Scapulohumeral joint luxation in alpacas: 10 cases (2003–2009)

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Objective—To describe the clinical findings, treatments, and outcome in alpacas treated for scapulohumeral joint luxation (SHJL).

Design—Retrospective case series.

Animals—10 alpacas.

Procedures—Medical records of alpacas with SHJL that were treated at 2 referral hospitals were reviewed. History, signalment, physical examination results, radiographic findings, treatments, complications, and outcome were evaluated.

Results—Records for 8 male and 2 female alpacas with 16 instances of SHJL were reviewed. Three male alpacas each had 2 recurrences of SHJL in the treated limb. The proportion of male alpacas treated for SHJL was significantly greater than the proportion of female alpacas treated for SHJL. Closed reduction was used in 2 female and 3 male alpacas; SHJL reccurred in the 3 males. Stabilization by use of a lateral extracapsular tension band suture technique was performed successfully in 4 male alpacas; in another male alpaca, reluxation caused by self-inflicted trauma occurred postoperatively. In 2 male alpacas, arthrodesis was performed but residual lameness remained 1 year after surgery.

Conclusions and Clinical Relevance—SHJL should be considered as a differential diagnosis in alpacas with thoracic limb lameness. Luxation may occur more frequently in males. A closed reduction technique may be used successfully to treat acute luxations. Extracapsular stabilization by use of the lateral extracapsular tension band suture technique was successful for treatment of recurrent SHJL and SHJL that could not be reduced via closed reduction. (*J Am Vet Med Assoc* 2010;237:1186–1192)

Partial or complete luxation of the SHJ is an infrequent cause of lameness in large animal species[1] (eg, cattle, goats, Himalayan tahr, horses, potbellied pigs, reindeer, sheep, and white-tailed deer) that can be associated with concomitant fracture of the glenoid cavity of the scapula. Diagnosis of SHJL is typically based on findings during physical examination and evaluation of radiographic images of the SHJ. Numerous treatments have been described for the treatment of SHJL in large animals, including conservative treatment,[1] closed reduction,[1–10] and open reduction and stabilization.[11–18] Surgical techniques reported include transposition of the biceps brachii tendon,[11,12] extracapsular stabilization by use of a lateral extracapsular tension band suture technique,[13,14] and arthrodesis of the SHJ.[15–18]

To our knowledge, there are 3 reports[12,14,17] of SHJL in 5 South American camelids; all of those camelids were alpacas, and all were successfully treated by open reduction and stabilization of the SHJ. Extracapsular stabilization was achieved by use of an extracapsular tension band suture technique applied to the lateral aspect of the SHJ (3 alpacas),[14] transposition of the biceps brachii tendon (1 alpaca),[12] and arthrodesis of the SHJ by use of a dynamic compression plate (1 alpaca).[17] We are not aware of any published information regarding the clinical signs, diagnosis, treatment, and outcome in a greater number of alpacas with SHJL. Furthermore, outcome of the closed reduction technique for correction of SHJL in alpacas has not been reported.

Abbreviations

SHJ	Scapulohumeral joint
SHJL	Scapulohumeral joint luxation

The purpose of the study reported here was to describe the clinical findings, treatments, complications, and outcome in alpacas treated for SHJL. We hypothesized that male alpacas would be more often treated for SHJL, compared with female alpacas. We also hypothesized that, in contrast to findings in large animal species (excluding horses), an acute simple SHJL could be successfully treated by use of a closed reduction technique.

Materials and Methods

Case selection—Medical records of alpacas with SHJL referred to the Veterinary Teaching Hospital at The Ohio State University between January 1, 2003, and May 31, 2006, or the Kansas State Veterinary Medical Teaching Hospital between June 1, 2006, and Sep-

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tember 1, 2009, were reviewed. The inclusion criterion was that the diagnosis of SHJL or SHJ subluxation had been made on the basis of physical examination results and radiographic findings.

Medical records review—Medical history, signalment, physical examination findings, descriptions of abnormalities detected in radiographic images, concurrent disease, treatments, surgery reports, and complications were obtained from the records of all alpacas included in the study. Data obtained from medical records were entered into a spreadsheet for statistical analysis.

