Lameness originating from the shoulder region is uncommon and can be challenging to diagnose given the complicated anatomy of this region. The bicipital bursa is a synovial structure located between the head of the humerus and the tendon of the origin of the biceps brachii muscle. It facilitates the gliding motion of the proximal bicipital tendon over the intertubercular groove. Synovial sepsis is not an uncommon occurrence in the equine population, particularly resulting from trauma or wounds involving a joint or tendon sheath. Septic bicipital bursitis is reported more commonly following trauma or via hematogenous spread. Septic inflammation of the bicipital bursa: clinical, imaging, and surgical findings in nine horses

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OBJECTIVE
To describe the etiologies, clinicopathologic findings, diagnostic modalities employed, treatments, and outcome associated with cases of septic bicipital bursitis.

ANIMALS
9 horses.

CLINICAL PRESENTATION AND PROCEDURES
Medical records of horses diagnosed with septic bicipital bursitis between 2000 and 2021 were reviewed. Horses were included if synoviocentesis of the bicipital bursa revealed a total nucleated cell count of ≥ 20,000 cells/µL with a neutrophil proportion of ≥ 80%, a total protein concentration of ≥ 4.0 g/dL, and/or the presence of bacteria on cytology, or positive culture of the synovial fluid. Information retrieved from medical records included signalment, history, clinicopathologic variables, diagnostic imaging findings, treatment, and outcome.

RESULTS
Trauma was the most common inciting cause (n = 6). Synoviocentesis using ultrasonographic guidance was performed in all cases and showed alterations consistent with septic synovitis. Radiography identified pathology in 5 horses, whereas ultrasonography identified pathology in all horses. Treatment consisted of bursoscopy (n = 6) of the bicipital bursa of which 1 was performed under standing sedation, through-and-through needle lavage (3), bursotomy (2), or medical management alone (2). Five (55.6%) horses survived to discharge. Long-term follow-up was available for 3 horses and all were serviceably sound, with 2 in training as pleasure horses and 1 case continuing retirement.

CLINICAL RELEVANCE
Ultrasoundography was the most informative imaging modality and paramount in obtaining synovial fluid samples for definitive diagnosis of septic bicipital bursitis. Bursoscopy performed under standing sedation is a feasible treatment option. Horses treated for bicipital septic bursitis have a fair prognosis for survival and may return to some level of athletic performance.
the synovial fluid or a positive bacterial culture are all indicators of infection.12,13 Prompt aggressive treatment is indicated once a diagnosis of synovial sepsis is made, including systemic and regional antimicrobial therapy and surgical intervention where appropriate.12–16 While septic inflammation of the bicipital bursa has been described,12,17–19 reports are limited to single cases or small case series with limited descriptions in the literature regarding outcome and long-term prognosis. The objectives of this study were to describe the different etiologies, clinicopathological and imaging findings, treatment, and outcome associated with septic bicipital bursitis. We hypothesized that horses presenting with septic bicipital bursitis would have a poor prognosis, particularly in long-standing cases with associated skeletal involvement.

Materials and Methods

The essential criterion for inclusion in the study was a diagnosis of septic bicipital bursitis in horses based on clinical signs, diagnostic imaging findings, and analysis of the synovial fluid. A diagnosis of septic synovitis was based on a total nucleated cell count of ≥20,000 cells/μL with a synovial neutrophil proportion ≥80%, a synovial total protein ≥4.0 g/dL, and/or the presence of intracellular bacteria on cytology, with or without a positive bacterial culture.20 Horses were excluded if no synovial fluid analysis was performed or the medical record was incomplete.

Computerized medical records from the William R. Pritchard Veterinary Medical Teaching Hospital at the University of California-Davis School of Veterinary Medicine for the years 2000 to 2021 were reviewed, and cases that met the criteria were included. Keywords used to search the medical records of equine patients were “bicipital bursa,” “bicipital bursitis,” “biceps bursa,” “intertuberal bursa,” and “intertuberal bursitis.” All included horses underwent physical and orthopedic examination. Diagnostics including synoviocentesis and subsequent cytological analysis and culture and radiographic and ultrasonographic imaging were pursued in all cases. Depending on findings and client consent, horses were subjected to either medical or surgical treatment.

