

Modified frontonasal sinus flap surgery in standing horses: surgical findings and outcomes of 60 cases

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Summary

Reasons for performing study: Previous studies of sinus surgery on standing horses have been based on techniques which utilise powered hand bone saws and preserve the bone flap, which was thought to be essential for a good cosmetic result. This report describes a simplified technique applied to the standing horse where the sinus flap construction used a large skull trephine and where the bone flap is necessarily discarded.

Objectives: To assess whether the modified standing frontonasal flap (SFF) surgery offers an effective method to investigate and/or treat sinunasal disorders in the horse.

Methods: The case records of 60 horses subjected to modified SFF surgery were reviewed to analyse the efficacy of the technique when applied to a range of sinunasal disorders in terms of diagnosis, surgical findings, complications and long-term outcomes, including cosmetic effect.

Results: Resolution of clinical signs was achieved in 54 out of 60 horses, and for the remainder the SFF technique proved useful on a diagnostic basis. The cosmetic result was, in the opinion of the owners, excellent or satisfactory in 48 of 56 (86%) horses.

Conclusions: The modified SFF technique was found to be practicable and provided satisfactory exposure of the sinus contents for diagnosis and removal of diseased tissue in a range of disorders. An acceptable cosmetic result can be obtained in the majority of horses despite rejection of the disc of overlying bone. Apart from avoiding the risks associated with general anaesthesia, the advantages of the modified SFF surgery are: a reduction of haemorrhage in the standing horse; reduced mucosal engorgement; straightforward anatomical orientation; a comfortable working height; and reduced surgery time. A sound knowledge of the functional anatomy of the area is a prerequisite before embarking on any form of sinunasal surgery. Complications are infrequent and usually transient.

Potential relevance: The modified SFF technique is a valuable alternative to other invasive methods of sinunasal surgery.

Introduction

Advances in techniques, together with improved agents for sedation

and analgesia, have allowed an increasing number of equine disorders to be evaluated and treated with the horse standing. This includes the investigation and treatment of equine nasal and paranasal sinus disorders (Lane 1987; Ford 1991; Ruggles *et al.* 1993; Schumacher and Crossland 1994; Schumacher *et al.* 1998, 2000), so that surgery of these structures under general anaesthesia is likely to be reserved for the more invasive procedures.

The clinical features of sinunasal disorders are usually dominated by a nasal discharge, which is almost invariably unilateral and where the nature varies from mucoid to purulent. Other signs may include epistaxis, facial deformity, malodorous breath, ocular discharge, abnormal respiratory noise and altered nasal airflow. However, the latter are normally features of expansive lesions or where there is impairment or obstruction of the normal drainage mechanisms (Tremaine and Dixon 2001a).

A variety of surgical approaches have been described to access the individual sinus compartments. However, where wide exposure is needed to enter multiple sinus compartments, the frontonasal route via the conchofrontal sinus (CFS) is a more versatile approach than the lateral maxillary approach (Lane 1993; Schumacher and Crossland 1994; Schumacher *et al.* 1998, 2000; Freeman 2003). Correct positioning of the osteoplastic flap permits the breakdown and removal of the intercompartmental septum so that access can be gained to the rostral maxillary sinus (RMS) and its medial extension, the ventral conchal sinus (VCS), a common site for empyema in young horses (Lane 1993; Schumacher and Crossland 1994; Schumacher *et al.* 1998, 2000). Laterally based maxillary flap approaches to the sinuses provide limited surgical access, especially in young horses, due to the positioning of the long reserve crowns and dental apices of the cheek teeth and the location of the infraorbital canal (Lane 1993; Freeman 2003).

The purpose of this report is to review the surgical findings, cosmetic results and long-term outcomes for 60 horses that were subjected to a modified standing frontonasal flap (SFF) technique to explore the paranasal sinuses.

Materials and methods

Case records of 60 horses with sinunasal disorders that underwent SFF surgery were reviewed. Follow-up examinations and long-term outcomes were obtained from either the referring

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Fig 1: Positioning of lavage portal below eye and relative positioning of sinus opening.



Fig 2: Trephine (5 cm) positioned following reflection of skin and periosteum.

veterinary surgeon or the owner/trainer by telephoned interview or written questionnaires.

