Gingival approach to correct wry nose using locking compression plates in two foals

Sapper, C B ; Suárez Sánchez-Andrade, José ; Theiss, Felix ; Fürst, Anton

Abstract: Wry nose (campylorrhinus lateralis) in foals leads to breathing and weaning problems as well as reduced performance. The objective of this retrospective study was to describe a new gingival approach for, and report the outcome after, surgical correction of wry nose in two foals. Two young foals with wry nose were surgically treated using a gingival approach. Osteotomy of the incisive and maxillary bones was carried out, and a 3.5-mm locking compression plate (LCP) with screws was inserted in the incisive and maxillary bones and in several teeth to stabilise the gap. The rostral part of the nasal septum was resected, and osteotomy and plate fixation were used to correct the nasal bone deviation. A 2.4-mm UniLOCK plate was used in one foal and 2.7-mm LCP in the other. Respiratory difficulties and facial malformation were markedly reduced in both foals. The existing brachygnathia superior and nasal bone deviation could not be completely eliminated. Main limitation was the small sample size of only two foals. In conclusion surgical correction of wry nose through a gingival approach resulted in a good outcome with a significant reduction in the deviation and associated clinical signs.

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Case Report

Gingival approach to correct wry nose using locking compression plates in two foals

C. B. Sapper†,* J. Suárez Sánchez-Andrade‡, F. Theiss† and A. Fürst‡

†Vetsuisse Faculty, Equine Hospital, University of Zurich, Zurich, Switzerland; and ‡Section of Diagnostic Imaging, Vetsuisse Faculty, University of Zurich, Zurich, Switzerland
*Corresponding author email: cassandra.sapper@hotmail.com

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Summary

Wry nose (campylorhinus lateralis) in foals leads to breathing and weaning problems as well as reduced performance. The objective of this retrospective study was to describe a new gingival approach for, and report the outcome after, surgical correction of wry nose in two foals. Two young foals with wry nose were surgically treated using a gingival approach. Osteotomy of the incisive and maxillary bones was carried out, and a 3.5-mm locking compression plate (LCP) with screws was inserted in the incisive and maxillary bones and in several teeth to stabilise the gap. The rostral part of the nasal septum was resected, and osteotomy and plate fixation were used to correct the nasal bone deviation. A 2.4-mm UniLOCK plate was used in one foal and 2.7-mm LCP in the other. Respiratory difficulties and facial malformation were markedly reduced in both foals. The existing brachygnathia superior and nasal bone deviation could not be completely eliminated. Main limitation was the small sample size of only two foals. In conclusion, surgical correction of wry nose through a gingival approach resulted in a good outcome with a significant reduction in the deviation and associated clinical signs.

Introduction

Wry nose (campylorhinus lateralis) is a congenital malformation characterised by lateral and sometimes ventral deviation of the bones of the rostral skull. Affected anatomical structures include the maxillary, incisive and nasal bones, the nasal septum as well as occasionally the vomer (Schumacher et al., 2008). The rostral part of the nasal septum is strong enough to hold the implants (Fürst & Auer, 2019). One surgical procedure includes resection of the nasal septum, osteotomy of the nasal bones and fixation with UniLOCK plates followed by osteotomy of both maxillary rami and fixation with LCPs with or without the use of an autogenous bone graft on the concave side (Fürst & Auer, 2019). Another technique uses a gingival approach for the osteotomy, followed by insertion of a bone graft as well as Steinmann pins for stabilisation (Schumacher et al., 2008). There have also been case reports on the use of an external fixator (Cousty et al., 2010; Robertson, 2010) and distraction osteogenesis (Puchol et al., 2004). Surgical interventions are often associated with complications such as persistent brachygnathia superior and deviation and do not always eliminate airway obstruction and respiratory noise (Cousty et al., 2010; Schumacher et al., 2008). The long-term outcome of surgical treatment was described as good in some cases with horses able to be used in competitive sports or pleasure riding without signs of impairment, but outcomes were not known in all reported cases (Puchol et al., 2004; Schumacher et al., 2008; and Cousty et al., 2010).