Data retrieved from the medical record included signalment, medical history, presenting clinicopathological data, synovial fluid cytological analysis and culture results, ultrasonographic and radiographic findings, inciting cause (if known), treatment, duration of hospitalization, and necropsy findings (if applicable). Cases with clinical signs >7 days prior to presentation were defined as long-standing cases. Short-term survival was defined as survival to hospital discharge. Long-term survival was defined as survival for ≥12 months after hospital discharge. Long-term follow-up information was obtained through either use of medical records or standardized telephone questionnaire answered by the owners. Owners were asked whether and when the horse became sound on the affected limb, whether and when the horse returned to its previous level of work, whether the horse was used for its intended purpose, whether other complications occurred, and whether the horse was still alive. Data obtained were summarized and are presented as median and IQR.

Surgical procedures

Horses that underwent bursoscopy under general anesthesia were placed in lateral recumbency with the affected limb uppermost and positioned parallel to the ground. Bursoscopy was performed with a 4-mm-diameter 30° forward oblique arthroscope. The bicipital bursa was distended, in some cases aided by ultrasonographic guidance, to facilitate the entrance of the arthroscopic sleeve using a blunt obturator. The arthroscope was inserted over the craniolateral margin of the humerus, 2 to 3 cm proximal to the deltoid tuberosity, and directed axially and proximally through the brachiocephalic muscle and between the cranial margin of the humerus and tendon of origin of the biceps brachii muscle.21 An instrument portal was made proximal to the lateral tuberosity of the humerus to facilitate exploration, lavage, and debridement of the bicipital bursa. If a wound or draining tract was present, these were also surgically debrided. At the completion of the procedure, bursoscopic portals were closed in routine fashion and stent bandages were placed for recovery. Slight variations in the procedure were dictated by location of the wounds or draining tracts.

Bursotomy was performed in either the standing sedated or anesthetized horse. Ultrasonography was used to map the bicipital bursa and guide the surgical approach. Through-and-through needle lavage was performed in either the standing or anesthetized horse with needle placement guided by ultrasound.

Statistical analysis

Results were reported as numbers, percentages, medians, and ranges. Calculations were made with the use of available software (Excel version 2208; Microsoft Corp).

Results

Eleven horses were identified upon search of the medical record database. Nine horses met the inclusion criteria for this study (Supplementary Table S1). The study population included 4 females, 4 intact males, and 1 gelding, with ages ranging from 22 days to 26 years of age (median, 1 year; IQR, 3.67 years). Represented breeds included 4 (44%) Quarter Horses, 2 (22%) Thoroughbreds, 2 (22%) Arabs, and 1 (11%) Andalusian.

Six horses (cases 1, 2, 3, 5, 6, and 9) had a history of trauma to the shoulder region, and 4 of these horses (cases 1, 2, 5, and 6) presented with a draining tract or wound. The remaining horses presented with lameness and swelling in the region of the shoulder. Onset of clinical signs ranged from 1 to 24 days prior to admission (median, 5 days; IQR, 6 days). Prior to referral, 4 horses were treated by the referring veterinarian with systemic antimicrobials (median duration of treatment, 9.5 days; IQR, 5 days). Five horses received NSAIDS prior to presentation.

Presenting clinicopathological data

Complete presenting clinicopathological data were available for 8 out of 9 cases (Table 1).
Five horses were febrile on admission (rectal temperature > 38.6 °C; range, 38.8 to 39.5 °C). Five horses presented with tachycardia (heart rate > 48 beats per minute; range, 56 to 126 beats per minute) and 6 horses with tachypnea (respiratory rate > 16 breaths per minute; range, 28 to 60 breaths per minute).

Lameness grade ranged from grade 4/5 to 5/5 on the American Association of Equine Practitioners Lameness Scale, with 8 horses presenting with a grade 4/5 lameness and 1 foal (case 7) presenting non–weight-bearing (grade 5/5) on the affected limb. For 3 cases (cases 4, 6, and 8), comments on the gait were recorded; all 3 showed reluctance to advance the affected limb cranially. Six right and 3 left forelimbs were affected.

