Article published online: 2024-01-26

Minimally Invasive Repositioning of a Frontal Sinus Anterior Wall Fracture Using Intraoperative Sonographic Guidance

OPEN ACCESS

Background

In rare cases, trauma to the midface can result in isolated fractures of the frontal sinus wall. Dislocated fractures usually require surgical treatment. Possible complications of a frontal sinus fracture include (persistent) CSF leaking, pneumocephalus, frontal sinusitis or meningitis, chronic headaches or dysesthesia, and the formation of a mucocele (Metzinger et al., Craniomaxillofac Trauma Reconstr. 2009; 2 (1): 27–34). Computed tomography (CT) is the imaging method of choice, ideally with high resolution (Kühnel et al., GMS Curr Top Otorhinolaryngol Head Neck Surg. 2015;14).

There are different surgical approaches to repositioning, each with specific advantages and disadvantages depending on the exact injury pattern and the individual anatomical conditions. Sometimes it is possible to operate through existing wound surfaces ("trauma approach"), and sometimes endoscopic treatment through an endonasal or transorbital approach is possible (Kühnel et al., GMS Curr Top Otorhinolaryngol Head Neck Surg. 2015;14) (Vincent et al., Management of Frontal Sinus Fractures. Facial Plast Surg. 2019; 35 (6): 645–50).

In some cases, open surgical repositioning of the fracture is needed. Established surgical approaches are the coronal incision, the blepharoplasty access, and the eyebrow margin cut. These approaches provide a broad view of the frontal sinus. Disadvantages are the relatively large procedure with a risk of permanent aesthetic disfigurement from scarring, the risk of damage to the supraorbital nerve, as well as the longer inpatient stay (Kühnel et al., GMS Curr Top Otorhinolaryngol Head Neck Surg. 2015;14). In 2007, Mavili et al. described a minimally invasive, closed reduction technique to treat isolated fractures of the anterior wall of the frontal sinus (Mavili et al., J Craniofac Surg. 2007 Mar;18 (2): 415–9).

A recent meta-analysis however, did not make any general recommendations regarding the surgical procedure (Le et al., Sinus Fracture Management Meta-analysis: Endoscopic Versus Open Repair. J Craniofac Surg. 2021; 32 (4): 1311–5). Vincent et al. described a possible algorithm for choosing the appropriate therapy of frontal sinus fractures (Vincent et al., Management of Frontal Sinus Fractures. Facial Plast Surg. 2019; 35 (6): 645–50).

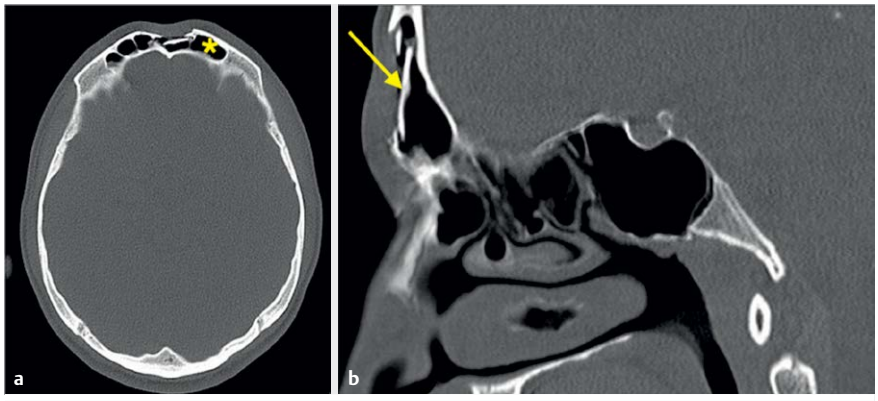
There is an increasing amount of literature describing the value of intraoperative sonography in midface fractures. Noy et al. reported superior results for closed reduction of fractures of the nasal bone in children when performed under ultrasound guidance (Noy et al., Rhinology. 2023; 61 (6): 568–573). Successful reduction under sonographic control has also been described for isolated extracapsular condylar fractures (Kucukguven et al., J Craniomaxillofac Surg. 2022 Jun;50 (6): 473–477). In some cases, intraoperative CT scan is used to check the reposition of midface fractures. An advantage here is the more accurate three-dimensional representation, especially of complex bony anatomy (for example, the orbit) as well as the more deeply located structures. The disadvantages compared to sonography are the radiation exposure as well as the higher time requirement and the lower availability of intraoperative CT. For more complex reductions, however, CT remains the gold standard (Wilde et al., Facial Plast Surg. 2014 Oct; 30 (5): 545–53).

