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Multicenter Analysis of Facial Suture Exostosis in Horses: Post-Surgical, Traumatic, Infectious, and Idiopathic Forms

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ABSTRACT

Suture exostosis is a relatively frequent and complex disorder that should always be considered when evaluating equine craniofacial swellings. Although isolated case reports have appeared in the literature, no extensive series has yet been described. The current research presents a multicenter retrospective analysis of confirmed cases of suture exostosis. Data from horses diagnosed with this condition in the facial area were retrospectively reviewed. Details, including breed, sex, age, case history, imaging outcomes, treatments administered, therapeutic response, and follow-up observations were compiled. A total of 105 cases from different breeds were analyzed. Evaluation showed that cases could be categorized into four distinct origins: 45 occurred after sinonasal surgery, 23 followed traumatic incidents, seven were associated with sinus pathology, and 25 had no identifiable cause. Treatments included removal of bone sequestra, plate fixation, antimicrobial and anti-inflammatory therapy, or, in some cases, no intervention. Local discomfort usually subsided within several days or weeks, while swelling typically diminished or resolved completely between 3 months and 1.5 years. The pathogenesis of suture exostosis appears multifactorial. Detecting any underlying factor—especially sequestrum formation or infection—can greatly facilitate recovery and should be ruled out before classifying a case as idiopathic. During sinusotomies, minimizing surgical trauma is essential to reduce the likelihood of suture exostosis as a postoperative complication.

Keywords: Equine, Facial bones, sutures; Sequestrum, Infection, Maxillofacial, Oral surgery

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Introduction

Facial suture exostosis—also termed suture periostitis, suture inflammation, or suturitis—is a relatively frequent and noteworthy cause of facial swelling in horses [1]. Affected animals often develop gradual, firm, unilateral or bilateral swelling in the frontal area, which is typically non-painful. The precise location varies depending on which suture lines are involved [2]. Diagnosis is generally based on clinical presentation and radiographic findings. Radiographs frequently display a radiolucent suture margin encircled by increased opacity and callus deposition [3]. Because of the intricate three-dimensional bone anatomy of the equine skull and overlapping structures, radiographic evaluation can be challenging; computed tomography (CT) provides more precise visualization. CT typically reveals irregular periosteal proliferation with diffuse, cloud-like bone formation along the affected sutures. This new bone deposition is often bilateral, symmetrical, and may extend toward the orbit [4].

The disorder is often self-limiting, resolving over time even without specific therapy. However, chronic complications can occur, such as persistent tearing when the nasolacrimal or lacrimo-maxillary sutures are

affected, or draining tracts when sequestra develop. In certain long-standing cases, ongoing bone instability may lead to progressive enlargement of the swelling. For complicated or persistent cases, surgical management involving sequestrum removal or even stabilization of the sinus sutures with bone plates has been applied successfully [2, 5].

While a few individual case descriptions exist in published literature [3, 5–8], comprehensive multi-case studies with long-term follow-up are lacking. The objective of the present multicenter retrospective investigation was to compile and evaluate clinical information from equine cases diagnosed with facial suture exostosis.

Materials and Methods

A multicenter retrospective study was designed to gather data from horses diagnosed with suture exostosis affecting the facial region. Any animal presented to one of the participating clinics with this condition and for which complete clinical records were available was included. Information gathered comprised breed, age, sex, trauma history, history of surgical intervention, prior sinus disorders, imaging outcomes, therapeutic strategies, response to treatments, and follow-up observations.

Results and Discussion

Case characteristics

A total of 105 cases were identified, originating from Europe, North America, and Australia. Details of breed, sex, and age distribution are listed in **Table 1**, while **Table 2** summarizes housing conditions and season of onset. No particular seasonality or housing predisposition was identified. Based on historical data, the cases were divided into four categories as outlined in **Table 3**. The swelling duration ranged from several days to 44 weeks (mean 5.67 weeks; median 4 weeks). The severity of trauma, when observed, varied considerably—from minor impact incidents such as “striking the head while exiting a trailer” to severe open impression fractures.

Table 1. Breed, age, and gender distribution among 105 equine suture exostosis cases.