**Hematological variables**

Hematological data obtained on admission were available for 8 out of 9 cases (Table 1). Three horses had an elevated WBC count (WBC count > 12 X 10^3/µL; range, 12.5 X 10^3 to 17.32 X 10^3/µL). Two horses had elevated neutrophil counts (> 8.4 X 10^3/µL; range, 9.63 X 10^3 to 11.69 X 10^3/µL). Fibrinogen was elevated (> 400 mg/dL) in all horses (n = 8). Creatinine (n = 5) was within normal limits for all horses with a median (IQR) of 1.0 mg/dL (0.1 mg/dL). Serum amyloid A was not routinely measured.

**Radiography**

Radiographs of the scapulohumeral joint of the affected side were obtained in all cases and included a mediolateral and craniomedial-caudodistal oblique projection in all cases. Additional views including skyline projections of the proximal humerus or additional obliques were obtained in some of the cases. No significant radiographic findings could be detected on admission in 5 horses. Three horses (cases 2, 5, and 6) had evidence of fragmentation involving the greater tubercle on admission; these changes were thought to be of traumatic origin rather than due to sepsis. Fragmentation was best appreciated using the skyline projections of the humeral tubercles. Four cases showed radiographic evidence of osteomyelitis of the humerus. This was most obvious on admission of case 6, as this horse presented 24 days after occurrence of the wound. In 2 other horses (cases 5 and 9) osteomyelitis was suspected on admission on the basis of mild periosteal reaction and faint radiolucency, respectively. One horse (case 1) did not have radiographic signs of osteomyelitis on presentation but developed severe osteomyelitis of the proximal humerus visible 1 month after admission with lysis and osteoporosis of the greater and intermediate tubercle (Figure 1). This horse was the only 1 of 4 euthanized horses with radiographic evidence of osseous involvement. Four of the 5 discharged horses had radiographic evidence of osseous involvement (Table 2).

**Figure 1**—Cranio proximomedial-caudodistal oblique radiographic views of the right proximal humerus of a 5-year-old Thoroughbred mare (case 1) evaluated for a draining wound over the right shoulder at initial presentation (A) and 32 days later (B). Arrowheads indicate the cranial and caudal parts of the greater tubercle. The intermediate tubercle is outlined by the arrows. On the recheck radiograph (B), there is osteolysis and loss of normal bone architecture (circle) of the proximal cranial humerus affecting the greater (arrowheads) and intermediate (arrows) tubercles, extending distally just proximal to the deltoid tuberosity. The findings are consistent with osteomyelitis. Cranialateral is to the left.

**Ultrasoundography**

Ultrasoundographic examination of the shoulder region was performed in all cases and included evaluation of the biceps tendon (origin to musculotendinous junction), bicipital bursa, supraspinatus muscle and tendon, infraspinatus muscle and tendon, infraspinatus bursa, scapula, proximal humerus, and scapulohumeral joint. Examination
was performed using a combination of 6- to 18-MHz linear and 3- to 9-MHz microconvex curvilinear transducers and console or portable ultrasound machine depending on availability at the time of presentation. All cases demonstrated ultrasonographic abnormalities of the bicipital bursa characterized most commonly by synovial thickening graded as mild (n = 1), moderate (3), and severe (5; **Figure 2**).

Eight bursas were effusive, graded as mild (n = 2), moderate (2), and severe (4). The 1 horse with no visible effusion revealed mililiary gas echoes visible within the severely thickened synovium. Communication between the wound and the bursa was visualized in 3 of 4 cases with wounds. Four horses showed irregularity/widening of the bone contour suspected to be osteomyelitis, 1 horse had 2 to 3 small avulsion fractures, and 2 horses (cases 3 and 4) had irregularity of the proximal humerus adjacent to the physis. Six horses were diagnosed with insertional supraspinatous tendonitis and 2 each with biceps tendonitis and infraspinatus tendonitis. Fifteen ultrasound-guided procedures were performed in 9 horses, including 11 cytologic aspirates and/or intrasynovial antimicrobial injections and 4 peri- or intraoperative ultrasound guidance for bursal distention and/or instrument placement (**Figure 3**).

