Equine Veterinary Journal

Equine Veterinary Journal ISSN 0425-1644
DOI: 10.1111/evj.12787

Diagnosis, treatment and outcome of cranial nuchal bursitis in 30 horses

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Summary

Background: No large retrospective case series describing the treatment and outcomes following diagnosis of cranial nuchal bursitis have been published.
Objective: To describe the clinical presentation, diagnostic techniques, treatment and outcome of horses suffering from cranial nuchal bursitis and to determine their outcome after medical or surgical treatment.
Study design: Retrospective case series.
Methods: Medical records (1990–2014) of two referral centres were reviewed for signalment, diagnostic features, method of treatment (medical, surgical or both) and outcome.
Results: The median age of horses was 13 years (range 5–22 years) and follow-up time ranged from 12 to 108 months. Fourteen horses were treated medically and 20 horses were treated surgically. Of those horses treated medically, four horses had recurrence of clinical signs requiring subsequent surgical treatment. Overall, 41.7% of horses had recurrence of clinical signs following treatment and 66.7% of horses were able to return to their previous level of exercise. Five horses underwent more than one surgical procedure due to recurrence of clinical signs. Of those horses treated solely surgically, 28.6% of the horses had recurrence of clinical signs and 78.6% returned to their previous level of exercise. Of those horses treated solely medically, 33.3% had recurrence of clinical signs and 66.7% returned to their previous level of exercise. Of those horses treated surgically following failed medical management, 100% had recurrence of clinical signs and 25% returned to their previous level of exercise.
Main limitations: Retrospective design with small sample number.
Conclusions: Nuchal bursitis can be successfully managed with either medical or surgical treatment. Prognosis for return to work tends to be worse in horses requiring surgical intervention following failed medical management.

Keywords: horse; poll evil; bursoscopy

Introduction

The cranial nuchal bursa is one of the three bursae associated with the nuchal ligament. Also referred to as *bursa subligamentosa atlantoidea*, it is located ventral to the funicular portion of the nuchal ligament and dorsal to the atlas [1]. The anatomy, ultrasonographic and magnetic resonance features and the technique for endoscopic examination have been recently described [2].

Historically, the most commonly reported condition affecting the nuchal bursa was poll evil, which involves the development of a septic process in the cranial nuchal bursa resulting in external drainage [3]. More recently, cranial nuchal bursitis was described in two horses; the report also included two horses affected with caudal nuchal bursitis. In that report, all four horses had resolution of clinical signs and were able to return to work following bursoscopic debridement [4]. Other conditions affecting the poll region can include septic arthritis and periarticular abscess formation in the atlanto-occipital joint.

The objective of this study was to describe the clinical presentation, diagnostic features, response to medical and/or endoscopic treatment and long-term outcome of a population of 30 horses with cranial nuchal bursitis. We hypothesised that horses treated surgically have a better prognosis and a lower incidence of recurrence than horses that received medical treatment.

Materials and methods

Horses

Medical records for horses treated for cranial nuchal bursitis at the Cummings School of Veterinary Medicine at Tufts University and Lingehoeve Diergeneeskunde from 1 January 1990 through 1 September 2014 were analysed. Cases were identified using the search feature of the current and previous electronic medical record systems using the terms 'nuchal bursitis', 'cranial nuchal bursa' and 'poll evil'. Both hand-written case files and completely electronic case files were available for analysis. Inclusion criteria were diagnosis of cranial nuchal bursitis and pursuit of medical or surgical treatment (bursoscopy). Exclusion criteria included the use of open debridement and euthanasia prior to treatment. Data retrieved included signalment, use, presenting complaint, duration of clinical signs and clinical signs on presentation. Clinical signs noted in the records included neck pain, lack of extension of the neck, abnormal head or neck carriage, the presence of swelling over the cranial nuchal bursa, asymmetry if present (noted as predominantly left- or right-sided swelling), pain on palpation, the presence of external trauma and the presence of drainage.