Follow-up information was obtained through communications with owners of the alpacas. The long-term follow-up period was defined as an interval ≥ 12 months after surgery. Outcome after a specific treatment was regarded as excellent if there was a return to a preinjury level of activity without residual gait abnormality (lameness), good if there was a return to preinjury level of activity with minimal gait abnormality, fair if there was a return to preinjury level of activity with moderate gait abnormality, or poor if there was a severe gait abnormality that precluded return to a preinjury level of activity.

Statistical analysis—Data obtained from medical records were entered into a spreadsheet for statistical analysis and used for the generation of descriptive statistics. A 2-tailed Fisher exact test[a] was used to test for sex predisposition in alpacas treated for SHJL, compared with the overall population of alpacas treated at the 2 referral hospitals. A value of $P < 0.05$ was used to indicate significance for all analyses.

Results

Signalment—Review of medical records identified 8 sexually intact male and 2 sexually intact female alpacas with SHJL for inclusion in the study. Age (mean, 3.6 years; median, 3.3 years; range, 9 months to 6.5 years) was recorded for 9 of 10 alpacas. There were two 3-year-old males (designated as A and B, respectively). Body weight (mean, 60.3 kg [132.7 lb]; median, 63 kg [138.6 lb]; range, 42.7 to 77 kg [93.9 to 169.4 lb]) was recorded for 7 of 10 alpacas. Compared with the overall population of all alpacas treated at the 2 referral hospitals, the proportion of male alpacas treated for SHJL was significantly ($P < 0.02$) greater than the proportion of female alpacas treated for SHJL.

Treatments prior to admission to the referral hospitals—Treatments were administered to 8 alpacas prior to admission to the referral hospitals. Of those 8 alpacas, 5 received flunixin meglumine alone, 2 were administered flunixin meglumine and penicillin G procaine, and 1 was administered flunixin meglumine and dexamethasone. In addition, recommendations for stall rest were made for 2 alpacas. In those 8 alpacas, no improvement in clinical findings was observed after treatment and prior to admission.

Clinical findings and diagnosis of SHJL—Scapulohumeral joint luxation was diagnosed 16 times in 10 alpacas. All alpacas were initially examined for lameness of the left (n = 6) or right (4) thoracic limb. The interval from the onset of the lameness in the thoracic limb until referral for lameness evaluation was 4 hours to 78 days (mean, 20.2 days; median, 4.5 days; n = 8). The duration of the lameness was not recorded for 2 alpacas (a 3-year-old male [alpaca A] and a male of unknown age); however, both of them had clinical and radiographic evidence of chronicity that was indicated by muscle atrophy and osteoarthritis (osteophyte formation, narrowing of the joint space, and dystrophic mineralization). Five of these alpacas were examined after an acute onset (< 7 days' duration) of lameness. Eight alpacas had a non–weight-bearing lameness. Severity of lameness was not recorded for 2 alpacas. Other clinical findings at the time of referral included signs of pain upon manipulation of the affected thoracic limb (n = 5), muscle atrophy (5), localized tissue swelling (4), distortion of anatomic landmarks (ie, nonpalpable acromion and prominent greater tubercle [3], crepitus [1], and localized fibrosis [1]). Cause of the SHJLs was known or suspected to be associated with trauma in 4 alpacas (an injury from fighting in 1 male, injury from falling in 1 female, and suspected trauma inflicted by cohorts in 2 males housed with other sexually intact males).