The aim of this report is to describe the surgical correction of wry nose in two foals, younger than 2 months of age, using a gingival approach and 3.5 mm LCPs at the osteotomy sites in the incisive and maxillary bones. In addition, the rostral part of the nasal septum was resected and the nasal bone deviation corrected by performing an osteotomy stabilised with a UniLOCK or LC plate. The goal of this technique was to provide a method for surgical correction of wry nose that is technically easier to perform than methods previously described and results in a clinically healthy horse with minimal post-operative complications.

Materials and methods

Case history

The two foals that underwent surgical correction of wry nose using the procedure described in this report were retrospectively analysed using the medical records.

Foal 1 was a Swiss Warmblood filly (Fig 1), presented in good condition at the age of 3 weeks. The foal was bright and alert with normal IgG levels and did not have problems nursing but appeared to be smaller than foals of the same age and breed. Inspiratory noise and absence of airflow through the right nostril were noted. The foal underwent surgery the day after it was presented.

Foal 2 was a Friesian colt, presented in good condition at the age of 5.5 weeks. The foal was bright and alert and had...
normal IgG levels and no problems nursing but appeared to be smaller than foals of the same age and breed. A noise was detected during inspiration and a subchondral cystic lesion in the medial condyle of the right femur was seen on radiographs. The colt underwent surgery at the age of 7.5 weeks.

**Diagnostic imaging findings**

Computed tomography (CT) and radiography were carried out in both foals before and after surgery. Imaging focused on the deviation of the nasal septum, the nasal and incisive bones (measured in degrees), brachygnathia superior (measured in centimetres) before and after corrective surgery, and healing of the osteotomy sites.

**Foal 1**

Radiographs and CT scans obtained before the corrective osteotomy showed marked deviation (58°) of the rostral part of the upper jaw to the left at the level of the margo interalveolaris and abnormal positioning of the upper incisors ([Figs 2 and 3](#)). The nasal septum (55°, Fig 4) and the nasal bone (50°) were also deviated to the left. An exact measurement of the brachygnathia superior was not possible because of the severe deviation of the upper jaw but was estimated to be about 3.6 cm. The brachygnathia superior and deviation of the jaw resulted in severe malocclusion of the incisors. The left margo interalveolaris was shorter than normal, but the physsis between the incisive and nasal bones appeared normal on the concave side.

**Foal 2**

The upper jaw was deviated 30° to left at the level of the margo interalveolaris. The right nasal bone was also displaced dorsally, but the physsis between the incisive and nasal bones was normal. The caudal part of the nasal septum was deviated to the left and the rostral part to the right, which resulted in complete obstruction of the right nasal passage. The overall deviation of the nasal septum was severe and measured 54° to the left, and the nasal bone curved 34° to the left.

**Treatment**

**Preparation**

On the day of surgery, each foal was fasted for 2 h and given broad-spectrum antibiotics and nonsteroidal anti-inflammatory drugs before undergoing general anaesthesia using the standard protocol of the clinic. Details concerning premedication and anaesthesia are shown in [Table 1](#). The foal was placed in dorsal recumbency, and the skin at the transition from the upper to the middle third of the ventral trachea was prepared aseptically for tracheotomy. A 5 cm vertical incision was made through the skin, subcutis and the cutaneous colli muscle. The two sternohyoideus muscles were separated and retracted. A 1.5 cm horizontal incision was made through the skin, subcutis and the cutaneous collai muscle. The two sternohyoideus muscles were separated and retracted. A 1.5 cm horizontal incision was made through the annular ligament parallel to the cartilage rings using a No. 10 scalpel blade. A plastic tracheotomy tube (Rüschelit Biesalski, 10 mm; Rüschi) was inserted and secured with interrupted sutures. The foals were ventilated during the entire procedure using a cuffed endotracheal tube.