**Table 2**—History, presence of radiographic changes, and outcome of the horses described in Table 1.

<table>
<thead>
<tr>
<th>Case</th>
<th>Duration of CS PTR (d)</th>
<th>Treatment PTR</th>
<th>Skeletal involvement (radiographically)</th>
<th>Days of hospitalization</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case 1</td>
<td>12</td>
<td>Yes</td>
<td>Yes</td>
<td>47</td>
<td>Euthanized</td>
</tr>
<tr>
<td>Case 2</td>
<td>10</td>
<td>Yes</td>
<td>Yes</td>
<td>17</td>
<td>Discharged</td>
</tr>
<tr>
<td>Case 3</td>
<td>5</td>
<td>No</td>
<td>No</td>
<td>9</td>
<td>Euthanized</td>
</tr>
<tr>
<td>Case 4</td>
<td>4</td>
<td>Yes</td>
<td>No</td>
<td>3</td>
<td>Euthanized</td>
</tr>
<tr>
<td>Case 5</td>
<td>8</td>
<td>Yes</td>
<td>Yes</td>
<td>14</td>
<td>Discharged</td>
</tr>
<tr>
<td>Case 6</td>
<td>24</td>
<td>Yes</td>
<td>Yes</td>
<td>0</td>
<td>Discharged</td>
</tr>
<tr>
<td>Case 7</td>
<td>3</td>
<td>No</td>
<td>No</td>
<td>1</td>
<td>Euthanized</td>
</tr>
<tr>
<td>Case 8</td>
<td>1</td>
<td>No</td>
<td>No</td>
<td>15</td>
<td>Discharged</td>
</tr>
<tr>
<td>Case 9</td>
<td>4</td>
<td>No</td>
<td>Yes</td>
<td>9</td>
<td>Discharged</td>
</tr>
</tbody>
</table>

CS = Clinical signs. PTR = Prior to referral.

**Figure 2**—Transverse composite image of the right biceps tendon and bicipital bursa obtained at the level of the humeral tubercles in a 4-year-old Quarter Horse mare with septic bicipital bursitis (case 6) taken at a depth of 7.4 cm with a 13-MHz linear transducer. Lateral is to the right. There is severe synovial thickening of the bicipital bursa (arrowheads) with scant visible synovial fluid. BT = Biceps tendon. GT = Greater tubercle. IT = Intermediate tubercle. LT = Lesser tubercle.

**Figure 3**—Transverse image of an ultrasound-guided aspirate of the right bicipital bursa obtained at the level of the humeral tubercles in a 2-year-old Arabian Cross gelding with septic bicipital bursitis (case 2) taken at a depth of 6.8 cm using an 8.5-MHz microconvex curvilinear transducer. The needle (arrowheads) is present within the lateral recess of the bicipital bursa adjacent to the greater tubercle of the humerus. Lateral is to the right. GT = Greater tubercle. IT = Intermediate tubercle. LL BT = Lateral lobe of the biceps tendon.

Five recheck ultrasound exams performed in 4 horses aided in decision-making during the course of treatment. Three recheck exams performed during hospitalization (3 to 25 days) revealed worsening imaging findings, 2 with progressive osteomyelitis, and 1 with additional evidence of biceps tendonitis. One recheck exam performed 60 days postdischarge revealed improvement in effusion and synovitis.