Diagnoses of all 10 SHJLs were confirmed by use of radiography obtained after sedation of each affected alpaca with butorphanol tartrate (0.11 mg/kg [0.05 mg/lb], IV), xylazine hydrochloride (0.33 mg/kg [0.15 mg/lb], IV), or both. Unilateral SHJ subluxation associated with fracture of the caudal aspect of the glenoid cavity and severe osteoarthritis or unilateral simple SHJL without concomitant fracture were diagnosed in 1 (5-year-old male) and 9 (9-month-old and 3-year-old females; 2-, 2.5-, 3- [alpaca A], 3- [alpaca B], 4.5- and 6.5-year-old males; and a male of unknown age) alpacas, respectively. Of the 9 alpacas with unilateral simple luxations, 3 (3-year-old male [alpaca A], 6.5-year-old male, and a male of unknown age) and 1 (3-year-old male [alpaca B]) had radiographic evidence of mild to moderate osteoarthritis or severe osteoarthritis, respectively. The humerus was medially or laterally displaced in 1 (9-month-old female) and 8 (3-year-old female and 2-, 2.5-, 3- [alpaca A], 3- [alpaca B], 4.5-, 5-, and 6.5-year-old males) alpacas, respectively; information for the direction of displacement of the humeral head was unavailable for the remaining alpaca (male of unknown age) because of incomplete information in the medical record. Treatments were selected on the basis of history, results of physical examination, and radiographic findings.

Surgical procedures—Closed reduction of SHJLs was performed in 5 alpacas (9-month-old and 3-year-old females and 2-, 2.5- and 4.5-year-old males) with acute simple luxations. Closed reductions were attempted after each alpaca was sedated with xylazine (0.3 mg/kg, IV), butorphanol (0.1 mg/kg, IV), or both. In all 5 instances, reduction of the luxations was achieved by the placement of traction on the affected thoracic limb and manual pressure on the humeral head while simultaneously abducting and laterally rotating the limb. The SHJ remained reduced after flexion and extension of the joint articulation in all 5 alpacas. A Velpeau sling was modified to include a thoracic component to apply tension in a manner to promote medial rotation of the SHJ; this was accomplished by applying the bandage

material from the medial aspect of the thoracic limb in a lateral and dorsal direction and maintaining tension across the dorsal midline and around the thorax. The sling was applied and maintained after the closed reduction procedure for 5 to 14 days (mean, 11 days; median, 14 days; n = 5). Flunixin meglumine (1.1 mg/kg [0.5 mg/lb], q 12 to 24 h for 1 to 6 days) was administered IV or SC in 4 alpacas (3-year-old female and 2-, 2.5-, and 4.5-year-old males) at the discretion of the attending clinician. In addition, a polysulfated glycosaminoglycan (1.1 to 2.2 mg/kg [0.5 to 1 mg/lb]) was administered IM in 2 alpacas (3-year-old female and 2.5-year-old male) as a chondroprotective agent. All 5 alpacas were discharged from the hospital 1 to 7 days (mean, 4.8 days; median, 6 days) after reduction of the luxation. Owners confined each of these 5 alpacas in a stall for 14 to 56 days (mean, 32 days; median, 30 days) after discharge from the hospital.