Breed	Count (n)	Gender	Count (n)
American Saddlebred	1	Mare	42
Arabian	1	Gelding	60
Paint	1	Stallion	3
Quarter Horse	5		
Shire	1		
Standardbred	6		
Stock Horse	1		
Thoroughbred	26		
Warmblood	55		
Welsh Cob	6		
Polo Pony	1		
Connemara	1		
Age (years)		**Value**	
Minimum		2	
Maximum		26	
Median		10	
Mean		10.46	

Table 2. Reported housing type and seasonal occurrence in 105 cases of equine suture exostosis.

Season	n	Housing	n
Spring	23	Stabled only	11
Summer	39	Pasture Only	9

Autumn	17	Mixed	71
Winter	17	Unreported	14
Unreported	9		

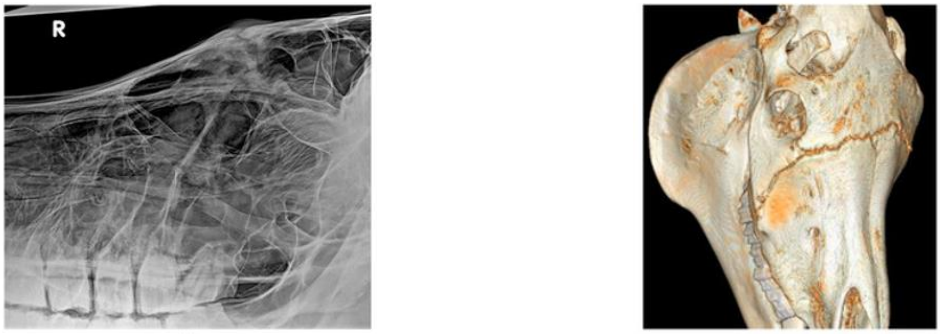
Table 3. Historical context and causative factors in 105 equine suture exostosis cases.

History Category	Number of Cases (n)
Swelling developed subsequent to trauma	23
Swelling observed after surgical intervention	48
Swelling associated with sinus pathology	8
Swelling with no identifiable cause (idiopathic)	26

Thirty-nine horses exhibited excessive tearing (epiphora) **(Figure 1)**, and 35 presented with nasal discharge. The occurrence of nasal discharge and epiphora per case category is shown in **Table 4**. In addition to these typical manifestations, one horse developed a severe overjet and another displayed headshaking, both linked to idiopathic swellings. A single case in the sinus pathology group had marked dental malocclusion that led to secondary sinusitis **(Figures 2a and 2b)**. No additional data regarding dental alignment was available. Horses evaluated during the acute phase—especially post-trauma or following surgery—showed tenderness when pressure was applied along the affected suture lines.

Figure 1. Horse exhibiting moderate purulent tearing linked to idiopathic suture exostosis.

Splenic lymph nodes were typically aligned along the dorsal aspect of the splenic vein **(Figure 3)**. Most displayed their long axis in the transverse plane, differing from the sagittal alignment seen in other abdominal lymph nodes.



a) b)

Figure 2. (a,b): Radiograph (a) and CT reconstruction (b) of a horse showing pronounced suture exostosis on the right side due to dental sinusitis. The sinus condition originated from a chronic diastema between teeth 108/109 and 109/110, accompanied by severe alveolitis.

Table 4. Distribution of 105 equine suture exostosis cases presenting with nasal discharge and epiphora, categorized by onset history.

Case History	Epiphora (n)	Nasal Discharge (n)
Following trauma	9	5
Following surgical procedure	16	24
Associated with sinus disorder	4	5
Without identifiable cause (idiopathic)	10	1

Among the 48 cases that developed post-surgical exostosis, details of the sinus entry technique are summarized in **Table 5**. Of the 25 flap surgeries **(Figure 3)**, 11 were completed using an oscillating saw, 2 with a chisel, and in 12, the exact technique was not specified.

Figure 3. Mare following a bone flap sinusotomy complicated by secondary suture exostosis, resulting in bacterial infection and abscess formation beneath the right eye and along the nasal bridge.

Table 5. Type of sinus surgical approach in 48 equine suture exostosis cases occurring after sinus procedures.

Type of Sinus Access	Number of Cases (n)
Frontal sinus trephination, 5 mm (with Foley catheter insertion)	2
Frontal sinus trephination, 13 mm opening	9
Frontal sinus trephination, 19 mm opening	2
Frontal sinus trephination, 24 mm opening	7
Frontal sinus bone flap	10
Maxillary sinus bone flap	3
Extended fronto-nasal bone flap	12
Alternative technique	1
Access method not specified	2

Of the eight cases where swelling corresponded to underlying sinus disease, six involved detection of a cyst or soft tissue mass, one presented with secondary dental sinusitis, and one exhibited bilateral sinus fluid accumulation consistent with primary sinusitis.