Diagnostic procedures

The results of all diagnostic imaging (radiography, ultrasonography, nuclear scintigraphy, computed tomography [CT] and magnetic resonance imaging [MRI]) performed was recorded for each case. When sampled, synovial fluid was obtained using an 18 gauge, 8.75 cm needle under ultrasonographic guidance. Fluid was placed into a glass EDTA tube for cytological analysis, into a glass tube without additives for *Borrelia burgdorferi* polymerase chain reaction (PCR) testing and a small amount was placed onto two culture swabs for aerobic and anaerobic bacteriologic culture. Synovial fluid analysis and culture results were recorded if available. For cases tested for *Brucella abortus* antibody titres, whole blood was collected into glass tubes without additives.

Treatment

Horses were treated medically (rest, nonsteroidal anti-inflammatories and/or intrabursal medication with a combination of steroids and hyaluronic

acid) and/or surgically (endoscopic debridement). Intrabursal injections were performed under ultrasonographic guidance, using a combination of corticosteroid (methyl prednisolone acetate or triamcinolone acetonide) and a hyaluronic acid product with or without an antimicrobial (amikacin sulfate).

Surgical treatment consisted of bursoscopic exploration and debridement, as previously described [2, 4]. Briefly, surgery was performed under general anaesthesia, with horses placed in lateral recumbency with the affected (or more severely affected side) uppermost. Distention of the cranial nuchal bursa was achieved by injection of approximately 60 mL of lactated Ringers solution (LRS) using an 18 gauge, 8.75 cm spinal needle. Ultrasonographic guidance was used to guide needle placement for distention when necessary. After distention, an 8 mm skin incision was made with a number 11 scalpel blade, extending into the superficial muscle layer (splenius muscle), followed by a stab incision into the bursa. The arthroscopy sleeve was then inserted at a 60° angle to the skin in the axial direction, perpendicular to the long axis of the neck. The conical obturator was replaced with a 30° forward oblique viewing 4 mm arthroscope and an ingress line, with the light cable and videocamera attached for viewing. The position within the bursa was confirmed by observation of the nuchal ligament surrounded by synovial membrane. The bursa was distended with LRS, with the ingress fluid line connected to an automated arthropump, initially set to maintain a pressure of 70 mmHg. For exploration and debridement procedures, an ipsilateral instrumental portal was created 4 cm caudal to the arthroscopic portal. Bursoscopy was performed with the operator standing at the dorsal aspect of the patient. Debridement was accomplished with a combination of mechanised synovial resectors and Ferris-Smith rongeurs. Skin incisions were closed primarily with nonabsorbable suture material (polypropylene) and a sterile bandage (consisting of sterile gauze and Ioban 2[a] adhesive drape) was applied for recovery.

Horses were given perioperative antimicrobials (typically a combination of ceftiofur[b] [Naxcel] 2.2 mg/kg bwt i.v. BID and gentamicin 6.6 mg/kg bwt i.v. SID or ampicillin 25 mg/kg bwt i.v. TID) and nonsteroidal anti-inflammatories (phenylbutazone 2.2 mg/kg bwt i.v. BID or flunixin meglumine 1.1 mg/kg bwt i.v. BID).

Rehabilitation included 2 weeks of stall rest with hand walking until suture removal, followed by exercise at the walk under saddle (with loose and long reins) for 4 weeks. At 8 weeks, if progression was deemed satisfactory, horses started exercise at the trot under saddle for 4 additional weeks before gradually resuming their previous exercise routine.

Follow-up appointments were performed at 2 weeks (for suture removal and intrabursal injection of HA) and 6–8 weeks post-operatively with clinical and ultrasonographic evaluations performed at the referral practices or by the referring veterinarians.

Outcome

Long-term follow-up information (minimum of 12 months following treatment) was obtained by contacting owners by telephone or email. Follow-up questions included whether the horse had any recurrence of the original clinical signs; if it had, what clinical signs were noted; whether the horse developed any new signs that the owner attributed to nuchal bursitis; if so, what signs were noted; and whether the horse was able to return to its previous level of performance; if not, was this due to the cranial nuchal bursitis or for other reasons. Follow-up was considered unavailable if the owners were unable to be contacted after three telephone and email attempts. Outcome was defined as 'return to previous level of performance' if the horse was able to resume the previous level of exercise or to perform intended use. Outcome was defined as 'decreased performance' when the horse failed to return to the previous level of exercise or was subsequently retired.