Open reduction with extracapsular stabilization of the left SHJ by use of lateral extracapsular tension band suture technique was performed in 3 alpacas (3-year-old male [alpaca A], 6.5-year-old male, and a male of unknown age) with chronic SHJLs. Radiography revealed evidence of mild to moderate osteoarthritis. Alpacas were administered flunixin meglumine (1.1 mg/kg, IV; n = 2 [3-year-old male {alpaca A} and 6.5-year-old male]) and ceftiofur sodium (2.2 mg/kg [1.0 mg/lb], IV; 2 [3-year-old male {alpaca A} and male of unknown age]) or a combination of penicillin G procaine (22,000 U/kg [10,000 U/lb], IM; 1 [6.5-year-old male]) and gentamicin sulfate (5 mg/kg [2.3 mg/lb], IV; 1 [6.5-year-old male]) before surgery. General anesthesia was induced via IV administration of xylazine (0.11 to 0.22 mg/kg [0.05 to 0.1 mg/lb]), ketamine hydrochloride (3 to 5 mg/kg [1.5 to 2.5 mg/lb]), and guaifenesin guacolate (50.6 to 99 mg/kg [23 to 45 mg/lb]) and then maintained by the administration of isoflurane vaporized in 100% oxygen by use of a semiclosed rebreathing circuit system. Each alpaca was positioned in right lateral recumbency. The surgery site was aseptically prepared and a craniolateral approach to the SHJ was performed, as described.[14] In all 3 alpacas, the joint capsule and insertion of the infraspinatus tendon were intact. An arthrotomy was performed, and reduction of the SHJL was achieved by the combined placement of intense traction on the affected limb and disruption of existing fibrous tissues by use of a periosteal elevator. Tension sutures were placed in a figure eight pattern coursing from the neck of the scapula to the lateral aspect of the greater tubercle of the humerus by use of size 5 coated and braided polyester suture[b]; the suture material was looped around a 4.5-mm-diameter cortical bone screw equipped with a washer or inserted through the eyelet of a 4.7-mm-diameter suture anchor[c] that was inserted into the scapula and then looped around a 4.5-mm-diameter cortical bone screw equipped with a washer that was inserted into the greater tubercle of the humerus. In addition, the tension band suture was passed deep to the deltoideus muscle and the lateral head of the triceps brachii muscle before being tightened with the limb in extension. If > 1 strand of suture was necessary, a second implant (a cortical bone screw equipped with a washer or suture anchor) was inserted into the neck of the scapula and the strand was tied to the humeral screw, as described. In 1 alpaca (3-year-old male [alpaca A]), the suture broke during insertion of the suture anchor and was replaced by an 18-gauge orthopedic wire. The joint capsule and surrounding muscles were apposed in a simple continuous pattern by use of size 0 polyglactin 910 suture. In a second alpaca (male of unknown age), the joint capsule and surrounding fascias were imbricated by use of size 2 coated and braided polyester suture.[b] The skin incision was closed by use of surgical steel staples. A modified Velpeau sling then was applied for a period of 2 days (n = 1 [male of unknown age]). Antimicrobial administration was continued for 5 days. Analgesia was provided by the administration of etodolac (10 mg/kg [4.5 mg/lb], PO, q 24 h for 1 week; n = 3) and the application of a fentanyl transdermal patch (supplying 25 µg of fentanyl/h, for 48 to 72 hours; 2 [3-year-old male {alpaca A} and 6.5-year-old male]) or administration of morphine sulfate (0.1 mg/kg, SC, q 6 to 8 h, as needed; 1 [male of unknown age]). Furthermore, all 3 alpacas were administered a polysulfated glycosaminoglycan (1 to 2 mg/kg, IM, q 7 to 14 d for 3 to 4 treatments). The 3 alpacas were discharged from the hospital 7 to 13 days (mean, 11 days; median, 12 days) after surgeries. Owners were instructed to confine each alpaca in a stall or small pen for 30 to 60 days. A follow-up examination was performed on all 3 alpacas 14 to 21 days after the surgeries at the time of suture removal, and no complications were reported.

Arthrodesis of the SHJ was performed in a 3-year-old male (alpaca B) and a 5-year-old male alpaca. The 3-year-old male (alpaca B) alpaca had chronic lateral luxation with severe osteoarthritis, and the other had chronic lateral SHJ subluxation concurrent with a comminuted fracture of the caudal aspect of the glenoid cavity and severe osteoarthritis secondary to the luxation and fracture. In preparation for surgery, each alpaca received IV administration of ceftiofur sodium (2.2 mg/kg) and flunixin meglumine (1.1 mg/kg). A craniolateral approach was used to perform an arthrotomy of the affected joint. The supraspinatus and infraspinatus muscles were then elevated from the scapula by use of a periosteal elevator; in addition, soft tissues were elevated from the lateral aspect of the greater tubercle of the humerus with a similar technique. In the 3-year-old (alpaca B) alpaca, a pneumatic burr was used to remove the cartilage of the glenoid cavity of the scapula and head of the humerus until penetration of the subchondral bone was observed. A synthetic bone graft material[d] then was packed into the joint cavity. In the 5-year-old alpaca, a periosteal elevator and curette were used to remove the proliferative bone surrounding the articulation of the SHJ and facilitate exploration of the joint before reduction. In both alpacas, a 6.5-mm partially threaded cancellous bone screw equipped with a washer was inserted transarticularly from the distal lateral aspect of the greater tubercle through the central region of the glenoid cavity and into the neck of the scapula in a manner similar to the application of a lag screw. Then, a tension band suture was applied to the cranial and lateral portions of the SHJ. In addition, the tension band suture was tied under tension with the limb in a