Diagnosis

The differential diagnosis of paranasal sinus disorders requiring SFF surgery was based on interpretation of the findings obtained following a physical examination, endoscopy *per nasum*, radiography, a thorough oral/dental examination and, occasionally, direct sinus endoscopy via the caudal maxillary sinus (CMS). Histopathological examination of samples obtained at the time of surgery was used to achieve a definitive diagnosis when required.

Surgical method

SFF surgery: Phenylbutazone (Equipalazone injection)¹ (2.2 mg/kg bwt i.v.), tetanus antitoxin² (7500 iu subcut.) and



Fig 3: Post operative appearance. This horse was subjected to bilateral removal of progressive ethmoidal haematomas.

procaine benzylpenicillin (Depocillin)² (20 mg/kg bwt i.m.) were administered before surgery. A 14 gauge i.v. catheter (Angiocath)³ was placed, for sedation using detomidine (Domosedan)⁴ (0.01 mg/kg bwt) and butorphanol (Torbugesic)⁵ (0.01 mg/kg bwt), with increments as required. The site was clipped and prepared for aseptic surgery.

Mepivacaine 2% (2 ml) (Intra-Epicaine)¹ was infiltrated 2 cm below the mid-point of the lower orbital rim. A 1 cm diameter skull trephine (Horsley's trephine)¹ was used to make an impression into the wheal of local anaesthetic and used as a guide for a circular skin incision made directly onto bone. The skin and periosteum were removed and the trephine was used to create a sinus opening. The disc of bone was discarded and the hole plugged temporarily with a gauze swab. At the conclusion of surgery, a Foley catheter (Silastic 26, Ch. 30 ml)⁶ was inserted via this portal to facilitate post operative sinus irrigation.

Mepivacaine 2% (20 ml) was infiltrated subcutaneously in an area midway between the nasal midline and medial canthus of the eye. The site for trephination was centred 5 cm axial to the nasolacrimal duct (identified by a line between the medial canthus and the naso-incisive notch), 4 cm lateral to the nasal midline and 2 cm below a horizontal line drawn between the medial canthi (Fig 1). A 5 cm diameter skull trephine¹ was used to make an impression into the wheal of local anaesthetic as described above. A semi-elliptical incision (based abaxially) was made 10–15 mm wider than the indentation through skin and periosteum (Fig 2). The edge of the trephine was aligned 10 mm inside the skin incision, and care taken to prevent damage to the reflected periosteum and surrounding tissues. The disc of bone was discarded, exposing the contents of the CFS. The sinus tissues were irrigated with 20–40 ml 2% mepivacaine¹ before proceeding with the intrasinal surgery. A hole was punctured in the caudodorsal extension (bulla) of the RMS, which was widened as required with scissors and bone rongeurs in order to inspect the

VCS and RMS (Freeman *et al.* 1990; Schumacher *et al.* 2000; Freeman 2003).

Copious lavage was directed into the sinus opening to dislodge exudates including inspissated pus, diseased tissues and haemorrhage. This was generally well tolerated by the horse and provided an opportunity to assess the patency of the nasomaxillary aperture.

Occasionally, a sinusal fenestration was created during the SFF surgery, either following debridement of conchal tissues for the extirpation of an expansive lesion or, in 3 horses, performed because drainage was impaired through the nasomaxillary aperture. The fenestration was created by removing part of the ventromedial wall of the ventral conchal sinus. This was associated with some haemorrhage that was controlled by direct pressure and, in one horse, required placement of a sock-and-bandage pack within the paranasal sinus compartments led through the fenestration to exit via the nares (Lane 1993).

At the conclusion of the surgery, 4 or five 0-metric nylon simple appositional sutures (Ethilon-Ethicon)⁷ were spaced to approximate the skin and periosteum in a single layer. Surgical staples (Leucoclip SD)⁸ were used to complete the skin closure (Fig 3).

Post operative care: Procaine benzylpenicillin² 20/mg/kg bwt q. 12 h i.m. and phenylbutazone (Prodynam)⁹ 2.2 mg/kg bwt q. 12 h *per os* were administered for 5 days. Paranasal sinus irrigation was initiated 24–48 h after surgery. Following removal of the intercompartmental septum between the rostral and caudal maxillary sinuses, it was possible to lavage the ipsilateral paranasal sinus compartments from the single caudal maxillary sinus portal. A solution of aqueous povidone iodine (Betadine Aqueous Solution)¹⁰ 10% w/v diluted 1:200 in saline or water was used to irrigate the paranasal sinuses via the Foley catheter. In addition, horses with mycotic sinusitis received topical antifungal therapy; approximately 50 ml of a 10% solution of enilconazole (Imaverol)¹¹ was instilled at the conclusion of sinus irrigation. Lavage rarely required specific restraint and was performed twice daily for at least 5 days, but the duration of treatment was adjusted on an individual case-by-case basis, generally until the nasal discharge was no longer evident.