**Resection of the nasal septum**

For the removal of the deviated nasal septum, the foals were placed in right lateral recumbency. To access the caudal part of the septum, a C-shaped 1.5 × 2 cm skin incision was made along the midline of the nasal bone where the bone started to deviate, using a No. 10 scalpel blade. The skin was reflected, and a bone flap centred over the midline of the deviation and measuring approximately 1.5 × 2 cm was excised using an oscillating saw. The septum was grasped with an Adson tissue forceps through the window and
separated from the nasal bone using a periosteal elevator. The septum was cut rostral to the forceps in a dorsoventral direction using Mayo scissors or a No. 10 scalpel blade. A scalpel (blade No. 10) was introduced through the nostril, and a vertical cut was made through the rostral part of the septum. Ideally, 4 to 5 cm of the rostral septum should be maintained to avoid collapse of the nostrils, but that portion of the septum is usually the most deviated making it difficult to preserve. To detach the septum, two horizontal cuts, one ventral and one dorsal, were made using Mayo scissors introduced through the nostril. The bone flap was replaced, and the skin closed using staples. Haemorrhage was controlled by packing the nostrils with gauze.

Correction of the deviated incisive and maxillary bones
The foals were placed in dorsal recumbency, and a mouth wedge was used to hold the mouth open. The gingiva on both sides was cut along the edge of the incisive bone and the maxillary ramus using a No. 10 scalpel blade. The cut was extended to the area of the incisors and premolars, and the gingiva was reflected from the incisive and maxillary bones using a periosteal elevator. The surrounding soft tissues were carefully dissected. Of particular importance was the palatine artery, which was identified and protected during the osteotomy. The incisive and maxillary bones were transected perpendicularly to their longitudinal axis using an oscillating saw, and the transected rostral portion was aligned with the axis of the lower jaw using a pointed reduction forceps. To correct the existing brachygnathia superior, the rostral part of the maxilla was moved rostrally to align with the mandibular incisors. The osteotomy sites on both sides were fixed using a 3.5 mm LCP and locking screws. To increase implant stability, several screws were placed through the incisive and maxillary bones as well as the incisors and premolars of the upper jaw. The exact placement of the screws is shown in Table 2. The gingiva was closed with absorbable suture material (Biosyn 2-0; Covidien) in a simple continuous suture pattern.

Correction of the deviated nasal bones
To access the nasal bones, the foals were placed in right lateral recumbency, and an approximately 2 cm skin incision was made along the midline of the nose at the point of the most severe deviation. The caudal end of this incision was 1–1.5 cm rostral to the rostral end of the incision made for the bone flap. The two nasal bones were then separated perpendicularly to their longitudinal axis using an oscillating saw or scissors depending on the thickness of the bone. A small wedge-shaped piece of the bone was removed on the convex side to facilitate straightening. After alignment of the nasal bone with the longitudinal axis, the osteotomy site was fixed with one or two UniLOCK or LC plates; one of the foals had very narrow nasal bones, and thus, only a single plate was used. Table 2 shows the details of the plates used. The subcutaneous tissues were closed with absorbable suture material (Biosyn 2-0; Covidien) in a simple continuous suture pattern and the skin with staples.

Post-operative care
A nasogastric feeding tube was placed during general anaesthesia or after recovery. The tracheotomy was
maintained for three and the feeding tubes for 7 days to support respiration and allow feeding. The tracheotomy tube was cleaned at least once a day depending on the amount of secretion produced. The foals were maintained on broad-spectrum antibiotics for a minimum of 5 days and nonsteroidal anti-inflammatory drugs for a minimum of 3 days post-operatively. The gauze was removed from the nostrils 2 days after surgery. **Table 2** shows the details of the post-operative treatment.

### Results

**Follow-up**

Follow-up examinations using CT and radiography were done in both foals within 8 weeks after surgery. The clinical follow-up examinations included the assessment of respiratory noises, physical activity and general health status. Additional follow-up information was obtained by questioning the owners 19 to 43 months post-operatively.