fixed position to aid arthrodesis of the SHJ. Incisions in the joint capsule and surrounding muscles were closed by use of 2-0 or size 0 polydioxanone suture in a simple continuous pattern. The skin incision was sutured by use of size 2 polypropylene suture or surgical steel staples. Intravenous or SC administration of ceftiofur sodium (2.2 mg/kg, q 12 h) was continued in both alpacas for 5 or 10 days after surgery. In the 3-year-old (alpaca B) alpaca, pain and inflammation were treated after surgery by the PO administration of etodolac (10 mg/kg, q 24 h for 7 days); in the 5-year-old alpaca, a fentanyl transdermal patch (supplying 25 µg of fentanyl/h for 72 hours) was applied and flunixin meglumine (1.1 mg/kg, q 24 h) was administered IV for 3 days and then replaced with treatment with phenylbutazone (4 mg/kg [1.8 mg/lb], PO, q 24 to 48 h) on days 4 through 14 after surgery. No short-term complications were observed in the alpacas prior to discharge from the hospital 5 (3-year-old male [alpaca B]) and 11 days (5-year-old male) after surgery. Skin sutures were removed 14 or 21 days after surgery.

Follow-up information and outcome assessments—Owners were contacted by telephone 1 year after the treatment of luxations in both male alpacas that underwent arthrodesis of the SHJ. Both males continued to have a residual gait abnormality, and owners of both alpacas thought this was caused by pain. Neither male was able to be used for breeding. Outcome was considered poor for this treatment.

Follow-up examination 1 year after repair of SHJLs by the application of tension band sutures in the 3 male alpacas revealed a mild gait abnormality. However, all 3 alpacas had returned to previous use. Therefore, outcome for this treatment was considered good.

Follow-up examination 1 year after closed reductions of SHJLs in the 2 female alpacas revealed no gait abnormality and a return to use for breeding; therefore, outcome for this treatment in these female alpacas was considered excellent.

Reluxation occurred 5 times between 41 and 442 days (mean, 158 days; median, 90 days) after closed reduction in the 3 male alpacas (2-, 2.5-, and 4.5-year-old males) that underwent closed reduction of SHJLs. In all 5 instances of reluxation, the type and direction of the displacement were similar to the initial luxation. Two (2.5- and 4.5-year-old males) of the 3 males were housed with other male alpacas at the time of the initial luxations and reluxations. A closed reduction technique was performed at the time of first reluxation in the 2-year-old male alpaca 3 months after the first procedure. This alpaca was not treated after the second reluxation because of financial constraints of the owners and was chronically lame with marked gait deficits and limited range of motion in the affected limb. Because of signs of chronic discomfort observed in this male, euthanasia was elected by the owners within 2 months after the second reluxation.

Radiography of the reluxated SHJs did not reveal signs of osteoarthritis in the 2.5- and 4.5-year-old male alpacas. A second closed reduction technique was performed on the 2.5-year-old male alpaca 15 months after the first procedure. The owner declined surgery both times for this male but elected for an open reduction technique with extracapsular stabilization by use of tension band sutures after the second reluxation (5 months after the first reluxation) despite a third successful closed reduction technique at that time. Similarly, although the luxated SHJ was successfully reduced with a closed reduction procedure, extracapsular stabilization by use of the lateral extracapsular tension band suture technique without arthrotomy was used to treat the 4.5-year-old male alpaca that had reluxation 41 days after the initial closed reduction technique. Perioperative drug administration as well as the surgical approach and extracapsular stabilization were similar, as described previously. Radiography was used to confirm reduction of the joints during surgery. A modified Velpeau sling was applied and maintained for 8 (2.5-year-old male) and 10 (4.5-year-old male) days after surgery, and alpacas were hospitalized for 2 (2.5-year-old male) and 8 (4.5-year-old male) days. Short-term complications were not reported for either alpaca during or after hospitalization. Follow-up examination of the 2.5-year-old male 3 years after surgery revealed no gait abnormality and a return to use for breeding; therefore, outcome for this treatment was considered excellent. In addition, this male had been continually maintained in isolation in a pasture and paddock when not used for breeding. The 4.5-year-old male alpaca had a self-inflicted traumatic reluxation of the SHJ 79 days after repair of the joint by use of the lateral extracapsular tension band suture technique. This alpaca made an unsuccessful attempt to climb over a gate during which the gate fell on the alpaca while the surgically repaired thoracic limb was in abduction. The owner did not elect to pursue surgery. A closed reduction technique was successfully used to repair the luxated SHJ. The male was maintained in isolation for 4 months and then returned to use for breeding. At 17 months after closed reduction of the second reluxation, the male continued to be in use without a gait abnormality; therefore, the outcome for this treatment was considered excellent.