**Synovial fluid analysis**

Synoviocentesis of the bicipital bursa was performed successfully under ultrasonographic guidance in all cases (**Table 3**). The total nucleated cell
Medical treatment

Medical management consisted of administration of systemic antimicrobial drugs and NSAIDs. When a wound was present, the area was thoroughly cleaned, debrided, and lavaged daily with saline or antiseptic solution. Procaine penicillin (n = 5; 22,000 IU/kg, IM, q 12 h) and gentamicin sulfate (7.6 mg/kg, IV, q 24 h) were the most commonly used antimicrobials. Other antimicrobials included ampicillin (n = 2; 20 mg/kg, IV, q 8 h), doxycycline (10 mg/kg, PO, q 12 h), sulfadiazine/trimethoprim (1; 24 mg/kg, PO, q 12 h), and ceftriaxone (1; 2.2 mg/kg, IV, q 12 h). NSAIDS were used in all horses, with non-steroidal anti-inflammatory drugs (NSAIDs) being the most frequently used. In horses undergoing bursoscopy (n = 4), proliferative or inflamed synovial fluid and exuberant fibrin production were the most commonly encountered changes. In all cases, debridement of the synovial lining was undertaken and the bursa was lavaged thoroughly. In 1 horse (case 2), damage to the cartilage covering the intertubercular groove of the humerus was noted at surgery with foreign material (hair) within the bursa. All horses had an antimicrobial (amikacin sulfate; 500 mg to 1 g) instilled into the bursa at the end of surgery. Additionally, amikacin-impregnated polymethyl methacrylate beads were placed in the draining tract of 1 horse (case 3).

Table 3—Synovial fluid cytological analysis of horses diagnosed with septic bicipital bursitis. Underlined cases were euthanized.

<table>
<thead>
<tr>
<th>Case</th>
<th>TNCC (cells/µL)</th>
<th>TP (g/dL)</th>
<th>Neutrophils (%)</th>
<th>Bacteria identified</th>
<th>Culture positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case 1</td>
<td>146,250</td>
<td>7.1</td>
<td>96</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Case 2</td>
<td>47,100</td>
<td>7.2</td>
<td>97</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Case 3</td>
<td>28,300</td>
<td>5.1</td>
<td>89</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Case 4</td>
<td>157,000</td>
<td>5.1</td>
<td>98</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Case 5</td>
<td>240,240</td>
<td>7.2</td>
<td>98</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Case 6</td>
<td>20,970</td>
<td>6.5</td>
<td>N/A</td>
<td>Yes</td>
<td>N/A</td>
</tr>
<tr>
<td>Case 7</td>
<td>80,300</td>
<td>4.7</td>
<td>99</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Case 8</td>
<td>30,810</td>
<td>5.4</td>
<td>94</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Case 9</td>
<td>65,640</td>
<td>4.5</td>
<td>96</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>65,640 (115,440)</td>
<td>5.4 (2.0)</td>
<td>96.5 (2.5)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

TNCC = Total nucleated cell count. TP = Total protein. N/A = Not applicable.

count was increased for all horses (> 20,000 cells/µL: range, 20,970 to 240,240 cells/µL). Likewise, the total protein was elevated (> 4.0 g/dL, range, 4.5 to 7.2 g/dL) in all samples. The proportion of neutrophils was available for 8 horses, all of which had a high percentage of neutrophils (range, 89% to 98%). Bacteria were identified on cytological analysis of the synovial fluid in 3 cases. Eight synovial fluid samples were submitted for bacterial culture and sensitivity testing for culture, of which 3 (37.5%) resulted in bacterial growth. Organisms cultured were Streptococcus equi subsp. zooepidemicus (n = 2; cases 1 and 5) and Bacillus spp in 1 other case (case 7).

Bacterial culture

Three horses had samples from draining tracts/wounds submitted for bacterial culture and sensitivity profiling. These yielded growth of S equi subsp. zooepidemicus (n = 2; cases 1 and 5), coagulase-negative Staphylococcus (1; case 5), and Enterococcus faecalis (1; case 2). Two samples obtained during surgery (synovial pannus [n = 1; case 8], debrided bone and synovium [1; case 1]) were submitted for culture, neither of which yielded bacterial growth. Two samples taken at necropsy from the biceps tendon (case 1) and bicipital bursa (case 3) yielded growth of Pseudomonas aeruginosa and Escherichia coli, respectively.