### Table 2: Details of plates and screws used for osteotomies of the nasal, premaxillary and maxillary bones

*mRepeated as needed.*

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Case history

Foal 1
The feeding tube and the tracheal tube were removed 7 days after surgery when the filly was able to nurse normally. Dyspnœa continued after the removal of the tracheal tube because of an airway obstruction caused by the remaining rostral part of the nasal septum, which was visualised via endoscopy and then removed under manual control using Mayo scissors with the foal standing and sedated. However, this resulted in collapse of the nostrils, which necessitated the resection of the alar folds in a third procedure, also done with the foal standing and sedated. The surgical procedure used is described (Fürst & Auer, 2019). The exposure of the right LCP was noted 1 week after surgery because of the dehiscence of the gingival suture, but this did not affect the health status of the foal or the stability of the plate fixation. The plate was cleaned regularly. Mandibular mucosal necrosis developed as a result of pressure exerted by the upper incisors due to residual brachygnathia superior but healed quickly after manual reduction in the teeth using a float. A screw in the rostral part of the nasal bone was removed because of an associated abscess. The foal was discharged 4 weeks after the initial surgery with no special discharge instructions. No respiratory noise was present at the time of discharge.

The foal was re-admitted 3 weeks later for the removal of the plates under general anaesthesia. During the pre-operative physical examination, the foal was bright, alert and responsive. The plates on the incisive and maxillary bones on both sides were not covered by gingiva and, therefore, directly visible. However, the gingiva was not inflamed, and the osteotomy sites were stable. The owner reported a respiratory noise at canter. During plate removal, the bone was stable and showed no signs of infection. The brachygnathia superior was permanent but was managed by means of regular incisor reduction and was not associated with abnormal eating behaviour. The owner was pleased with the cosmetic result (Fig 5) of the surgery. At the time of writing, the filly was 4.5 years old and was used for therapeutic riding.

Foal 2
For unknown reasons, the foal was unable to breathe through the tracheal tube immediately after surgery. Therefore, a 10 mm endotracheal tube for dogs was inserted into each nostril for 24 h to keep them open. After their removal, the foal was able to breathe through the tracheal tube. The tracheotomy tube was removed 3 days after surgery. A feeding tube was placed on the day after surgery because of difficulty nursing and then removed after 1 week when the colt was able to breathe and nurse without problems. Additional resection of the remnant of the nasal septum was not indicated because the remaining rostral part was not as deviated compared with Foal 1 and, therefore, did not obstruct the nasal passage. The colt developed foul-smelling nasal discharge and gingival suture dehiscence with associated implant exposure, which prompted regular cleaning of the implants. Seven weeks after surgery, the LCP in the nasal bone was removed because of loosening of the screws; the LCPs in the incisive and maxillary bones were removed during the same surgery. The oral wounds were cleaned daily after implant removal, the nasal discharge resolved within a week and the foal was discharged. The foal and dam had spent the entire time since the initial surgery at the hospital. At the time of follow-up evaluation almost 2 years after surgery, the colt had not yet been in training but had a mild constant respiratory noise and persistent brachygnathia superior, although this did not affect food intake. The colt was subjected to euthanasia because of subchondral cystic lesions in a stifle joint that had been ongoing since early in life. The owners considered the stifle pathology as the limiting factor for performance and were satisfied with the cosmetic result of the facial surgery.

Diagnostic imaging findings

Foal 1
Surgery reduced the deviation of the incisive bone to 4°, the remaining caudal part of the nasal septum to 20° and the nasal bone to 5° (Fig 6). Approximately 4.5 cm of the rostral nasal septum remained after the initial surgery but were reduced to a 3.0 cm section after the second surgical intervention. There were no abnormalities along the edges of the nasal septum, no signs of implant failure and the osteotomy sites all showed normal healing. The brachygnathia superior was reduced to 1.6 cm.