Discussion

On the basis of the findings of the study reported here, acute simple luxation of the SHJ in alpacas can be successfully treated by closed reduction. However, outcome for closed reduction of luxations may be better in female alpacas, compared with outcome in males. This may be because trauma inflicted by cohorts and mounting behaviors, which are possible risk factors for repeat injury, are more common in males. A review of the literature revealed 8 clinical reports[2,4–10] of successful treatment of SHJL by closed reduction procedures in horses. This is likely an overrepresentation of the success of this procedure because in a retrospective case series[1] of 14 animals with unilateral SHJLs, 3 animals (1 goat, 1 calf, and 1 potbellied pig) were treated by use of a closed reduction procedure and closed reduction was successful only in the goat. Of the other 11 instances of SHJL, 5 were in horses and closed reduction was not attempted because of concurrent injuries.[1] In that study, 8 of 14 SHJLs were in animals < 1 year old. This contrasts to the results of our study in which 8 of the 9 affected alpacas for whom the age was known were adult alpacas.

In the present study, closed reduction was easily achieved after the alpacas were sedated and resulted

in a joint that was stable during flexion and extension. Apparent stability of the SHJ after a closed reduction procedure is an essential prerequisite for continuing conservative treatment. Surgical intervention should be recommended when stability is not apparent. Closed reduction for SHJLs of acute duration should be attempted only after ruling out concurrent fracture of the scapula and proximal portion of the humerus via radiography or other imaging techniques. In addition, closed reduction should be recommended only if the owner is able to maintain the alpaca in isolation during the healing process. Following closed reduction of an SHJL, isolation and restricted activity of horses for a period ≥ 2 months has been suggested[4]; however, on the basis of the timing of reluxations in the male alpacas in the present study, we suggest a period of 3 to 4 months of isolation and restricted activity in alpacas.

Extracapsular stabilization of SHJL has been reported and has had an excellent short-term and long-term outcome in 5 goats in 1 study[13] and a steer and 4 alpacas in another study.[14] In the present study, extracapsular stabilization was selected instead of a bicipital tendon transposition procedure because extracapsular stabilization is less invasive, can be readily applied, and requires less surgical time. The application of an extracapsular prosthesis as described in the present study was modified from a technique used in alpacas.[14] Suture anchors or a screw equipped with a washer were used in the present study as proximal points of fixation, compared with proximal fixation by use of scapular bone tunnels or a screw equipped with a washer.[14]

The use of suture anchors is becoming increasingly more popular for the fixation of soft tissues (eg, ligaments, tendons, and joint capsules) to bone for temporary stabilization of an injured joint and facilitation of periarticular fibrosis development.[19] The application of suture anchors requires less dissection of soft tissue structures than does the creation of bone tunnels. Suture anchors[c] used in the present study have similar pullout strengths to those of orthopedic screws of similar size[20] but cause less abrasion of the surrounding soft tissues than do screws. Suture anchors are used for fixation of prosthetic sutures to bone for surgical stabilization of shoulder luxation in dogs.[19] The size and weight of alpacas are similar to those of large-breed dogs; therefore; we estimated that the use of suture anchors would be feasible during surgical stabilization of SHJLs in alpacas.