In this article, we describe a minimally invasive method for repositioning an impression fracture of the frontal sinus anterior wall.

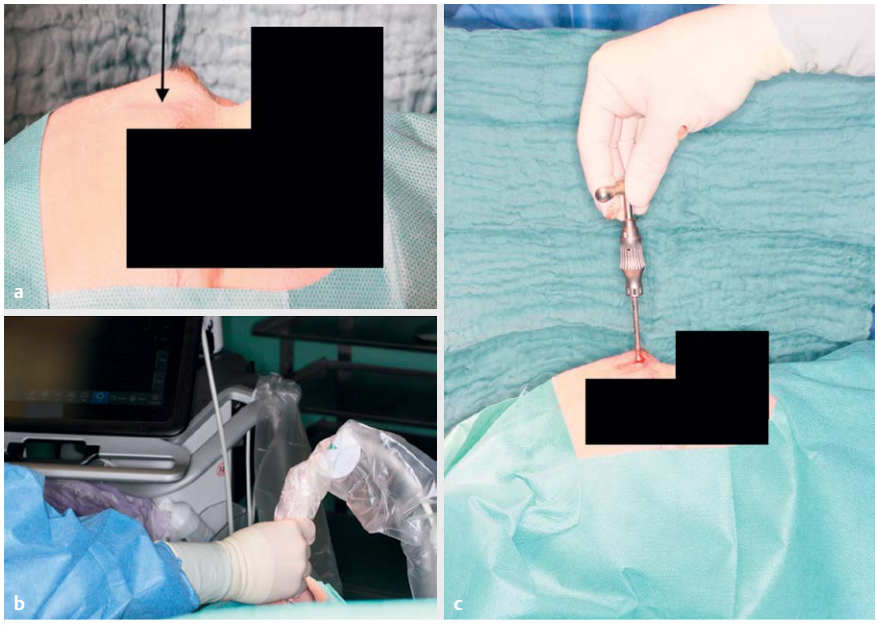
Case

A 25-year-old patient presented initially at our interdisciplinary emergency department due to a traumatic injury of the forehead caused by an assault. The visible impression in the area of the forehead was already clinically highly suspicious of a fracture of the Os frontale. CT confirmed an isolated, median, multi-fragment fracture of the frontal bone with dislocation into the frontal sinus (see ▶ **Fig. 1**) but without evidence of an obstruction of the outflow tract. There were no other fractures of the midface or other injuries. Owing to the dislocation and the resulting aesthetic impairment, surgical treatment was indicated. Local cooling of the lesion, appropriate analgesia, as well as an appointment to return in 3 days for the planning of surgery were recommended to the patient.

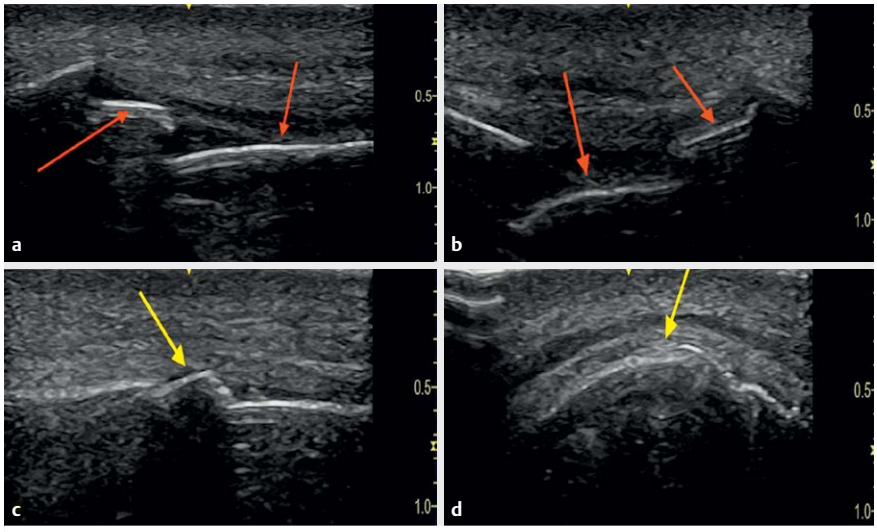
At this presentation, the patient reported a persistent headache and occasional bleeding when blowing his nose. There were no other symptoms. There was nothing in the patient's history or examination to indicate



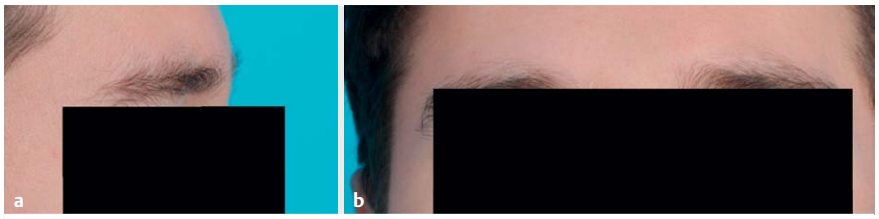
▶ **Fig. 1** Initial CT image of the fracture dislocated in the frontal sinus in axial (**a**) and sagittal (**b**) views. The yellow arrow (**b**) points to the fracture, and the yellow star (**a**) marks the left frontal sinus.