Imaging findings

Eight horses underwent CT scans of the skull **(Figure 4)**; four had no imaging performed, while radiographs were available for the remaining cases **(Figure 5)**. The predominant imaging feature included well-defined periosteal and endosteal proliferation localized along affected suture lines, with mild-to-moderate soft tissue thickening nearby. Various degrees of suture widening were noted.

Bone sequestra were detected in 28 cases through imaging **(Figure 6)**, as summarized in **Table 6**. In two horses, ultrasonography was necessary to verify and locate sequestra **(Figure 7)**.

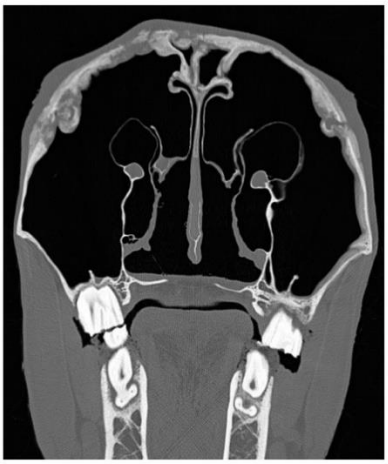


Figure 4. Transverse CT image of a horse with bilateral idiopathic suture exostosis affecting both nasolacrimal ducts. Mucosal and skin reactions appear minimal.

Figure 5. Radiograph of a young horse demonstrating extensive suture exostosis with sequestrum (marked by a metallic pin) and moderate soft tissue edema.

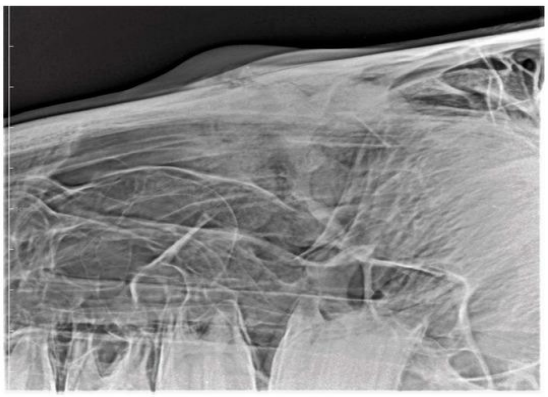


Figure 6. Radiograph illustrating a mild-to-moderate but painful exostosis with visible bone sequestrum.

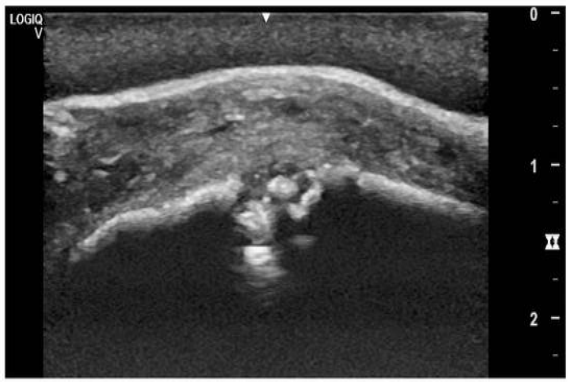


Figure 7. Ultrasonographic image showing suture exostosis with central sequestrum; note the thickened periosteum and overlying soft tissues.

Table 6. Frequency of bone sequestra observed in 105 horses with facial suture exostosis, categorized by the onset cause.

Case History	Number with Sequestra (n)
Following trauma	6
Following surgical procedure	19
Associated with sinus disease	1
Idiopathic onset	6

Treatments

A variety of management combinations were reported. Surgical debridement and sequestrectomy **(Figures 8a and 8b)** were performed in 19 post-sinusotomy horses with confirmed infection and bone necrosis. Among 23 trauma-related cases, six underwent sequestrectomy, and all received systemic and local NSAID therapy.