To our knowledge, the insertion of suture anchors in the bones of alpacas has never been reported. Results of the study reported here suggest that the use of suture anchors as proximal points of fixation in combination with size 5 braided polyester suture[b] or 18-gauge orthopedic wire for lateral SHJ tension band sutures would be appropriate for use in alpacas. However, further in vitro and in vivo biomechanical testing is necessary to determine the optimum specifications of anchor-suture combinations to be used in extracapsular stabilization by use of a lateral extracapsular tension band suture technique for alpacas. This need is supported by the traumatic reluxation in the 4.5-year-old male alpaca. Alpacas with acute SHJL treated by extracapsular stabilization had no gait abnormalities at long-term follow-up.[14]

In the present study, alpacas treated by extracapsular stabilization by use of the lateral extracapsular tension band suture technique were able to return to their previous use. A mild residual gait abnormality was expected to be observed in the 3 alpacas that underwent surgical repair of chronic SHJL because of osteoarthritis. Thus, acute simple SHJL[14] or uncomplicated chronic SHJL with mild osteoarthritis in alpacas treated with extracapsular stabilization by use of the lateral extracapsular tension band suture technique has an overall good to excellent outcome.

A modified Velpeau sling was applied to the affected limb to immobilize and protect the joint during the healing process after closed reduction or extracapsular stabilization with the lateral SHJ tension band suture technique. The suggested duration of immobilization in small animals is 1 to 3 weeks after surgical repair or a closed reduction procedure.[21] Velpeau-type slings have not been recommended in instances of lateral SHJL in dogs because of increased lateral rotation of the humeral head. However, a modified Velpeau sling was applied in the alpacas of the study reported here to prevent or minimize weight bearing during healing. The Velpeau sling was modified to include a thoracic component so that lateral and dorsal tension could be applied by the sling. This modified Velpeau sling was thought to assist healing, as previously reported,[14] by protecting the surgical site and facilitating recumbency.

Arthroscopic examination of the SHJ after a closed reduction procedure has been suggested[4] for assessing cartilage injury, performing debridement as necessary, and enabling more accurate prediction of outcome. Arthroscopy was not considered necessary and was not performed in any alpaca in the study reported here. We do not believe that the lack of use of arthroscopy adversely affected the likelihood for reluxation on the basis of the intervals that lapsed between treatment and reluxation and the absence of signs indicative of osteoarthritis in the SHJ of the affected alpacas. During extracapsular stabilization with the lateral SHJ tension band suture technique, the affected joints were not explored via arthrotomy in instances of acute or recurrent SHJLs. This intraoperative decision was made to avoid iatrogenic damage to the cartilaginous surfaces of the glenoid cavity and humeral head. Medial cartilage defects on the humeral head have been associated with lateral SHJLs.[6,14] Tearing of the joint capsule is also possible,[6] but not always present,[14] and does not require repair unless damage to the joint capsule is extensive. Open surgical exploration of the SHJ is indicated when there is evidence of subchondral bone damage, osteoarthritis, or both. In a retrospective case series[14] in which investigators studied lateral SHJLs in 4 alpacas, the subchondral bone of the humerus was not affected and debridement was not required.

Arthrodesis is considered a salvage procedure used to treat debilitating and advanced degenerative disease of the SHJ. In another study[17] of complications of orthopedic surgeries in alpacas and llamas, 2 alpacas underwent arthrodesis of the SHJ by application of a dynamic compression plate. To our knowledge, the present study is the only other report of SHJ arthrodesis in alpacas. Arthrodesis by use of the transarticular lag-