▶ **Fig. 2** Illustration of the intraoperative situation. The images show the impression of the forehead (**a**, the black arrow points to the impression), the intraoperative use of sonography (**b**), and the repositioning of the fractured fragment via a stitch incision with the help of the DePuy Synthes threaded screwdriver (**c**).



▶ **Fig. 3** Sonographic imaging of the fracture of the frontal sinus wall before (**a**+**b**) and after (**c**+**d**) repositioning in sagittal (**a**+**c**) as well as transverse (**b**+**d**) views (red arrow: fracture fragments before repositioning, yellow arrow: fracture fragment after repositioning)



▶ **Fig. 4** Postoperative follow-up 11 days after surgery. The preoperative impression and the stitch incision are no longer visible.

rhinorrhea as a sign of a skull base defect. The patient was informed about the different operative methods which included minimally invasive procedure via stitch incision, eyebrow margin incision, coronal incision, as well as their respective advantages and disadvantages. Owing to the medial position of the defect, the patient was furthermore specifically informed about the possibility of an extension of the access via a coronal incision if it were to be determined that the attempt at minimally invasive ultrasound-guided repositioning would not yield a stable result. The patient was also informed that another postoperative dislocation could not be ruled out in the absence of osteosynthesis. The already known impression of the os frontale slightly cranial to the glabella was seen intraoperatively (▶ **Fig. 2a**).

B-scan sonography (see ▶ **Fig. 3**) was performed using an 18-Mhz linear transducer (hockey stick probe, GE Healthcare) for precise visualization of the fracture. ▶ **Fig. 3a, b** show the sonographic appearance of the fracture before repositioning in sagittal and horizontal orientation.

A stitch incision was made directly over the larger bone fragment. Using the threaded screwdriver from DePuy Synthes (Raynham, USA), the bone fragment could be screwed into (see ▶ **Fig. 2c**), and then pulled outwards with audible and perceptible crepitation. A subsequent sonographic scan in the operating room directly confirmed the successful repositioning (see ▶ **Fig. 3c, d**). The nose and forehead were placed in a cast and the patient was instructed not to blow his nose. Furthermore, the recommendation was made to avoid the prone position and contact sports for 4–6 weeks to prevent a new dislocation. The patient was well post operatively and discharged on the same day after the procedure. After 11 days, the patient was seen again for a check-up in our clinic. The result of the fracture repositioning was stable (see ▶ **Fig. 4**) and the patient was very satisfied with the cosmetic result.

Conclusion

This case demonstrates an example of how the use of intraoperative ultrasound in special situations enables a minimally invasive

procedure in the treatment of isolated midface fractures. This is in line with the available literature describing the benefit of intraoperative sonography in midface fractures, for example of nasal bone fractures. However, more complex fractures require intraoperative CT. The success of fracture repositioning could be checked in real-time through the use of ultrasound without radiation exposure. The chosen treatment was less painful for the patient and was functionally and aesthetically less disruptive than the alternative of a coronal incision. In addition, the duration of the operation under general anesthesia as well as the inpatient stay was markedly reduced. One limitation of the described procedure is the lack of an osteosynthesis option. In addition to the minimally invasive options, the preoperative information should also include access extensions so that further surgery can be avoided for the patient.

Conflict of Interest

Julian Künzel received fees for lectures from GE Healthcare (Chicago, IL, USA).

Authors

Maximilian Rink, Luisa Symeou, Thomas Kühnel, Christopher Bohr, Julian Künzel

Affiliations

Department of Otorhinolaryngology, Head and Neck Surgery, University Hospital Regensburg, Regensburg, Germany

Correspondence

Maximilian Rink
Department of Otorhinolaryngology, Head and Neck Surgery, University Hospital Regensburg
Franz-Josef-Strauß Allee 11
93053 Regensburg
Germany
maximilian.rink@ukr.de

published online 2024

Bibliography

Ultrasound Int Open 2024; 10: a22235552
DOI 10.1055/a-2223-5552
ISSN 2509-596X

Georg Thieme Verlag KG, Rüdigerstraße 14, 70469 Stuttgart, Germany