Surgery

In horses undergoing bursoscopy (n = 4), proliferative or inflamed synovium and exuberant fibrin production were the most commonly encountered changes. In all cases, debridement of the synovial lining was undertaken and the bursa was lavaged thoroughly. In 1 horse (case 2), damage to the cartilage covering the intertubercular groove of the humerus was noted at surgery with foreign material (hair) within the bursa. All horses had an antimicrobial (amikacin sulfate; 500 mg to 1 g) instilled into the bursa at the end of surgery. Additionally, amikacin-impregnated polymethyl methacrylate beads were placed in the draining tract of 1 horse (case 3).

In a 26-year-old gelding (case 5), bursoscopy followed by bursotomy was performed under standing sedation. Local anesthesia was performed using mepivacaine instilled at the proposed portal sites. Under ultrasonographic guidance, the bursa was anesthetized, distended using mepivacaine, and entered with the arthroscopic cannula and obturator. Bursoscopy revealed marked inflammation of the synovial lining; however, visualization of the underlying intrathecal structures was obscured. The wound was debrided, and communication between the bursa and the wound was confirmed. Ultrasound was then utilized to identify bony irregularities on the proximal humerus, and a 10-cm vertical incision was made and extended through the musculature to facilitate drainage and allow debridement of the irregular bony margins at the proximal humerus. After debridement, the arthroscope and egress cannulas were removed. The bursoscopic portal was closed with 2-0 USP polypropylene suture material in a simple interrupted suture pattern. The larger surgical incision was closed with 2-0 USP polyglactin 910 suture material in a simple continuous pattern for the muscle plane, and the skin was closed proximally with a ford interlocking pattern.
using 0 USP polypropylene suture material with the distal aspect left open to facilitate drainage. A stent bandage was placed.

Through-and-through needle lavage was performed in 3 cases, 1 of which was performed under general anesthesia in a 2-month-old foal (case 9). The other 2 were performed under standing sedation (cases 4 and 8). All 3 cases had amikacin sulfate (125 mg to 1 g) instilled into the bursa at the end of the procedure.

Four horses required a repeat procedure or surgery. One horse (case 8) that had needle lavage performed initially went on to undergo bursoscopy, at which time lavage and debridement were performed. The 4-month-old foal (case 3) that underwent bursoscopy initially required a second bursoscopy due to poor response to treatment and ongoing lameness. At the second surgery extensive bony involvement was noted, and the foal was euthanized at surgery due to poor prognosis. Another adult horse (case 1) underwent bursoscopy after a previous bursoscopy due to poor response to initial treatment. With the horse in lateral recumbency and the affected limb uppermost, the biceps tendon and bicipital bursa were mapped using ultrasonographic guidance. A 20-cm curvilinear incision was made along the path of the biceps tendon. A 5-cm longitudinal incision into the bicipital bursa was made, and debridement and lavage were performed. The distal third of the incision was left open to facilitate drainage, and the site packed using an antimicrobial-impregnated gauze dressing. A stent bandage was applied.

A 2-year-old Arab (case 2) also underwent repeat bursoscopy to further lavage the bursa, attempting to reduce contamination. At the time of the second surgery, a negative pressure suction drain was placed into the bicipital bursa due to the degree of contamination and expected buildup of fluid preventing the wound from healing. The drain was removed 3 days after surgery, and drainage subsided.

**Clinical follow-up and outcome**

Length of hospitalization for all cases ranged from 0 to 47 days, with a median of 9 days (Table 2). Five (55.6%) horses survived to discharge. This included 1 of 2 horses treated medically and 4 of 7 horses treated with surgical intervention. Complications associated with treatment included the development of contralateral limb laminitis in 2 cases (cases 1 and 5). Four horses were subjected to euthanasia with reasons including severe contralateral limb laminitis (n = 1; case 1), poor prognosis due to failure to respond to treatment (cases 1, 3, and 7), and/or request of the owner (cases 1, 3, 4, and 7). Duration of clinical signs prior to presentation in euthanized horses was a median of 4.5 days (range, 3 to 12 days) and in those surviving to discharge was a median of 8 days (range, 1 to 24 days).