Data analysis

Stata[c] version 12 statistical software was used for all analyses. Normality of the data and equality of variances were assessed using the Shapiro–Wilk and Bartlett's tests, respectively. Continuous variables that did not meet the assumptions for parametric testing (age and duration of clinical signs) were log-transformed prior to analysis. An one-way ANOVA was used to compare age and duration of clinical signs between treatment groups. Comparisons of outcomes (recurrence following treatment and return to previous work) between groups was done using a Fisher's exact test. The value of significance was set at $P \leq 0.05$.

Results

Medical records search yielded a total of 35 cases of cranial nuchal bursitis during the study period. Four cases treated with open debridement were excluded. A single case that was subjected to euthanasia immediately after diagnosis was also excluded. The remaining 30 horses, including 21 geldings and 9 mares, admitted for examination and treatment of cranial nuchal bursitis were included in this study. For the purposes of analysis, horses were separated into three treatment groups: medical treatment only (Group A; n = 10), surgical treatment only (Group B; n = 16) and surgical treatment following failed medical management (Group C; n = 4). A table with individual case information can be found in Supplementary Item 1.

Mean age at presentation was 13.4 years with a range of 5–22 years; there was no significant difference in age between groups (Group A: median 13 years, 10th and 90th percentiles 5–22 years; Group B: 13, 9.7–20 years and Group C: 17, 13–20 years, P = 0.4). The distribution of breeds was 19 Warmbloods, 2 Belgian crosses, 2 Thoroughbreds and one each of various other breeds (Appaloosa, Arabian, Friesian, Morgan, Percheron cross, Quarter horse, Welsh pony). The breed distribution reflected the populations of the two hospitals from which cases were drawn. Of the 21 horses where use was recorded, 12 (57.1%) were used for dressage, 6 (28.6%) for hunter/jumper and 3 for pleasure (14.3%). In those horses where it was recorded, the mean duration of clinical signs was 22.4 weeks, with a range of 1 week to 3 years; there was no significant difference in duration of clinical signs between groups (Group A: median 2.5 weeks, 10th and 90th percentiles 1–104 weeks; Group B: 6, 1.2–78 weeks; Group C: 12, 2–156 weeks; P = 0.5).

Presenting complaints included swelling over the cranial nuchal bursa area (14/30; 46.7%), decreased neck flexion (13/30; 43.3%), abnormal head carriage (9/30; 30.0%) and drainage (2/30; 6.7%). Clinical signs upon examination at the referral practices included swelling over the cranial nuchal bursa region (26/30; 86.7%), with asymmetry (left-side more prominent in 14 cases, right in 4 cases and not recorded in 12 horses), pain on palpation of the poll region (12/30; 40.0%), abnormal head-neck carriage with head and neck persistently held in extended position (10/30; 33.3%), decreased range of motion of the neck (10/30; 33.3%) and drainage from the poll (2/30; 6.7%).

Diagnostic imaging

Diagnostic imaging modality used for each case was based on clinician preference. Advanced imaging using CT or MRI was not available prior to 2006. Radiographs were performed in 27 horses; 22 horses presented radiographic changes including mineralisation of nuchal bursa capsule (12/27; 44.4%), bony remodelling of dorsal arch of C1 (11/27; 40.7%), soft tissue swelling (7/27; 25.9%) and mineralisation of the nuchal ligament (3/27; 11.1%) (Fig 1). Ultrasonography was used in all cases, with the following ultrasonographic changes: synovial effusion (28/30; 93.3%), thickening of the bursal capsule (11/30; 36.7%), synovial proliferation (8/30; 26.7%) and the presence of fibrin/cellular debris (7/30; 23.3%) (Fig 2).