Foal 2
Surgery reduced the deviation of the upper jaw to 7°. After resection, the rostral end of the caudal part of the nasal septum underwent soft-tissue proliferation, and the septum showed a sigmoid shape, which was not observed before surgery. The overall deviation was 16° to the left, and the

Fig 5: Photograph of Foal 1 six weeks after surgical correction of wry nose. The deviation of the upper jaw has resolved, but there is still brachygnathia superior.
A gingival approach to correct wry nose

remaining rostral part of the nasal septum measured 3.0 cm. The nasal bone deviated 4° to the left, and the brachygnathia superior increased to 1.9 cm. All osteotomy sites had radiographic evidence of normal healing.

Discussion

The surgical technique used in the present report resulted in good bone healing, and satisfactory cosmetic results in two young foals with wry nose. This technique was largely equivalent to the gingival approach described by Fürst and Auer (2019). This new approach does not involve cutting the skin and muscles of the lateral head, which means less soft-tissue trauma. Muscles, blood vessels and nerves were preserved, and nerve damage and haemorrhage were minimised. Dehiscence of the gingival suture occurred in both foals but had no adverse effects. This complication may have been partially caused by the size of the implants; smaller plates may eliminate this complication provided that they stabilise the osteotomy sites adequately.

As described (Fürst & Auer, 2019), LCPs were used for the fixation of the osteotomy sites of the incisive and maxillary bones. These implants combine several benefits such the possibility to either use standard or locking screws and less plate-bone contact. These implants have many advantages, especially in the oral cavity, because it requires different types of screws, and these implants are also frequently contaminated. To secure the osteotomy of the nasal bones in Foal 1 a smaller plate was needed compared with Foal 2, which is why a 2.4 mm UniLOCK plate was used. In both foals, the osteotomies were well stabilised and showed progressive bone healing.

Brachygnathia superior could not be eliminated with the corrective surgery and in fact increased in one of the foals. To ensure proper alignment, the upper and lower jaws should be stabilised after the osteotomy and before plate fixation, but this was not done in these two foals. One possible way to achieve this is to fix the corresponding upper and lower incisors with wire as described by Fürst and Auer (2019). A wedge-shaped autogenous rib graft placed on the concave side of the incisive and maxillary bones may reduce or prevent brachygnathia (Fürst & Auer, 2019; Schumacher et al., 2008). A rib graft can also be inserted into the gap created by the osteotomy in the nasal bone, but bone grafts do not always resolve brachygnathia superior (Schumacher et al., 2008). Even though bone grafts were not used in the present report, both foals showed progressive bone healing despite large gaps between the bone segments. According to Robertson (2010), the removal of the nasal septum alone can lead to growth retardation of the upper jaw in foals. Therefore, brachygnathia is sometimes an unavoidable complication of surgical correction of wry nose because the deviated part of the nasal septum needs to be removed to allow straightening of the upper jaw and elimination of respiratory difficulties.

The resection of the nasal septum should be the first step to facilitate correction of the incisive and maxillary bones. Ideally, 4–5 cm of the septum should be preserved rostrally to ensure support of the alar folds and nostrils and thus avoid collapse of these structures. However, the rostral part of the septum is often the most deviated section, and when an insufficient amount is removed, the resolution of the airway obstruction is not achieved. Airway obstruction after the removal of the endotracheal tube in Foal 1 necessitated further resection of the remaining rostral part of the nasal septum via endoscopy; however, a subsequent resection of the alar folds was required to ensure a patent airway. The second and third interventions could have been avoided had a larger amount of nasal septum been removed in the first surgery and the alar folds resected at the same time. Schumacher et al. (2008) and Cousty et al. (2010) describe respiratory noise in foals after the resection of the nasal septum, which necessitated an additional surgical procedure to excise the alar folds. The excision of the alar folds at the same time as nasal septum resection, therefore, appears to be a reasonable step. Common complications associated with the removal of the nasal septum include the formation of excessive granulation tissue at the rostral end of the caudal part of the remaining septum and the collapse of the nasal bone (Tulleners & Raker, 1983). The formation of excessive granulation tissue is a possible cause for persistent respiratory noise after the partial resection of the septum. In Foal 2, the proliferation of the rostral edge of the caudal part of the septum could have been avoided by resecting the entire nasal septum, but this would have risked the collapse of the nares and further surgical intervention. Nasal septum resection has also been achieved with obstetrical wire instead of a scalpel or scissors (Doyle & Freeman, 2005).