Results

Surgical findings, clinical outcome and post operative complications

The diagnostic findings and outcome of the 60 horses managed by the modified SFF technique are summarised in Table 1.

All 14 horses with inspissated pus located within the VCS/RMS were cured. Eleven horses recovered after the initial surgery, while one recovered after receiving antibiotics due to the recurrence of clinical signs. Another horse developed contralateral disease after clinical signs from the first side had resolved. One horse recovered after repeat surgery under general anaesthesia for sinusal fistulation.

Of the 8 horses where empyema was primarily confined to the RMS/VCS but without inspissation of pus, 6 made full recoveries, one horse improved but had an intermittent mild discharge, and one horse failed to show improvement. This horse had already experienced multiple surgical interferences before SFF surgery.

There were 10 horses in which the empyema was located within multiple sinus compartments (CFS/CMS/RMS/VCS), of

which 9 were available for follow-up; all made full recoveries. Two horses required secondary surgery under general anaesthesia for sinusal fistulation before signs resolved.

Mycotic sinusitis was confirmed in 8 horses and all made a full recovery following SFF debridement of the fungal plaques and topical antifungal therapy.

There were 6 cases of sinus-based progressive ethmoidal haematomas (PEH), all of which were treated by surgical extirpation of the lesions. In 2 of these horses the PEH was positioned within the rostral maxillary sinus. A further horse required bilateral SFF to extirpate PEH lesions on the sinus aspect of the ethmotubercles (Fig 3). Thirty months after SFF surgery, this horse continued to receive tactical intralesional treatment of nasal PEH lesions. Although the lesions located within the paranasal sinuses have not been re-evaluated by direct sinus endoscopy, there has been no evidence of further haemorrhage from within the paranasal sinus airspaces.

Three out of 4 horses with sinus cysts made uneventful recoveries. One horse has a low-grade intermittent nasal discharge but the owner considers this to be a satisfactory result. Another horse was subjected to euthanasia 6 weeks post operatively for economic reasons when treatment was ongoing.

The remaining 10 horses consisted of 4 horses with dental disorders, 3 with sinusal neoplasia and 3 grouped under 'other' in Table 1. The last 3 horses comprised single cases of ethmoidal abscessation, bone sequestration secondary to trauma and a bony reaction within the rostral maxillary sinus of uncertain aetiology. In all of these horses the SFF surgery contributed to diagnosis and in 2, to treatment. These horses were managed on an individual basis and required specific surgical and/or medical intervention; their outcomes offer no useful comparison.

Cosmetic outcome

Most horses were left with a small scar following removal of the sinus lavage catheter; however, this was considered to be clinically insignificant in all cases. Twenty-five of the 60 (42%) horses had already had at least one minor surgical procedure before presentation. In the majority (23/25), the cosmetic appearance of the small trephinations and second intention healing were deemed by the authors to be noticeable but acceptable. Two horses had undergone more than one previous surgery and had noticeable cosmetic deficits before the SFF procedure.

Where follow-up information was available and horses were neither subjected to euthanasia nor died for other reasons in the post operative period, the cosmetic appearance of the SFF surgical site was reported to be excellent or very good in 28/56 (47%) horses. With close inspection, some of these horses had irregular hair growth associated with the incision site or possibly a very slight concavity that was barely noticeable to the owners and was often masked by normal hair growth.

A good or satisfactory cosmetic appearance was noted in a further 20 (36%) horses. These horses typically developed mild to moderate asymmetry when observed in the frontolateral oblique plane, as a result of a slight proliferative frontonasal suture reaction or mild concavity at the surgical site. These blemishes were considered to be clinically insignificant.

A poor cosmetic appearance was seen in 8 (13%) horses. The signs included marked suture periostitis and facial asymmetry as a result of concavity at the surgical site and were defined as features that would have been easily noticed by most observers.

