critical need for precision in restoration.

Treatment Planning for Frontal Bandeau Fractures

In facial reconstruction, treatment planning follows the methodologies established by pioneers like Tessier and further refined by Merville, with a strong emphasis on restoring both form and function. The initial stage involves obtaining a precise three-dimensional diagnosis of the facial skeleton at all levels. This

comprehensive evaluation necessitates the exposure of the cranial vault, cranial base, and fractures across the middle and lower thirds of the face. Subsequent osteosynthesis techniques are then employed to strategically secure bone fragments, facilitating the restoration of facial anatomy.

The reconstruction of the frontal bandeau is particularly significant due to its role in shaping the forehead, determining the anterior projection of the upper third of the face, and maintaining transverse facial width. It also provides a stable foundation for subsequent reconstruction of the central and lateral midface. Precise positioning of the frontal bandeau is crucial, as any misalignment can severely compromise the accurate reconstruction of these facial regions. In addition to surgical precision, it is essential to ensure the effective isolation of the intracranial compartment from the paranasal sinuses to prevent complications during reconstruction.

Early Intervention and Risk Assessment

While early surgical intervention is generally favored, it must be balanced against the potential risks, including mortality. Studies have documented mortality rates as high as 12% with immediate surgery. However, adherence to specific criteria—such as a post-

resuscitation Glasgow Coma Scale (GCS) score above 13, stable intracranial pressure below 15 mmHg in a cardio vascularly stable patient, and the absence of midline shift on CT-makes early intervention a safe and viable option.

Infection Prevention and Reconstruction Strategies

Preventing both early and late infections is another critical consideration, as fractures in this region pose a heightened risk of meningitis and brain abscesses, even in the absence of cerebrospinal fluid (CSF) leaks. The absence of a CSF leak does not preclude the possibility of an underlying dural tear. Therefore, a thorough evaluation of the fracture configuration, bone segmentation, bone loss, and the condition of the overlying tissues is necessary. The “jigsaw” method of piecing the fracture together is often the most reliable approach to maintain transverse facial width and achieve optimal contour. Alternatively, primary bone grafting or the use of alloplastic materials such as titanium mesh or PEEK implants can be considered for the reconstruction of the frontal bandeau.

Osteology and Anatomy Considerations

The frontal bandeau encompasses the frontal bone, a critical component of the skull, located in close proximity to the frontal sinuses. These sinuses are of particular importance due to their role in both facial structure and function. Understanding the detailed anatomy of this region is vital for devising effective treatment strategies for fractures.

The frontal sinuses, typically existing in pairs, are situated posterior to the superciliary arches, lying between the outer and inner tables of the frontal bone. Unlike typical trabecular bone, they are airfilled cavities lined with mucous membrane, draining into the nasal passages. Each sinus’s shape and distribution are unique to the patient, usually centered around the nasion and extending towards the junction of the medial and lateral thirds of the supraorbital margin. Their approximate dimensions are 3 cm in height, 3 cm in width, and 2 cm in depth.

Frontal Sinus Fracture Management

Frontal sinus fractures, commonly resulting from high-energy impacts such as motor vehicle accidents or assaults, present significant risks to the brain, eyes, and neck. Complications arising from these fractures include CSF leaks, meningitis, encephalitis, mucocele, empyema, brain abscess, osteomyelitis, and cavernous sinus thrombosis. The complexity of managing frontal sinus fractures underscores the necessity of a comprehensive approach to prevent and address these potential complications.

Achieving a “safe sinus” is a primary goal, focused on restoring facial contour and minimizing short- and long-term complications. Early and aggressive intervention is advantageous in establishing a secure sinus environment. One critical aspect of achieving this goal involves the reconstruction of the anterior sinus wall. Decisions on initiating treatment depend on factors such as the degree of displacement, the thickness of the soft tissues, and the shape of the defect. While definitive guidelines are scarce, a practical approach often involves using a 3 mm cutoff for surgical intervention. In

cases requiring secondary intervention, materials like Norian bone cement offer a reliable option. For extensive comminution, autogenous grafts from the inner or external tables of the calvarium provide a dependable solution, and the use of titanium mesh combined with a folded cushion of pericranium is a viable alternative for anterior wall reconstruction.

Managing Posterior Wall Fractures

Posterior wall fractures of the frontal sinus are common but often involve minimal displacement. The decision to intervene surgically is guided by the fracture’s size and the presence of intracranial air, which may indicate a dural tear, especially if displacement exceeds the sinus wall’s thickness. Given the high risk associated with the proximity to the nose and sinuses, a surgical approach is typically favored. This usually involves performing a frontal craniotomy with brain retraction for exploration and dural repair.

Surgical Planning and Considerations

Key considerations in planning surgery for frontal sinus fractures include the location of the defect, the degree of fragmentation and displacement, and the size and thickness of the anterior sinus wall. Additionally, evaluating extensions into the supraorbital and naso-orbito-ethmoid regions, as well as the presence of other mid-facial fractures, informs the surgical approach for comprehensive reconstruction. A fundamental principle is ensuring adequate bone fixation, which is essential for immobilizing fracture elements and achieving stability. This principle underscores the importance of stability in optimizing both aesthetic and functional outcomes in frontal sinus fracture management.

Patient Triage and Life-Saving Procedures

In triaging patients with frontal sinus fractures, a crucial determinant is the assessment of a displaced posterior wall. In the absence of such displacement and a CSF leak, surgery may be unnecessary. However, if a CSF leak is present, observation for 4-7 days is recommended, with cranialization considered if the leak persists. If a displaced posterior wall is identified along with a CSF leak, the approach involves reduction and fixation of the anterior wall along with cranialization. If no CSF leak is observed, the decision hinges on the involvement of the frontonasal duct. If implicated, cranialization is advised; otherwise, it remains a consideration. The cranialization procedure involves a coronal flap, craniotomy, removal of the posterior wall and mucous membranes, dura sealing, duct obliteration, and closure of the defect.

Frontal sinus fractures pose a considerable risk to vision and adjacent structures. Immediate evaluation and stabilization, including a thorough ophthalmologic examination, are foundational steps. CT scans guide the assessment of fracture severity and the consideration of surgical interventions, such as Open Reduction and Internal Fixation or Endoscopic Sinus Surgery. Orbital decompression becomes critical in cases with significant orbital involvement. Proactive management of complications, including prompt attention to cerebrospinal fluid leaks or infections, is

essential for achieving optimal outcomes. These measures, when executed collaboratively by a multidisciplinary team, play a pivotal role in preserving eyesight and mitigating potential complications associated with frontal sinus fractures [1-4].

Conclusion

In conclusion, the management of frontal bandeau and sinus fractures necessitates a nuanced understanding of both anatomy and surgical techniques. A multidisciplinary approach, early and appropriate intervention, and meticulous planning are essential for optimizing both functional and aesthetic outcomes. By addressing the unique challenges posed by these fractures, including the risk of infection, CSF leaks, and the maintenance of facial symmetry, clinicians can significantly improve patient outcomes. As surgical methods and materials continue to advance, the prospects for effective management of these complex injuries will only improve.

Conflict of Interest

I declare no conflict of interest in the preparation of this manuscript.

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