Nuclear scintigraphy was performed in four horses with all cases having increased radiopharmaceutical uptake at the dorsal aspect of C1. Computed tomography (CT) was performed in four horses (Supplementary Item 2). The findings included increased bursal size, bursal asymmetry and mineralisation dorsal to C1. Magnetic resonance imaging (MRI) was performed in two horses (Supplementary Item 3). The findings included communication between the cranial and caudal nuchal bursae, with inflammation of the musculature surrounding the bursa and hyperintense signal on T2-weighted images in combination with hypointense signal on T1-weighted images consisting in fluid contained within the bursa. In addition, thickening of the bursal wall and septum were observed consistent with inflammation.

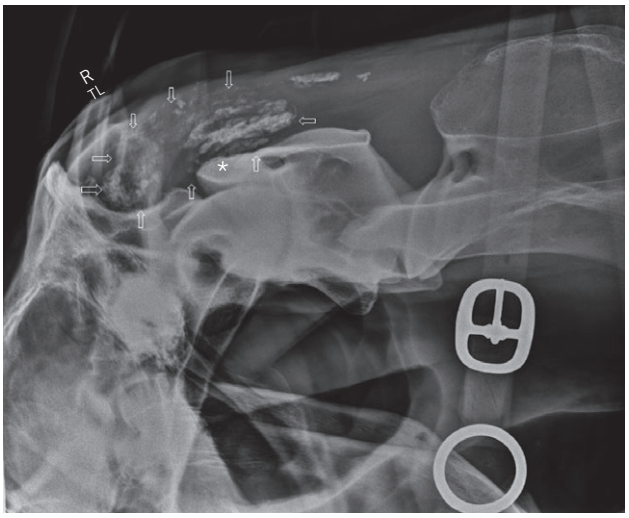

Fig 1: Lateral radiograph of the poll region from a horse with mineralisation of the cranial nuchal bursa (arrows), remodelling of the dorsal arch of the first cervical vertebrae (asterisk) and soft tissue swelling.

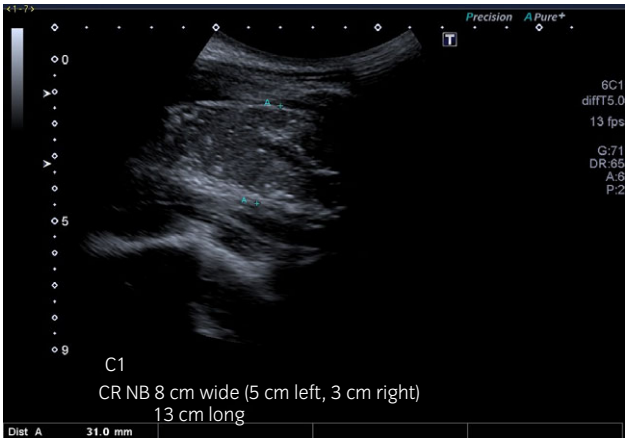

Fig 2: Longitudinal ultrasound image of the cranial nuchal bursa at the level of the first cervical vertebrae from a horse with synovial effusion and deposition of fibrin and cellular debris within the bursa. Cross-hairs indicate the dorsal and ventral boundaries of the cranial nuchal bursa.

Laboratory data

Synovial fluid cytology was available in eight horses; neutrophilic inflammation was present in five cases and eosinophilic/acellular proteinaceous material was present in three cases. Fluid analysis of these samples yielded a mean nucleated cell count of 48.5 $\times$ 10^3 cells/μL (range: 3.61 $\times$ 10^9 to 119 $\times$ 10^9 cells/L) and mean total protein of 60.3 g/L (range: 14 to 74 g/L).

Antibody titres to *B. abortus* were measured in two cases, both of which had negative results. Polymerase chain reaction testing of synovial fluid for *B. burgdorferi* nucleic acid was performed in two cases, both of which had positive results.