screw technique in the study reported here was similar to a transarticular cortical screw fixation in lag-fashion technique used for arthrodesis of the proximal interphalangeal joint in horses.[22] To prevent failure (bending) of the transarticular screw and improve lateral stabilization of the joint, application of a tension band wire was also used. Cancellous bone screws were used because intraoperative assessment of the bone revealed diminished holding power of cortical screws by bone that was assumed to have been associated with chronic disuse of the limb. Curettage of the cartilaginous surfaces was performed to promote arthrodesis of the joint,[18] and a single cancellous bone screw was inserted in lag fashion to compress the congruent SHJ. The transarticular lag-screw technique was selected because it is less invasive and expensive and easier to apply than a dynamic compression plate. This transarticular lag-screw technique is best suited for use in joints that have a limited range of motion. However, we believed that the transarticular lag-screw technique, when combined with a lateral tension band suture, could be used in the SHJ of alpacas because of their body weight and tendency to remain recumbent for prolonged periods and our ability to apply a sling that does not allow the alpaca to bear weight on the affected thoracic limb. Owners reported that alpacas treated with this method had a residual gait abnormality that they thought was associated with pain. Although the nature of the gait abnormality and the presence or absence of pain were not assessed, arthrodesis by application of the transarticular lag-screw technique is not currently advocated.

In general, widening of the SHJ observed in a lateral radiographic view concurrent with clinical findings of lameness is suggestive of SHJL. Two orthogonal radiographic views are necessary to confirm a diagnosis of SHJL and rule out concomitant fractures. However, radiography may not reveal SHJL in some alpacas because of spontaneous reduction of the luxation during positioning for radiography. This may be facilitated by muscle relaxation that is secondary to sedation or anesthesia.[11] In the study reported here, radiographic findings confirmed SHJL in all alpacas. However, displacement of the humerus was not always evident on the lateral radiographic view when the luxated limb was positioned in the lateromedial plane.

Although SHJL is a common sequela to trauma, congenital SHJL in various species has been reported.[23] Dysplasia of the SHJ has been suspected as a cause of osteoarthritis in association with complete or partial SHJL in horses.[18,24–26] A congenital defect has been suspected as the cause of a chronic simple medial SHJL in a 3-month-old llama cria that had been lame since birth.[e] To our knowledge, there are no reports of congenital SHJL in camelids in the veterinary medical literature.

The results of the present study are similar to those of a previous study[14] in which SHJL occurred more frequently in male alpacas than it did in female alpacas. Furthermore, reluxation of the SHJ after a closed reduction procedure was observed only in males maintained in groups with other males. Thus, behavior and farm management are implicated in the development of SHJL in male alpacas. Both the prevalence of SHJL and success of treatment may be influenced by behavioral factors in males. Sexually intact male alpacas are more active and, in group settings, will fight as part of the establishment of herd hierarchical behaviors. An SHJL injury, especially a lateral luxation, in males is likely caused by trauma during fighting. Therefore, it is recommended that owners house adult males individually to prevent injury. In addition, breeding behavior involves a male mounting a female that is in a standing position while forcefully grasping the female's shoulders with the thoracic limbs until the female lies down in a sternally recumbent position. Therefore, breeding activities should be performed on surfaces that provide good footing and involve female alpacas that are at an appropriate stage of estrus to be receptive to copulation.

Half of the initial instances of SHJLs in the study reported here were diagnosed during a chronic stage of luxation. Delayed treatment of luxations increases the possibility of osteoarthritis and may have a negative effect on outcome. A complete orthopedic examination should be performed in sexually intact male alpacas with lameness in a thoracic limb to rule out SHJL[14] or SHJ subluxation, especially if the affected male is housed with other male alpacas.

In contrast to previous reports,[12,14] the findings of the present study indicated that acute simple luxation of the SHJ may be successfully treated by closed reduction with the potential for a better outcome in female alpacas. We recommend closed reduction in acute uncomplicated instances of SHJL but recommend extracapsular stabilization via the lateral SHJ tension band suture technique in alpacas with reluxation when the luxation cannot be reduced with a closed reduction procedure or evaluation of the SHJ is necessary.

a. GraphPad QuickCalcs, GraphPad Software Inc, La Jolla, Calif.
b. Ethibond, Ethicon Inc, Somerville, NJ.
c. IMEX suture anchors, IMEX Veterinary Inc, Longview, Tex.
d. Consil Orthopedic Bioglass, Nutramax Laboratories Inc, Edgewood, Md.
e. Niehaus AJ, Department of Veterinary Clinical Sciences, The Ohio State University, Columbus, Ohio: Personal communication, 2004.

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