TABLE 1: Summary of surgical findings and outcomes for 60 horses treated by modified standing frontonasal flap (SFF) surgery

Disorder confirmed during SFF exploration	No. of cases (n = 60)	Age (years) median (range)	No. full recovery after frontonasal flap surgery (%)	No. long-term improvement, incl. subsequent treatments (%)
PE with inspissated pus within the VCS/RMS	14	9 (3–20)	11 (78)	14 (100)
PE without inspissated pus within the VCS/RMS	8	9 (3–18)	6 (75)	7 (88)
PE of multiple paranasal sinus compartments	10	9 (4–18)	8 (80)	9 (90)
Mycotic sinusitis	8	8 (3–21)	8	8
PEH (paranasal sinuses)	6	9 (5–17)	5	6
Sinus cysts	4	15 (14–20)	3	3
Dental apical infection	4	11 (9–15)	0	4
Neoplasia	3	21 (3–24)	1	1
Other	3	NA	2	2

PE = Primary empyema; VCS = Ventral conchal sinus; RMS = Rostral maxillary sinus; PEH = Progressive ethmoidal haematoma; NA = not applicable.

Discussion

The overall results achieved following treatment of horses with a range of paranasal sinus disorders including sinus empyema, sinus cysts and ethmoidal haematomas with the SFF technique described here are comparable to those of other reports of equivalent surgery performed under general anaesthesia or with sedation and local anaesthesia (Schumacher *et al.* 1987, 2000; Freeman *et al.* 1990; Schumacher and Crossland 1994; Tremaine and Dixon 2001b).

It is suggested that the SFF technique is of diagnostic and therapeutic value early in the course of disease, and where signs have failed to respond to conservative treatment or simple sinus lavage. A sinusal fenestration through the most rostral aspect of the VCS was performed under general anaesthesia in 3 horses in the present study where drainage via the nasomaxillary aperture was reduced post operatively and clinical signs associated with impaired mucociliary clearance persisted. In all horses, the fenestration provoked significantly more haemorrhage than with the standing horse, and every case required 'sock and bandage' packing for haemostasis as described by Lane (1993). Exploratory SFF surgery is useful for detecting cases of dental apical disease but does not provide the means for extraction if required.

The results reported here show that treatment of primary empyema and primary empyema with inspissation of pus within the RMS/VCS by SFF surgery carries a favourable prognosis (88 and 100% full recovery, respectively) which is similar to the findings of other authors (Schumacher *et al.* 1987, 2000; Freeman *et al.* 1990; Schumacher and Crossland 1994). Horses afflicted with primary empyema in these other studies showed a comparable incidence of complications or persistence of clinical signs (Freeman *et al.* 1990; Schumacher *et al.* 2000).

The aetiopathogenesis of PEH remains unclear (Greet 1992; Schumacher *et al.* 1998; Rothaug and Tulleners 1999; Tremaine *et al.* 1999). Results following treatment of sinus-based PEH by curettage through SFF were comparable to those mentioned in other reports (Specht *et al.* 1990; Greet 1992; Schumacher *et al.* 1998; Marriott *et al.* 1999; Rothaug and Tulleners 1999). The small number of cases within this series makes it difficult to draw conclusions of the merits of this or other surgical extirpation techniques over alternative treatments such as formalin injection or laser ablation. However, the latter techniques either involve expensive equipment or appear to be best suited to smaller lesions located within the nasal turbinates (Specht *et al.* 1990; Greet 1992; Schumacher *et al.* 1998; Marriott *et al.* 1999; Rothaug and Tulleners 1999). PEH is a multifocal disorder and it is possible for new lesions to arise nearby or at remote locations in the same individual, many months or years after treatment of a primary lesion(s). It is likely that horses with

bilateral disease are more at risk of developing additional lesions following treatment (Rothaug and Tulleners 1999). Two horses had PEH lesions within the rostral maxillary sinus, which were confirmed histologically. Cook and Littlewort (1974) described small PEH-like lesions that may arise from the paranasal sinus mucosa remote from the ethmoidal turbinates, but there is only one other report of a PEH within the RMS (Sullivan *et al.* 1984).

