ABSTRACT

Image guidance is widely used for the endoscopic treatment of sinonasal and anterior skull base pathology. We report a patient with a frontal sinus fracture who underwent reduction using image guidance technology. We describe a novel technique that aids the surgeon in identifying sinusotomy sites that can be used to develop the osteoplastic flap for access to the frontal sinus. We believe that this is a tool that not only allows the surgeon to enter the frontal sinus with precision, but also minimizes the potential for inadvertent intracranial entry.

CASE REPORT

A twenty-three year old male presented with a cosmetically deformity anterior table frontal sinus fracture one week after being assaulted. Facial CT showed no involvement of the posterior table or nasofrontal outflow tract, and he had no other cranial, facial or medical problems. There was no evidence of cerebrospinal fluid leak. After a detailed discussion of the risks, benefits, and alternatives the patient elected for open repair to correct the cosmetic deformity.

During pre-operative planning the patient underwent a sinus CT using the InstaTrak Surgical Navigation System (GE Healthcare, UK). Rather than wearing the registration headset in the standard fashion the headset was reversed so that the headset receiver rested near the patient's sternum rather than over his forehead. The scanning protocol was unchanged except that the scan was carried out more inferiorly to include the entire forehead.

Following endotracheal intubation the forehead was again placed in the inverted position as during the imaging protocol. A 1000 drape (3M, St Paul, MN) was placed over the forehead and the patient was prepped for a bicoronal approach to the frontal sinus. (Fig 1) The InstaTrak system was registered and the registration was confirmed using surface anatomy. A bicoronal incision was made in a standard fashion. Dissection proceeded in a subaponeurotic plane until approximately 5 cm above the suprabrowial rim where a subperiosteal dissection was done. The subperiosteal neurovascular bundle was identified bilaterally. The anterior table fracture was identified. The InstaTrak Long Pointer (GE Healthcare, UK) was then used to identify areas of intact frontal sinus bone where sinusotomy sites were selected. (Fig 2 and 3) Using a high-speed otologic burr these marked sites were entered and then connected using a guarded Pediatric Craniotome (Anspach, Palm Beach Gardens, FL). The frontal sinus was inspected and the patency of the nasofrontal outflow tract ensured. The anterior table fracture was then reduced and plated. The patient recovered uneventfully and follow-up imaging showed no involvement of the posterior table or nasofrontal outflow tract, and he had no other cranial, facial or medical problems. There was no evidence of cerebrospinal fluid leak. After a detailed discussion of the risks, benefits, and alternatives the patient elected for open repair to correct the cosmetic deformity.

DISCUSSION

Image guidance systems (IGS) in sinonasal and skull base procedures have been increasingly utilized over the past decade. Proposed benefits of image guidance include increased accuracy, decreased radiation exposure, and improved outcomes especially for revision sinus surgery.(2) A role for image guidance in reconstructive surgery following facial trauma has not been well established; however, it is increasingly being utilized for minimally invasive procedures of the anterior skull base and endoscopic exploration and repair of the frontal sinus.

Image guidance systems use either electromagnetic (radiofrequency) or optical (infrared) signals to localize instruments relative to the patient's anatomy. (3) Both systems have their advantages and disadvantages. Electromagnetic systems such as the InstaTrak use a radiofrequency transmitter that is attached to a patient worn headset and a separate receiver that is placed in the cranial cavity in 4/6 patients. (4) Sindwani et al. described using an optical based system with a headset anchored to the skull. With electromagnetic systems the patient is required to wear a headset during the initial CT scan and during the operation. Optical based systems such as Landmark's (Landau Electronics, Jacksonville Florida) use an infrared camera to track the location of light emitting diodes attached to surgical instruments and to a headset worn by the patient. With optical systems the patient does not have to wear a headset during the initial CT scan. Studies have not shown a difference between electromagnetic and optical systems. (5) Both provide anatomical accuracy within 2 millimeters and surgical results, intra-operative blood loss, and complications are similar. System selection is institution and surgeon dependent.

Image guidance in osteoplastic frontal sinus surgery and cranial procedures has been described previously, yet not using radiofrequency systems. Caruso at al. first described the use of image guidance compared to the conventional radiographic template technique. They found that an optical based IGS did not underestimate the size of the frontal sinus while the Caldwell view template would have resulted in entrance into the cranial cavity in 4/4 patients. (6) Sindwani et al. described using an optical based system with a headset anchored to the patient's skull to accurately demarcate the perimeter of the frontal sinus. (5) Their findings were significant in that there were no complications in the fifteen patients where IGS was used, yet in three of nine where conventional technique was used complications included dural tear and orbital fat exposure due to overestimation of the size of the frontal sinus.

Our technique utilizes a radiofrequency based system familiar to many Otolaryngologists as an aid in external approaches to the frontal sinus. Multiple studies have demonstrated that IGS provide for an accurate assessment of the size of the frontal sinus. In contrast, the 6 foot Caldwell approach via highly technically dependent and frequently overestimates the size of the frontal sinus. Transillumination techniques are frequently ineffective as any fluid density within the frontal sinus such as pus or blood will distort the boundaries. An advantage of the InstaTrak system over an optical based system is that the headset does not have to be aligned to the skull. This technique allows those hospitals and departments with the InstaTrak system to use an external based approach to the frontal sinus whether it is for trauma, chronic sinus disease or other skull base and transnasal procedures.

REFERENCES