A total of 20 bacterial cultures were available for 12 cases. Eight horses had a single culture performed, two horses had two cultures, one horse had three cultures and one horse had five cultures. A total of six horses had positive cultures, with three cultures being positive on initial examination and three cultures being positive on subsequent examinations. Bacteria isolated included: *Staphylococcus* spp. (three horses), *Streptococcus* subsp. *zooepidemicus* (one horse), *Escherichia coli* (one horse), *Bacillus* spp. (two horses) and *Enterococcus* spp. (one horse). Of horses with positive cultures on initial examination, two of the three cases were treated surgically and the remaining case was treated medically. All horses with positive cultures on subsequent examinations were treated surgically following initial examination and had repeat surgery performed following re-examination. Overall at initial presentation, one (10%) horse treated medically and two (10%) horses treated surgically had positive cultures from synovial fluid obtained from the nuchal bursa.

Treatment

A total of 30 clinical cases were included. Fourteen horses were treated medically with either stall rest and nonsteroidal anti-inflammatory administration (n = 4) or intrabursal injection in the cranial nuchal bursa under ultrasonographic guidance (n = 10). Injections included triamcinolone acetonide (8–40 mg) in five cases and methyl prednisolone acetate (60–120 mg) in five cases combined with different formulations of hyaluronic acid. Of these 14 horses, 4 (28.6%) subsequently had surgery due to the failure of the medical therapy to resolve the clinical signs. Time from initial medical treatment to bursoscopic surgery ranged from 4 weeks to 3 years.

Twenty horses were treated surgically with bursoscopic debridement and lavage (Supplementary Items 4 and 5). Of those, 16 were treated surgically following the initial examination at the referral centre and 4 received surgery following failed medical management at the referral centre. At the conclusion of surgery, all horses received intrabursal hyaluronic acid and eight horses received intrabursal antimicrobials (seven amikacin sulfate and one ticarcillin clavulanate). Repeated intrabursal injection with antimicrobials (amikacin sulfate or ceftazidime) was performed in five horses at 48–96 h post-operatively. A continuous infusion pump was placed for administration of antimicrobial therapy (ticarcillin clavulanate) in one horse. Perioperative i.v. antimicrobials (ceftiofur sodium[b] [Naxcel] or ampicillin and gentamicin or enrofloxacin[d] [Baytril]) were administered for 24 h to 7 days. Fifteen horses were discharged with oral antimicrobials (trimethoprim sulfamethoxazole, enrofloxacin[d] [Baytril] or doxycycline) that were administered for an additional 3–21 days. Nonsteroidal anti-inflammatories (phenylbutazone) were administered on a tapering course for 7–10 days post-operatively.

Recurrence and complications

Follow-up information was available for 24 (80%) out of 30 horses. Specifically, follow-up was available for 6 out of 10 horses in Group A, 14 out of 16 horses in the Group B and 4 out of 4 horses in Group C.

Overall, 10 (41.7%) horses had recurrence of clinical signs following initial treatment. Seven (29.2%) horses were noted to have continued swelling of the poll region and four (16.7%) horses developed fistulous tracts from the previous endoscopic portal sites. In Group A, 2 (33.3%) out of 6 horses had recurrence of clinical signs, with both horses having continued swelling of the poll region. In Group B, 4 (28.6%) out of 14 horses had recurrence of clinical signs. Of those, 3 (75%) out of 4 had continued swelling of the poll region and 2 (50%) out of 4 had drainage from the endoscopic portal sites. In Group C, 4 (100%) out of 4 horses had recurrence of clinical signs. Of those, 2 (50%) out of 4 had continued swelling of the poll region and 2 (50%) out of 4 had drainage from the endoscopic portal sites. A difference was found between groups with regards to recurrence of clinical signs following treatment ($P = 0.05$).

Of the horses with complications, five had repeated surgical intervention (two from the surgical group and three from the surgery following medical management group); three due to draining tracts and two due to persistent swelling of the poll region. One horse was treated with lavage of the cranial nuchal bursa (standing under sedation and local anaesthetic blocks) and intrabursal antimicrobial administration (amikacin sulfate, clindamycin phosphate gel and clindamycin-impregnated polymethylmethacrylate beads). Four horses underwent repeated endoscopic surgery. Of these, three horses had a single repeat bursoscopy (total of two surgeries) and one horse had two repeat bursoscopies (total of three surgeries) for further debridement and lavage of the cranial nuchal bursa.