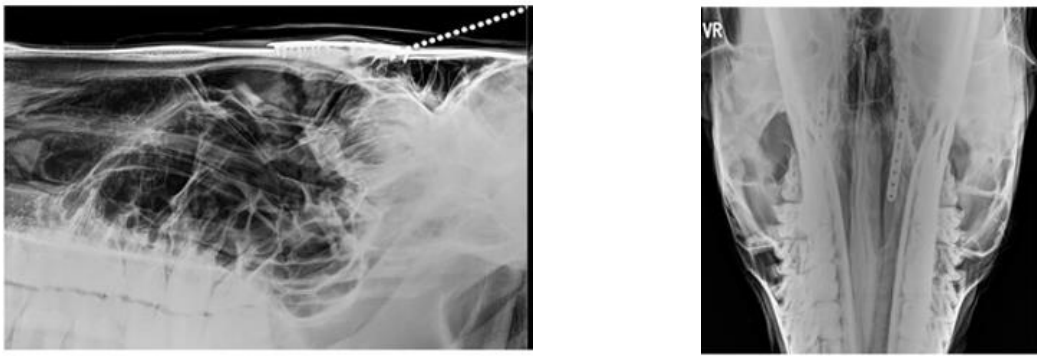
Horses with sinus-origin exostosis were treated by cyst or mass removal (six cases), sinus lavage (one case), while one was euthanized due to extensive dental and sinus involvement.

In idiopathic cases, treatment approaches varied — from no therapy to the use of NSAIDs, topical anti-inflammatories, or corticosteroids. Most animals were placed on stall rest with controlled walking, and dietary modifications (e.g., avoiding carrots and hard feed) were commonly advised.

Two horses underwent suture line fixation, one using double 10-hole 2.7 mm DCP plates and another with an LC-DCP plate **(Figures 9a and 9b)**.

a) b)

Figure 8. (a,b): Surgical cleaning and sequestrectomy in a horse presenting with purulent abscesses following bone flap surgery.



a) b)

Figure 9. (a,b): Lateral (a) and dorsoventral (b) radiographs showing internal suture stabilization using two 10-hole plates positioned about 2.5 cm lateral to the midline.

Follow-up and outcomes

One horse was euthanized immediately after initial evaluation. Follow-up data for 88 of the 104 surviving cases are presented in **Table 7**. None of these horses showed ongoing nasal discharge or persistent epiphora at the time of reassessment.

Table 7. Follow-up details for 88 horses with facial suture exostosis, organized by etiology of onset.

Case Category	Cases with Follow-Up / Total	Observed Outcome
Post-trauma	18 / 23	– In 5 horses, the swelling fully resolved after an average of 25.6 weeks (range 2–36 weeks).– In 4 cases, the swelling remained unchanged at 26 weeks follow-up.– In 9 cases, the enlargement had lessened after a mean period of 23.5 weeks (range 4–78 weeks).
Post-surgical	40 / 48	– Of 19 cases treated for sequestrum or infection: • Complete resolution occurred in 10 within an average of 6.4 weeks (range 1–12 weeks). • Partial improvement was noted in 7 after a mean of 5 weeks (range 2–8 weeks). • One horse was euthanized after 11 weeks due to multi-resistant infection and treatment failure. • Another was euthanized at 7 weeks because of persistent infection, one-sided blepharospasm, worsening pain, and non-response to therapy.– Of 5 cases without further intervention: • In 2, mild improvement was noted at 8 weeks. • In 2, swelling had resolved by 8 weeks. • In 1, the horse examined 2 years later showed no swelling, but the exact time of resolution was unrecorded.– Of 16 horses receiving only medical therapy (NSAIDs: phenylbutazone, flunixin; topical diclofenac; ± antimicrobials): • In 6, swelling resolved within a mean of 5.4 weeks (range 4–6 weeks). • In 10, swelling was reduced after an average of 10.4 weeks (range 4–24 weeks).
Post-sinus disease	5 / 7	– After removal of mass or cyst: • 2 horses showed complete disappearance of swelling at 6 months. • 2 had minor residual swelling at 6 months. • 1 showed no change even after 1 year.
Idiopathic	25 / 26	– In 5 horses, the swelling resolved after a mean of 25 weeks (range 4–78 weeks).– In 1, disappearance was noted 10 years later, but the timeframe for regression was unspecified.– In 17, swelling decreased but persisted at a mean follow-up of 48.6 weeks (range 8–208 weeks).– In 2 cases treated with internal fixation, slight improvement was observed at 8 and 9 months post-surgery, respectively.