It may be possible to resect the nasal septum and carry out osteotomy of the nasal bones via a single bone flap. This would require a longer incision and a longer bone flap that extends from the caudal part of the deviation (to transect the caudal part of the septum) to the site of the wedge-
shaped osteotomy rostrally. Extending the incision should make the resection of the nasal septum and the fixation of the transected nasal bones possible and would eliminate the need for two different access windows. It would also mean that the foal could remain in dorsal recumbency after osteotomy of the upper jaw because the resection of the nasal septum and the correction of the nasal bone can be achieved in the same step. It is important that the nasal septum is removed before the corrective osteotomies are carried out to facilitate manipulation and correct alignment of the bones.

It has been suggested that corrective osteotomy in foals with wry nose should be done at 2–3 months of age to allow sufficient growth of the maxilla to accommodate the implants (Fürst & Auer, 2019). The foals in this study were 3 and 7.5 weeks old, which was thought to be an advantage because of faster healing of the osteotomy sites associated with rapid bone growth. Indeed, implant fixation in the incisive and maxillary bones was not a problem, and radiographic follow-up confirmed rapid healing of the osteotomies. This suggests that corrective surgery of wry nose can be accomplished in younger foals.

Conclusion
The findings of this report suggest that osteotomy of the incisive and maxillary bones via a gingival approach and fixation with LCPs is a viable option to correct wry nose in foals. The surgical technique had a satisfactory cosmetic outcome but did not lead to complete resolution of the respiratory problems. We feel that the described complications can be minimised through modification of the surgical technique.

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Authors’ declaration of interests
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Ethical animal research
Not applicable: a retrospective study.

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Authorship
All authors have contributed substantially to the data analysis and interpretation and the preparation of this paper. All authors have given their approval for the manuscript.

References
Cousty, M., Haudiquet, P. and Geffroy, O. (2010) Use of an external fixator to correct a wry nose in a yearling. Equine Veterinary Education 22, 458–461.
Doyle, A.J. and Freeman, D. (2005) Extensive nasal septum resection in horses using a 3-wire method. Veterinary Surgery 34, 167–173.
Fürst, A.E. and Auer, J.A. (2019) Cranio-maxillofacial disorders. In: Equine Surgery, 5th edn. Eds: J.A. Auer, et al. Elsevier Saunders. pp 1820–1823.
Gaughan, E.M. and DeBowes, R. (1993) Congenital diseases of the Equine Head. The Veterinary Clinics of North America. Equine Practice 9, 93–110.
Puchol, J.L., Herrán, R., Durrat, I., López, J. and Díaz-Bertrana, C. (2004) Use of distraction osteogenesis for the correction of deviated nasal septum and premaxilla in a horse. Journal of the American Veterinary Medical Association 224(7), 1147–1150.
Robertson, J.T. (2010) Surgical correction of wry nose in newborn foals. Equine Veterinary Education 22, 462–466.
Rush, B. and Mair, T. (2004) Congenital and developmental malformations of the nasal cavity. In: Equine Respiratory Disorders, Eds: B. Rush and T. Mair, Blackwell Science Ltd, Oxford. pp 33–35.
Schumacher, J., Brink, P., Easley, J. and Pollock, P. (2008) Surgical correction of wry nose in four horses. Veterinary Surgery 37, 142–148.
Tulleners, E.P. and Raker, C.W. (1983) Nasal septum resection in the horse. Veterinary Surgery 12, 41–47.
Vandeplasche, M., Simoens, P., Bouters, R., De Vos, N. and Verschooten, F. (1984) Aetiology and pathogenesis of congenital torticollis and head scoliosis in the equine foetus. Equine Veterinary Journal 16, 419–424.

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