Bacterial cultures were performed in four out of five cases undergoing repeated surgical intervention. Three cases had no growth on initial culture taken during the first bursoscopy. *Staphylococcus epidermis* was obtained

on the initial culture in one case. This case had two follow-up cultures performed of which the first one grew a *Bacillus* sp. and the second follow-up culture was negative. One initially negative case had a follow-up culture, which did not show any growth. One initially negative case had a second culture performed, which grew a *Bacillus* sp. One initially negative case had four follow-up cultures performed, all of which were positive (*E. coli*, *Streptococcus* subsp. *zooepidemicus*, and mixed infection of *E. coli*, *Streptococcus* subsp. *zooepidemicus* and *Enterococcus* sp.).

Outcome

Long-term follow-up information was available for 24 (80%) out of 30 horses (range 15–120 months, median of 67 months). Of the six horses, four (66.7%) in Group A returned to their previous level of exercise. Of the 14 horses, 11 (78.6%) in Group B returned to their previous level of exercise. Of the four horses, one (25%) in Group C returned to its previous level of exercise. No significant differences were found between groups in regards to return to previous level of exercise ($P = 0.2$).

A median duration of clinical signs of 6 weeks was found for horses that were able to return to their previous level of performance vs. 14 weeks for those horses that failed to return to their previous level of performance. No significant association was found with regard to duration of clinical signs and ability to return to previous level of exercise ($P = 0.5$).

Discussion

Although a relatively uncommon condition, cranial nuchal bursitis can result in decreased performance of equine athletes. Inflammation of the cranial nuchal bursa should be included as a differential diagnosis for horses presenting with neck stiffness, abnormal head carriage and the presence of pain or swelling in the poll region.

For the majority of cases, diagnosis was based on clinical signs, radiographic and ultrasonographic changes. Ultrasonographic evaluation of the nuchal bursa was performed with the technique described by Abuja *et al.* [2]. We consider this evaluation one of the most important diagnostic modalities since it allowed the evaluation of the size of the nuchal bursa, thickening of the synovium, echogenicity of the bursal fluid content and best approach for centesis or bursoscopy by confirming the dominance of fluid filling to the right or left side of the nuchal ligament [2]. A limited number of cases underwent nuclear scintigraphy due to nonspecific clinical signs or multiple perceived problems (e.g. neck pain and lameness). Advanced diagnostic imaging techniques, such as CT and MRI, are typically reserved for cases in which radiography and ultrasonography fail to provide adequate detail, as these techniques are more costly and may require general anaesthesia. These modalities may be most useful in chronic cases with extensive calcification of the bursal tissues, communication between cranial and caudal nuchal bursae, the presence of additional pathology in the atlanto-occipital joint or surrounding osseous structures. Neurological examinations were not routinely performed in the absence of any clinical signs that could be attributed to neurological disease.

