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A stepwise approach to open surgery for the frontal sinus

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Abstract

Background. Despite advances in endoscopic techniques, there are still instances when the frontal sinus must be approached externally. Given its variable anatomy, the frontal sinus continues to present a challenge to the surgeon. Our rule of thumb capitalises on the consistent embryological development of the frontal sinus, aiding safe external access.

Methods and results. The presented stepwise approach includes trephination, fenestration, an osteoplastic flap and obliteration. The obliteration procedure has produced good results in managing those patients with disabling symptoms despite multiple endoscopic procedures.

Short Communication

Mr A Kelly takes responsibility for the integrity of the content of the paper

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Introduction

Despite advances in endoscopic techniques, there are still instances when the frontal sinus must be approached externally. We outline an incremental stepwise approach to open frontal sinus surgery.

Prior to the advent of the endoscopic sinus surgery, the mainstay of surgical intervention to the frontal sinus was via an external approach, often with an osteoplastic flap.[1] As endoscopic techniques and equipment have continued to improve, the need for external approaches has reduced.[2]

The frontal sinus continues to present a significant challenge to the operating surgeon, owing to its anatomical location and variability, predilection for stenosis, and close proximity to the orbit and skull base. In rare cases not amenable to endoscopic techniques, and in cases of failed endoscopic surgery, an understanding of open surgical techniques can be vital for salvage.

Figure 1 illustrates the steps involved in external approaches to the frontal sinus, in ascending complexity. The frontal trephine technique should be in the repertoire of most junior rhinologists, whilst the osteoplastic flap and frontal obliteration are more advanced techniques requiring greater skill and experience.

Applied embryology

The operating surgeon must understand the embryological development of the frontal sinus and the resulting anatomy. Although the frontal sinus is highly variable anatomically, the embryological development is very consistent and this aids the surgeon clinically.

The frontal sinus begins to develop in the fourth or fifth week of gestation, along with the majority of other head and neck structures.[3] It continues its development for many years and is only fully developed in early adulthood. The frontal sinus always starts at the frontonasal bud, and pneumatises between the leaves of the frontal bone to a varying extent. This origin in the frontonasal bud is anatomically just below the nasal process of the frontal bone.

Step 1: frontal sinus trephination

We suggest that all senior ENT trainees should have the frontal trephine technique in their armoury for dealing with the frontal sinus. Indications for this procedure include as an adjunct to endoscopic surgery, where fluid (saline or fluorescein) from a trephine can aid the surgeon in identifying the natural frontal drainage pathway. It can also be used to drain infection both in the sinus and intracranially. Furthermore, anatomical factors such as bleeding and scarring may make an endoscopic or wholly endonasal approach to the frontal sinus impossible.

The anatomical surface marking of the frontonasal bud can be identified reliably using a simple 'rule of thumb' to allow a safe entry point for frontal trephination and fenestration. Figure 2 helps to explain the concept we use for identifying the anatomical location of the frontal sinus on a patient. When using this rule, we must imagine a clock face over the orbit on the same side as the frontal sinus we are addressing. Much like holding a steering wheel when learning to drive, the points of significance on the clock face are 10 and 2 o'clock.

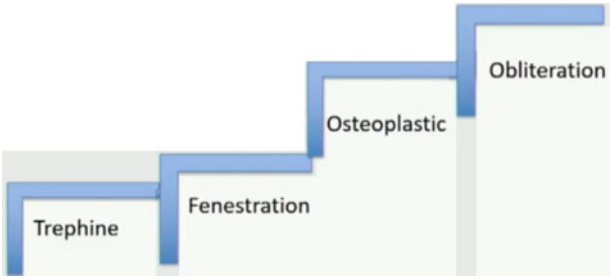

Fig. 1. The steps involved in external approaches to the frontal sinus, in ascending complexity.

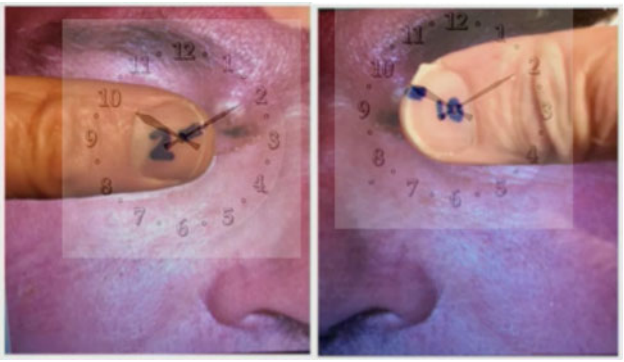

Fig. 2. Illustration of the concept used for identifying the anatomical location of the frontal sinus on a patient. We imagine a clock face over the orbit on the same side as the frontal sinus we are addressing. The points of significance on the clock face are 10 and 2 o'clock.

The operating surgeon places their thumb horizontally over the relevant eye. Using an appropriate marker, they then mark 2 o'clock for the right eye and frontal sinus, or 10 o'clock for the left eye and frontal sinus. Each marking will then point directly at the surface marking for drilling at the location of the frontonasal bud. One will always hit the frontal sinus with this technique if indeed the patient has a frontal sinus on the relevant side. The outline of the thumb acts as a guide for the small incision through skin.

The incision is made right down to bone, and the clock face point is marked on the exposed bone. Drilling can then take place with the soft tissue retracted (Figure 3). The sinus is 'blue-lined' in advance of breaching the mucosa with a blunt probe in order to ensure a safe and minimally traumatic entry into the frontal sinus.

Step 2: frontal fenestration

The next step in the external approach to the frontal sinus is fenestration. As illustrated in Figure 1, this does not represent a large step up and simply involves enlarging the trephination (Figure 4). It offers more lateral access to the sinus than one would get with a trephine or endoscopy, and it can be used in cases of tumour or osteomata. As always, this must be conducted with careful attention to the variable anatomy of the frontal sinus and guided by the pre-operative imaging.