**Necropsy**

All euthanized horses (n = 4) were subjected to necropsy and had evidence of chronic bicipital bursitis, characterized by marked synovial hyperplasia with chronic granulation tissue (Supplementary Table S1). Predominantly lymphoplasmacellular synovitis was found in 1 horse, prominent histiocytic inflammation in 1 horse, and evidence of marked fibrin exudation with neutrophilic infiltrates in 3 horses. Tendinitis was identified in 1 horse (case 1) and myositis of the infraspinatus, supraspinatus, and/or biceps muscle was present in 3 horses (cases 1, 3, and 4) and varied from mild and regional to severe and focally extensive with myonecrosis. The humeral head showed cartilage erosions in 3 horses (cases 1, 3, and 4), with subchondral bone necrosis in 1 case (case 4). Contralateral limb laminitis was confirmed in 1 horse (case 1).

**Follow-up**

Of the 5 horses discharged from the hospital, 3 owners were available for follow-up interview (Supplementary Table S1). All 3 horses were alive at the time of obtaining the follow-up information. One horse (case 5) that underwent standing bursoscopy and bursotomy was sound at the walk but had been already retired from work prior to the diagnosis of septic bicipital bursitis. One horse (case 6) that was treated medically required 3 months of antimicrobial therapy but was sound at the time of the follow-up interview and being used for trail riding. An additional colt (case 8) that was treated with needle lavage and subsequent bursoscopy was in training as a 2-year-old at time of follow-up interview and doing well.

**Discussion**

Contrary to the hypothesis, the results of this study showed that horses diagnosed with and subsequently treated for septic synovitis of the bicipital bursa have a fair prognosis with 5 of 9 (55.6%) horses surviving to discharge. Furthermore, the hypothesis that horses that displayed clinical signs for a prolonged time prior to presentation and/or those with skeletal involvement would have a worse outcome was not valid. Only 1 of 4 horses that were euthanized had radiographic changes associated with the humeral head; however, necropsy revealed subchondral bone necrosis and cartilage erosions in 2 additional horses. Of the 5 horses that survived to discharge, 4 had radiographic evidence of osseous involvement.

The shoulder is a prominent structure with little soft tissue coverage, which predisposes this region to lacerations, foreign body puncture, and blunt trauma such as kicks from other horses. Trauma was observed in 6 of 9 horses prior to the onset of clinical signs evidenced by a wound or draining tract in 4 of 9 horses. This reflects findings of previous reports of septic bicipital bursitis in adult horses. 17,18

No definitive etiology was apparent in 3 of 9 horses. Hematogenous spread of bacteria from a remote site of infection has previously been suggested as a possible etiology for septic bicipital bursitis in adult horses. 9,10 However, while hematogenous bacterial spread is a common cause of synovial sepsis in foals14,20 and occasionally seen in adults,14,21 no history of recent infectious events was noted in the records of these 3 horses.

In the literature, survival to discharge after septic synovitis is reported to be between 45% and 80% for foals14,20,22-25 and up to 85% in adult horses.14,26 Interestingly, a study

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14,20,22–25
by Milner et al\textsuperscript{25} found a reduced likelihood of survival in cases of septic synovitis involving a bursa compared to septic arthritis. While no explanation for this observation was given in that study, we speculate that a combination of lower prevalence and the increased challenge in diagnosing a septic bursa might be factors leading to delayed recognition and referral for treatment. This delay may result in progression of infection and possible extension to adjacent soft tissue and bony structures, thus lowering the survival rate in these cases. Interestingly, in the current case series the median duration of clinical signs prior to presentation was longer in survivors compared to the nonsurvivors. However, given the small number of cases it is difficult to draw any significant conclusions.