Both septic and nonseptic nuchal bursitis have been described in the literature [3, 4]. Septic cases of nuchal bursitis have historically been deemed poll evil and frequently present with external drainage from the poll region [3]. In nonseptic cases, chronic inflammation of the bursa may be attributable to single or repeated episodes of trauma; three of these cases have been described by Garcia-Lopez *et al.* [2, 4]. Synovial fluid analysis was only recorded for eight of the presented cases. In the majority of these cases, nucleated cell count and total protein were significantly increased, consistent with an inflammatory or infectious process. However, as some of the cases had nucleated cell counts between 3.61×10^9 and 22.9×10^9 cells/L or a total protein of less than 20 g/L, the analysis did not always yield a definitive diagnosis of inflammation or sepsis. The differential cell counts were not available for most of these cases, further complicating retrospective interpretation of these results. Due to the retrospective nature of the study, it is not apparent why synovial fluid analysis was included or omitted from the diagnostic work-up. Despite the infrequency of synovial fluid analysis in this report, the authors encourage collection and analysis of synovial fluid, especially if medical management with corticosteroids is being considered. Aerobic and anaerobic bacterial cultures were performed in 12 out of the 30 cases in this report. Of these, 50% of horses had positive bacterial cultures which grew a variety of Gram-positive and Gram-negative organisms. Only two horses in this population presented with external drainage; both of these cases had no growth on bacterial cultures. Of those horses with positive culture results, no history of penetrating wounds or systemic illness was recorded. Due to the retrospective nature of the study, it is not possible to ascertain why cultures were submitted for individual cases but in general cultures were taken during surgery in cases with draining tracts and in cases with suspicious cellular bursal fluid and intrabursal debris. Two cases had serological testing for *B. abortus*; both cases had negative titres. While *B. abortus* poses a zoonotic risk, testing of horses for this agent is not routine in our hospital due to the rarity of the disease following nationwide elimination programmes in livestock. In areas where horses and cattle are housed together, testing for *B. abortus* may be advisable. Two cases had PCR for the presence of *B. burgdorferi* nucleic acid; both cases had positive results. The significance of this finding is not yet known as exposure to *B. burgdorferi* is common in the northeastern United States and PCR testing has not been conducted on fluid obtained from the nuchal bursa of unaffected horses.

In this case series, only cases that were treated medically or with minimally invasive endoscopic surgery were included. Cases that were treated with open surgical techniques were not included. While open techniques to allow debridement and drainage of the bursae associated with the nuchal ligament are described in the literature, these techniques were used infrequently in both hospitals during the study period [3, 5]. The limited number of horses treated with open debridement were cases of chronic bursitis that were known to be septic. Because of this, a fair comparison between the open debridement and endoscopic techniques would likely be impossible and the outcomes described in this report may not be applicable to those horses treated with open debridement.

Following treatment, recurrence of clinical signs was reported in 10 (41.7%) out of the 24 horses. The most common clinical sign reported was continued swelling of the poll region, occurring in 7 (29.2%) out of the 24 horses. Recurrence of swelling was reported in horses in all treatment groups. Of 24 horses, 4 (16.7%) were reported to have drainage from fistulous tracts that formed at the cranial or caudal endoscopic portal sites post-operatively. Formation of draining tracts occurred in two horses in Group B and two horses in Group C. Horses that received surgery only after failed medical management (Group C) had greater recurrence of clinical signs following treatment. As with any bursitis, long-standing inflammation is likely to result in synovial proliferation and deposition of fibrin and cellular debris. As such, medical management with intrabursal medication may prove insufficient and surgical debridement may become necessary. This short-lived improvement following intrabursal medication has also been described with medical management of navicular bursitis where endoscopic intervention has been found to offer a more favourable prognosis [6, 7]. Our findings, and the observations of others in regards to other types of bursitis, may indicate prompt surgical intervention is likely to offer the best chance at resolution of clinical signs for horses with cranial nuchal bursitis.

Overall, 16 (66.7%) out of the 24 horses returned to their previous level of performance. No significant difference was found between groups in this regard. However, a tendency was noted for those horses in Group C to be less likely to return to the previous level of performance. This is likely tied to the increased incidence of recurrent clinical signs in this group, as those horses with continued clinical signs would be less likely to return to their previous level of exercise whether due to discomfort or cosmesis. While not significant, the median duration of clinical signs for horses that were able to return to their previous level of performance was substantially shorter than the duration of signs in those horses unable to return to their previous use. The lack of significance with this finding may reflect the small numbers of horses in the study or the wide range of values within each group. Despite the lack of significance, prompt intervention following the development of clinical signs is still recommended. The prognosis for horses to return to full work in the current report is less favourable than was previously reported by Garcia-Lopez *et al.* [4] where 100% of cases returned to full work. This difference is likely attributable to the larger number of cases reported in the current study allowing for more variation in severity of cases.