Small trephinations and fenestrations can be closed by careful suturing of the soft tissue superficially, with no noticeable defect. For larger fenestrations, we recommend using a piece of polydioxanone sheet sutured into place; this forms a framework for scar formation and healing, with no significant increase in morbidity.

Fig. 3. Soft tissue retracted for frontal sinus trephination.

Fig. 4. Enlargement of the trephination for frontal sinus fenestration.

Step 3: frontal osteoplastic flap

The next step up represents a larger jump in complexity. The frontal osteoplastic flap[4] is reserved for a small number of more complex cases. Instances where a frontal osteoplastic flap may be required include: very lateral lesions; recurrent disease with anterior or posterior table erosion; when there is dural involvement; or very large osteomata.

If the frontal osteoplastic flap is to be combined with an endoscopic approach during the same operation, it is best to perform the endoscopic work first, as the use of power tools during external work can potentially impair the fine motor skills required for endoscopic work.

The bicoronal incision is marked out using a silk suture, from the root of the helix of one ear to the other. We have found no advantage to zig-zagging or stepping the incision. The surgeon should aim for the incision to be hidden by the patient's hairline (Figure 5).

Care should be taken to incorporate the superficial temporal artery within the flap bilaterally and to incise down to the loose aponeurotic layer, to acquire a relatively bloodless field. We recommend extending the flap down to the supra-orbital rim bilaterally, preserving supra-orbital and

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Fig. 5. The frontal osteoplastic flap incision should be hidden by the patient's hairline.

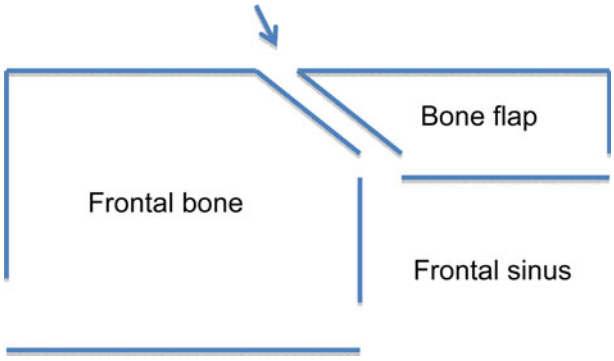

Fig. 6. For the frontal osteoplastic flap, we recommend chamfering the cut into bone with an oscillating saw at an angle of approximately 30 degrees (arrow indicates chamfered cut).

supratrochlear nerves. The cranial periosteum is a very useful flap and can be raised separately to the bicoronal flap. The extent of this peri-cranial flap is dependent on the size and shape of the frontal sinuses, and on the amount of tissue required. A frontal sinus template is made from is occipito-frontal plain film X-ray or by careful measurement of computed tomography scans. We recommend chamfering the cut into bone with an oscillating saw at an angle of approximately 30 degrees (Figure 6). This avoids bone loss that is inevitable with use of a drill or fissure burr, and enables the bone flap to be replaced and secured with tissue glue without the need for microplates.

The key to not losing the viability of the bone flap is replacement of the intact periosteal flap previously raised. The wound is closed in layers, corrugated drains are used bilaterally and a robust head bandage is applied, to reduce the risk of haematoma and post-operative infection.

Step 4: frontal sinus obliteration

Sinus obliteration is appropriately placed at the highest step of the incremental staircase. When the frontal sinus continues to cause problems despite previous extensive intervention such as a Lothrop procedure[5] or osteoplastic flap, the surgeon may want to consider removing the sinus from the equation. Instances where this may also be necessary include aggressive osteomyelitic processes or when the bone is totally sclerosed.

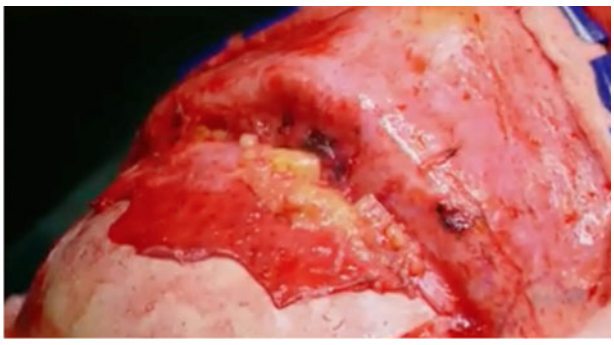

Fig. 7. Abdominal fat should be packed into the sinus to fill all space during the frontal sinus obliteration procedure.

Frontal obliteration is approached with a standard frontal osteoplastic flap. It is imperative that all mucosa from within the sinus is removed to leave healthy exposed bone. The sinus is then lined with a peri-cranial periosteal flap. Abdominal fat is an appropriate graft material for the obliteration procedure and should be packed into the sinus to fill all space (Figure 7).

Unlike the standard osteoplastic flap, the use of microplates and screws are recommended, as the bone flap will have to be pushed on top of the compressed fat graft. Having obliterated the sinus from above, the nasal component should also be 'closed'. The frontal recess is closed endoscopically by local mucosal flaps, and by lateralising the middle turbinate to induce scarring and narrowing of the potential space. This is usually carried out as the first stage.

Conclusion

This paper aims to be a useful guide to open frontal sinus surgery. We reiterate the importance of understanding the embryology of the frontal sinus and the use of the 'rule of thumb' to identify a drilling point for trephination. These approaches remain important and should be part of all rhinologists' repertoire. The obliteration procedure has produced good results in patients who, after repeated endoscopic operations, continued to have disabling pain and infection in the frontal sinus.

Competing interests. None declared

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