Paranasal sinus cysts in this study carried a good prognosis following surgical removal, in accordance with the findings of other reports (Lane *et al.* 1987; Freeman *et al.* 1990; Ruggles *et al.* 1993; Tremaine and Dixon 2001b). Treatment aims to achieve maximal removal of the lining of the cyst although total extirpation is rarely possible (Lane *et al.* 1987). In a recent case not included in this review (J.G. Lane, unpublished data), the expansion of a cyst within the paranasal sinuses led to disruption of the bony infraorbital canal. The horse showed violent responses during intrasinal manipulation, which was attributed to stimulation of the infraorbital nerve. Such was the violence of the response that it was necessary to resort to general anaesthesia midway through the surgery to complete the extirpation of the cyst.

Neoplastic disorders of the paranasal sinuses are rare and are usually seen in elderly horses. Although the prognosis is related to the histological nature of the original lesion (Head and Dixon 1999), the SFF was effective in permitting thorough inspection of the sinus compartments and allowed biopsy of diseased tissue for histopathological examination.

It is accepted that preservation of a bone flap is likely to prevent a depression at the surgical site due to the stability that it provides for the overlying skin and periosteum (Freeman 2003). On the basis that 48/56 (86%) owners felt that the outcome was satisfactory to excellent, this report establishes that acceptable cosmetic results can be obtained even if the bone flap is discarded. It may be necessary to preserve the bone flap if the animal has significant potential value for showing, or if a large bone flap is required. It is conjectured by the authors that iatrogenic suture periostitis results from vibration in the suture line following the use of either a skull trephine or an oscillating saw in which case this complication could arise regardless of whether the bone flap is replaced.

Preservation of the periosteum is essential for a post operative seal and primary healing. Instances of incisional dehiscence or abscess formation were rare. A true sinucutaneous fistula occurred in one of the first horses in this series to undergo SFF surgery and this led to a revision of the surgical technique. In subsequent surgeries, a specific effort was made to provide a substantial (10–15 mm) margin between the skin incision and the bone, so that on closure the bone margin provided support for the overlying skin/periosteal closure.

The timing of the initiation of sinus lavage was also felt to be an important consideration; early and overzealous lavage was felt to contribute to partial incisional dehiscence in 3 horses. Post operative management regimes for horses recovering from surgery for paranasal sinus disorders are rarely described. Post operative sinus lavage and a prompt return to exercise were advised in the cases described here, with a view to assisting passive drainage from the sinuses and encouraging the return of active mucociliary clearance mechanisms (Lane 1993).

Although the adverse reactions reported in this series were minor, complications arising from sinunasal surgery performed under general anaesthesia can be serious and even fatal (Freeman *et al.* 1990; Greet 1992; Lane 1993; Frees *et al.* 2001; Tremaine and Dixon 2001b).

The authors found that there was surprisingly little haemorrhage associated with SFF surgery and it is conjectured that this can be attributed to the enhanced venous return in the standing horse contrasted with nasal engorgement in the recumbent animal. A sound knowledge of the functional anatomy of the area is a prerequisite for those embarking on any form of sinunasal surgery. However, anatomical orientation is easier in the standing patient and when the tissues are not engorged. These factors also combine to reduce overall surgery time; most procedures were completed in less than one hour.

The findings of this study confirm that SFF surgery provides an effective method of diagnosis and treatment of many cases of paranasal sinus disease in horses. Although the size of the exposure may be less than can be obtained using large frontonasal flaps, the access provided was found to be sufficient to bring the majority of the cases (54/60) to a successful conclusion and, for the remainder (6/60), it proved to be at the very least a useful diagnostic exploratory procedure.

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Manufacturers' addresses

- ¹Arnolds Veterinary Products Ltd, Harlescott, Shrewsbury, UK.
- ²Intervet UK Ltd, Milton Keynes, Buckinghamshire, UK.
- ³Becton Dickinson, Franklin Lakes, New Jersey, USA.
- ⁴Pfizer Ltd, Ramsgate Road, Sandwich, Kent, UK.
- ⁵Fort Dodge Animal Health, Southampton, Hampshire, UK.
- ⁶Bard UK Ltd, Crawley, West Sussex, UK.
- ⁷Johnson & Johnson, New Brunswick, New Jersey, USA.
- ⁸Beiersdorf AG, Hamburg, Germany.
- ⁹Leo Laboratories Ltd, Princes Risborough, Buckinghamshire, UK.
- ¹⁰Seton Healthcare Group, Oldham, Lancashire, UK.
- ¹¹Janssen Animal Health, High Wycombe, Buckinghamshire, UK.

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