The clinical manifestation of suture periostitis, exostosis, separation, or suturitis likely represents several distinct pathological mechanisms [2]. This interpretation aligns with the present case series, in which the disorder appeared in four main categories: following trauma, after sinonasal surgery, associated with sinus disease, or occurring without any evident cause (idiopathic). Any form of mechanical stress or injury to the cranial sutures that leads to local instability or inflammation may precipitate the condition. Direct traumatic forces causing facial bone fractures or suture disruption often trigger callus formation as part of normal fracture repair. Similarly, surgical trauma during procedures such as sinusotomy (via trephination or bone flap) or infection along the suture

lines after such interventions can induce periosteal or endosteal reactions, generating new bone and resulting in a comparable clinical picture.

The development of cranial and facial bones is a highly coordinated process starting in early embryonic stages and continuing into maturity. During fetal growth, both cranial and facial bones arise through intramembranous ossification within mesenchymal tissue that surrounds the brain [9]. In face, these ossification centers are initially separated by connective tissue, which later evolves into fibrous "joints" known as sutures.

Anatomically, these structures represent non-synovial joints (syndesmoses). As the bones enlarge with growth, the connective tissue zones diminish, and interlocking bone edges—called cranial sutures—form. Specific sutures are identified based on the bones they connect, e.g., Sutura internasalis or Sutura lacrimomaxillaris. Despite appearing rigid, sutures retain a layer of connective tissue microscopically for extended periods, making them nearly immobile fibrous articulations rather than true bone fusions.

In younger horses, facial sutures typically remain open and appear irregular, while in aged individuals, they progressively close through osseous fusion [9]. The timing of fusion is well documented in humans, but comprehensive data for horses remain limited. In a study involving 52 equines aged 2–30 years, the histological features of equine cranial sutures were shown to be identical to those in humans and other mammals [10]. The suture structure was defined as a fibrous joint composed of collagen-rich connective tissue that is both cellular and vascularized [10].

Among the most clinically significant sutures, only the frontomaxillary suture demonstrated complete bony closure in horses over 20 years old. The lacrimomaxillary and zygomaticomaxillary sutures frequently retained connective tissue, even in horses up to 30 years of age, while the internasal suture generally remained unfused [10]. Although these findings were based primarily on high-resolution CT data and selective histological sections, the authors noted that minimal connective remnants may have been overlooked in some specimens deemed "fully fused."

These results [10] suggest that facial suture lines can act as open conduits for inflammatory spread, consistent with clinical observations of bilateral swelling despite a unilateral insult. Thus, infection or sequestration on one side of the head may provoke a mirror response along the opposite suture line **(Figures 10a and 10b)**. The sutures effectively serve as pathways for inflammatory propagation.

a) b)

Figure 10. (a,b): Clinical view (a) and CT image (b) of a horse showing nearly symmetrical, bilateral suture exostosis originating unilaterally and progressing across the facial midline.

Trauma cases

The severity of trauma does not appear to directly correlate with the onset or extent of suture exostosis. Among the 23 trauma-related cases, one notable instance involved a horse that bumped its head while backing out of a trailer—without any visible wound or deformity. Swelling appeared weeks later, and radiographs showed bone proliferation and sclerosis along the frontonasal suture. This contrasts with cases involving open trauma and bone sequestra, where infection developed prior to visible swelling.

In a review by Tremaine and Dixon [11], five out of fifteen horses with secondary sinusitis following facial fractures also presented trauma-induced suture exostosis. For cases where trauma leads to suture instability,

surgical stabilization is expected to promote more rapid and complete healing at the suture or fracture site. While this method was used in two idiopathic cases in the current series, it was not applied in the traumatic group.

Post-sinusotomy cases

Approximately half of the cases documented (n = 48) developed facial swelling following sinusotomy. This aligns with prior literature on sinusitis surgery, which often lists suture exostosis among common postoperative complications [11-13]. Although Tremaine and Dixon (2001) reported favorable outcomes using conservative management after sinusotomy, the current dataset suggests that successful resolution of post-surgical suture periostitis depends on detecting and removing sequestra and addressing any concurrent infections. In 18 of the sinusotomy-related cases, sequestra were found; swelling subsided in 10 of these within 12 weeks of removal. Two horses were euthanized due to poor therapeutic response, and follow-up for the remaining seven extended only to 8 weeks, which likely limited assessment of full recovery. Among the cases managed medically without sequestrectomy, the reduction or disappearance of swelling occurred less often and at a slower rate.