Four of 9 horses in this case series had no significant abnormalities detected radiographically, whereas ultrasound was able to detect abnormalities in all horses. Other studies also report superior sensitivity of ultrasonography compared to radiography at detecting both soft tissue and osseous changes in the shoulder region.\textsuperscript{16,20,27-30} Ultrasonography more readily identifies a potential septic process within the synovial structure and allows for ultrasonography-guided sampling for definitive diagnosis,\textsuperscript{11,31-35} as documented in this case series. Early identification and treatment of synovial sepsis has been shown to improve prognosis.\textsuperscript{16,20} While radiography can be helpful to rule out the presence of a fracture as documented in some of the cases presented here, it is of limited value for identification of bone infection in the first 7 to 10 days. In this case series, 3 of 4 euthanized and radiographically normal horses had changes on ultrasonography consistent with bone involvement, which was subsequently confirmed on postmortem examination. This emphasizes the complementary nature of ultrasonography alongside radiographic examination in the diagnostic workup of horses with shoulder swelling with and without associated wounds. Additionally, ultrasonography was instrumental in facilitating accurate intrasynovial instillation of antimicrobials and surgical planning to identify the most appropriate location for needle placement for lavage and arthroscopy portals. Necropsy confirmed extension of infection and varying degrees of associated inflammation of tendons, muscles, and bone adjacent to the bicipital bursa in 3 of 4 euthanized horses.

Osteomyelitis and involvement of adjacent structures has been previously associated with a poor prognosis and decreased survival rate in cases of septic synovitis.\textsuperscript{16,24,34} Subchondral bone necrosis and cartilage erosions of the humeral head were most commonly diagnosed in horses included in this study.

Bursoscopy of the bicipital bursa has been described in the literature\textsuperscript{9,18,35-37}; however, to the authors’ knowledge this was the first report of standing bursoscopy of the bicipital bursa in the horse. The procedure (case 5) was well tolerated, and due to the extensive swelling and chronicity, ultrasonographic guidance was essential to approach the bursa and ensure correct anatomical placement of the arthroscope. Visualization and maneuverability were limited and possibly could have been improved by unweighting the limb as described for synoviocentesis of the structure.\textsuperscript{29} Due to the degree of inflammation and bone involvement, the procedure was converted to a 10-cm-long bursoscopy to allow adequate debridement and lavage. Bursoscopy has been described by Gough et al\textsuperscript{7} in 1998 as treatment for septic bicicipital bursitis but has generally been replaced by bursoscopy. Due to the extent and severity of the infection in 2 cases included in this series, bursoscopy was elected to facilitate good access and aggressive debridement of the infected bone and synovial lining. Tenectomy of a 10-cm-segment of the proximal biceps tendon has also been described in the standing or anesthetized horse.\textsuperscript{10,29} with good outcomes reported; however, the procedure was not pursued in any of the cases presented here. Considering the poor response to treatment and positive culture of a biceps tendon tissue sample obtained during necropsy in 1 case (case 1), it is possible that tenectomy may have improved the outcome in this case.

The yield in positive synovial cultures (3/8 [37.5%]) in our submitted samples was within the reported range of cultures yielding bacterial growth (25% to 85.7%).\textsuperscript{21,23,26} Due to the low number of cases no connection of bacterial isolates to outcome could be ascertained. Previous reports have documented that the overall survival for horses with positive bacterial culture was lower (50%) compared to those with a negative culture (70.5%).\textsuperscript{25} Interestingly, both horses with positive synovial culture of \textit{S. equi} subsp. \textit{zooepidemicus} also had concurrent growth on culture of the associated wound. Given the low yield of positive synovial cultures, culture of any associated wound or draining tract would be prudent to help isolate possible contaminants and direct antimicrobial therapy on the basis of susceptibility profiles.

The main limitations of this study were similar to any retrospective study. Bias associated with case management and clinical judgment of the attending surgeon cannot be controlled. The small number of cases over a large period of time should also be considered a limitation, and the 21-year duration of the study may have contributed to variability through changes in personnel, clinical advances, and economic climate. Retrieval of data was limited by the completeness and accuracy of the medical records.

In conclusion, septic bicicipital bursitis should be considered a differential diagnosis in horses presenting with moderate to severe forelimb lameness and swelling or wounds associated with the shoulder region. In this case series, ultrasonography was the most helpful modality in detecting pathology associated with the bicipital bursa and instrumental to guide needle placement, facilitating synovial sampling and treatment. Both surgical and nonsurgical treatment can be successful in select cases, and standing bursoscopy could be considered in horses without an option for general anesthesia.

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