Further consideration of the horses successfully treated with solely medical management was sought by the authors in order to determine

which cases may benefit from medical management rather than surgical intervention. Appraisal of these cases revealed the horses to have a tendency towards a shorter duration of clinical signs prior to presentation, with a median duration of 2 weeks (range 1–3 weeks). The severity of nuchal bursitis in this subset of horses varied from mild to marked, as determined by ultrasonographic findings and synovial fluid analysis. As cytological analysis was available for very few cases in this series, the authors do not presume to make suggestions for surgical intervention based upon specific cell count or total protein thresholds. However, ultrasonographic examination was performed in all cases and was found to be useful for determining the severity of bursitis by examining the degree of synovitis, the character of the fluid within the bursa and the amount of fibrin/debris within the bursa. The authors postulate the success of medical treatment in this subset of cases may be attributable to treating the inflammation prior to the deposition of large amounts of fibrin and cellular debris. Based on the observations from this population of horses, medical management should be reserved for the treatment of acute cranial nuchal bursitis.

The limitations of the current study are many. Although cases were collected from two referral centres, the overall number of reported cases is still low. Due to the low numbers of cases, the statistical power in comparing treatment groups is very low and the detection of significant differences between groups is difficult. In the light of this, it is difficult to determine if there is truly no significant difference between treatment methods or if a difference might be detectable with larger numbers of cases. Our hypothesis that recurrence of clinical signs was less frequent in horses treated surgically was ultimately rejected. It is conceivable that a type II error could be present, resulting in the rejection of a true hypothesis. Additionally, owing to the retrospective nature of the study, medical records were incomplete in several cases. Furthermore, treatment of cases was not randomised but determined based on clinician preference and the owners' wishes. Follow-up was not obtained for all cases and when gathered it was at variable intervals.

The *Equine Veterinary Journal* antimicrobial stewardship policy requires a robust defence of the use of critically important antimicrobials, including third-generation cephalosporins and fluoroquinolones [8]. As study was completed retrospectively, it was not apparent why specific antimicrobials were chosen for each case. In spite of the first-line antimicrobial choices made historically, the use of culture and susceptibility to guide further antimicrobial choices were appropriate.

In conclusion, cranial nuchal bursitis can be successfully managed with either medical or surgical treatment. Recurrence of clinical signs is common and repeated surgical procedures may be necessary in some cases. Prognosis for return to work overall is fair. Both recurrence of clinical signs and return to previous level of work tend to be worse in horses requiring surgical intervention following failed medical management. In the light of this, the authors feel prompt surgical intervention may be the best management strategy.

Authors' declaration of interests

No competing interests have been declared.

Ethical animal research

Research ethics committee oversight not required by this journal: retrospective analysis of clinical data. Owners gave informed consent for their horses' inclusion in the study.

Sources of funding

None.

Acknowledgements

The authors thank Brenton Credille, DVM, PhD, DACVIM for assistance with statistical analysis.

Authorship

All authors contributed data to the manuscript and were involved in the editing and final approval of the manuscript.

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Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's website:

Supplementary Item 1: Table with individual case information (Age, Sex, Breed, Duration of symptoms, Treatment modality, Culture results, Fluid analysis and Outcome).

Supplementary Item 2: Computed tomographic images of a horse with cranial nuchal bursitis and mineralisation along the dorsal aspect of C1 (asterisk). Image A: bone highlighting modulus, Image B: soft tissue highlighting modulus, Image C: 3D reconstruction.

Supplementary Item 3: Magnetic resonance images of a horse with cranial nuchal bursitis. Image A: Longitudinal view in T2 sequence, Image B: Transverse view in T2 sequence. NL, nuchal ligament; SC, spinal cord; C1, atlas; C2, axis, arrow heads are outlining the distended cranial nuchal bursa.

Supplementary Item 4: Intraoperative images of the cranial nuchal bursa during bursoscopy. Image A: Arthroscopic view of cranial nuchal bursa before debridement, Image B: Arthroscopic view of cranial nuchal bursa after debridement.

Supplementary Item 5: Intraoperative images of the cranial nuchal bursa during bursoscopy. Image A: Arthroscopic view of cranial nuchal bursa before debridement, Image B: Arthroscopic view of cranial nuchal bursa after debridement.