Woodford and Lane [12] described two occurrences of suture exostosis in a series of 50 sinusotomies conducted by various techniques. Similarly, Quinn *et al*. [14], employing a 5 cm trephine approach, observed mild exostosis in 36% and more pronounced, cosmetically poor cases in 13% of 60 patients. Tremaine and Dixon [11] documented one case of suture exostosis among 115 operated sinusitis cases from a total of 277. Fenner *et al*. [15] reported six cases out of 37 sinusotomies, though their work focused primarily on sinonasal cyst complications, limiting its representativeness for overall prevalence. In this study, the total number of sinusotomies across participating institutions was not recorded, preventing exact incidence determination. Nevertheless, both the present and referenced data suggest that suture exostosis is a relatively frequent surgical complication.

No particular sinusotomy or trephination technique appeared to predispose to exostosis development in this cohort. Two surgeons noted fewer cases after switching from sinus flaps created with oscillating saws to trephination methods (T. Zwick, H. Simhofer; personal observation), though this remains anecdotal and requires further study. Because osteotomy corners often generate small bone fragments, drilling rounded terminal points at flap corners may prevent intersecting cuts and reduce sequestrum formation (D. Verwilghen; personal observation). Using reciprocating instead of oscillating saws could also mitigate this issue. Ensuring all loose bone pieces are cleared prior to closure may help prevent postoperative sequestration. Moreover, CT-based preoperative planning can assist in selecting sinus entry points that avoid suture lines and minimize trauma.

Idiopathic cases

Twenty-six horses showed no record of trauma or prior sinusotomy. Earlier, Dixon [1] proposed that the frequent occurrence of this condition in Thoroughbreds and the often bilateral presentation make trauma an unlikely cause. However, given the range of minor to severe trauma documented in other series, the presence of sequestra in six idiopathic cases, and histological findings in normal horses, this hypothesis might require reevaluation. Reports from two histologically examined idiopathic cases [3, 5] revealed callus formation, consistent with bone repair after fracture.

While undetected trauma remains a probable cause, other potential mechanisms deserve consideration. Equine facial bone and sinus structures evolve dynamically alongside tooth growth and occlusal forces [16]. Masticatory pressure across the naso-frontal and inter-nasal sutures (see Supplementary Video S1) may trigger bone proliferation at these sites [17]. Malocclusion could further amplify strain on suture lines [18], suggesting that idiopathic exostosis cases should be evaluated for dental abnormalities or eruption problems. Unfortunately, dental records were unavailable for review in this series.

Though osteochondromas typically occur in long bones—especially the distal radius—they can also develop in smaller bones undergoing endochondral ossification. Bonilla and Wilson [19] described a nasal septum osteochondroma concurrent with naso-frontal exostosis, though histology did not confirm involvement of the suture line. In humans, a fronto-temporo-sphenoidal osteochondroma has been documented in a 34-year-old woman [20], but no such finding has been reported in equids. Future histopathological analysis of additional idiopathic cases may clarify whether osteochondromas play a role.

Various therapeutic strategies were applied in idiopathic cases, but outcome data remain insufficient for analysis. Two horses treated with suture stabilization as per Klein and Sacks [5] showed improvement—pain resolved, and swelling decreased notably within months, though remodeling appeared incomplete due to limited follow-up. The

method of plate fixation for these cases has been debated [2], considering the biomechanical forces acting on craniofacial sutures during mastication.

Clinical presentation and diagnosis

Earlier literature described suture exostosis as painless [4]. However, in this series, regardless of etiology, many horses in the acute stage exhibited pain upon palpation, indicating the importance of analgesic therapy, either systemic or local.

While CT remains the diagnostic gold standard, plain radiographs generally suffice to confirm suture exostosis. Nevertheless, radiographs may fail to reveal sequestra due to complex suture anatomy. Ultrasonography proved especially effective in detecting sequestra and abscesses in several cases **(Figure 7)**, and its use is recommended as part of diagnostic evaluation.

Conclusion

The study's primary limitation is the inconsistency in follow-up duration, which affects the interpretation of recovery times among case groups. Despite this, comparisons indicate that surgical intervention involving sequestrectomy and infection control resulted in faster and more consistent recovery, particularly in post-sinusotomy horses.

In summary, conservative or purely medical management seldom achieves complete resolution. Some spontaneous recoveries occurred within six months (one case required 1.5 years), suggesting that surgical treatment for idiopathic exostosis may be postponed until after this period. Overall, this series underscores the significance of identifying and removing sequestra to expedite healing and achieve favorable outcomes.

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