Veterinary Medicine and Science

WILEY

CASE REPORT OPEN ACCESS

Cats

Application of NanoScope in Treating Severe Shoulder Dysplasia With Intraarticular Osseous Bodies in a Cat

Julian Hauer[1] | Barbara Bockstahler[2] | Carina Strohmayer[3] | Sabine Breit[4] | Barbara Richter[5] | Eva Schnabl-Feichter[1]

[1]Department of Companion Animals and Horses, University Clinic for Small Animals, Small Animal Surgery, University of Veterinary Medicine Vienna, Vienna, Austria | [2]Department for Companion Animals and Horses, University Clinic for Small Animals, Small Animal Surgery, Section for Physical Therapy, University of Veterinary Medicine Vienna, Vienna, Austria | [3]Department of Companion Animals and Horses, University Clinic for Small Animals, Clinical Unit of Diagnostic Imaging, University of Veterinary Medicine Vienna, Vienna, Austria | [4]Department of Pathobiology, Institute of Topographic Anatomy, University of Veterinary Medicine Vienna, Vienna, Austria | [5]Institute of Pathology, University of Veterinary Medicine Vienna, Vienna, Austria

Correspondence: Julian Hauer (julian_hauer@gmx.at)

Received: 5 April 2024 | **Revised:** 18 November 2024 | **Accepted:** 30 December 2024

Funding: The authors received no specific funding for this work.

Keywords: cat | lameness | NanoScope™ | shoulder dysplasia | shoulder joint

ABSTRACT

Case summary: A 2-year and 9-month-old male neutered Himalayan cat was evaluated for lameness of the left thoracic limb. Orthopaedic examination and radiography revealed severe bilateral shoulder joint dysplasia and intraarticular osseous bodies. The lameness was resolved after successful removal of two intraarticular bodies from the left shoulder joint using a needle-sized chip-on-tip technology arthroscope (NanoScope). Histology of these two bodies showed enchondral ossification. Nine months after surgery, radiographs showed a new osseous body at the same location as before, and a gait analysis using a pressure plate revealed mild lameness, which was not detectable in orthopaedic examination.

1 | Introduction

Shoulder joint pathologies in cats can either be caused traumatically (e.g., fractures) or atraumatically (e.g., shoulder dysplasia, bicipital tenosynovitis, osteochondrosis dissecans, or accessory centre of ossification) (Voss and Langley-Hobbs, 2009).

Shoulder dysplasia is well described in humans (Trout and Resnick, 1996) and dogs, (Butteworth, 1994) whereas only two studies on cats have been published to date (Scharf et al., 2004; Schwarze et al., 2015). Incomplete ossification centres have been described in small animals, the most common being an ununited anconeal process (Cawley and Archibald, 1959). While an ununited accessory caudal glenoid (UCG) ossification centre can either be an incidental finding or a cause of lameness in dogs (Olivieri et al., 2004), it has only been described in a cat once before (Serck and Wouters, 2019). Performing an arthroscopy, the standard diagnostic method for joint injuries, in a cat's joint can be a challenging task due to its relatively small size. Thus, the use of a new chip-on-tip needle-sized arthroscopy technology (NanoScope) was evaluated and compared to conventional arthroscopy (Burt et al., 2023).

This case report is the first to describe the use of diagnostic needle arthroscopy in a cat with severe shoulder dysplasia.

2 | Case History

A 2-year and 9-month-old male neutered Himalayan cat was presented with a lameness of the left thoracic limb. The lameness started 1 month before presentation and did not resolve despite

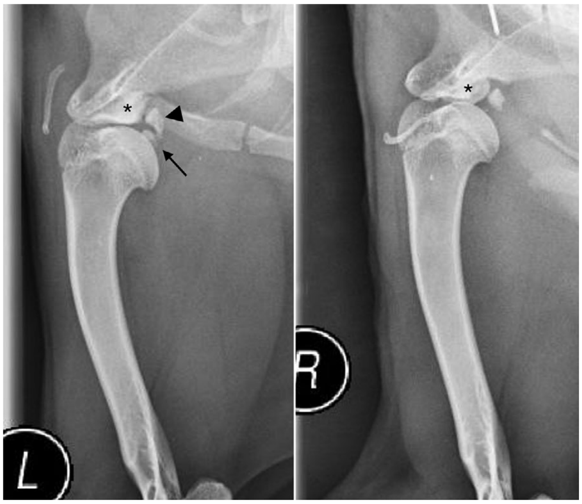

FIGURE 1 | Mediolateral radiograph of both shoulder joints. The caudal aspect of the glenoid cavity is bilaterally shortened (asterisk) and the humeral head is misshaped more on the left side than on the right side, resulting in severe incongruency of the shoulder joints. The subchondral bone of the glenoid cavity is mildly thickened on both sides. On the left side there is one triangular shaped mineral opacity in close proximity to the caudal rim of the glenoid cavity (arrowhead). A second smaller oval mineral opacity is located caudodistal to the glenoid cavity (arrow). On the right side, there is a rectangular mineral opacity in close proximity to the caudal rim of the glenoid cavity. (Diagnostisches Zentrum für Kleintiere).

the use of nonsteroidal anti-inflammatory drugs (NSAIDs) (dosage unknown).

The physical examination was normal, and the cat had a body weight of 4.2 kg. Orthopaedic examination revealed a mild lameness on the left thoracic limb, accompanied by a pain on extension of the left shoulder joint and both elbow joints. The blood tests (haematology and routine blood chemistry) and neurologic examination were unremarkable.

The referring veterinarian had performed radiographs on both shoulder joints (mediolateral and craniocaudal views), which revealed severe bilateral glenoid dysplasia and mineralised opacities caudal/caudodistal to the glenoid rim, two on the left (approximately 4 × 3 mm and 2 × 1 mm) and one on the right body side (approximately 3 × 3 mm) (Figure 1).

The surgeon recommended arthroscopy for diagnosis and removal of the osseous bodies on the lame left thoracic limb. The cat was premedicated using medetomidine (Domitor, 0.007 mg/kg) and methadone (Methadon Streuli, 0.2 mg/kg). Propofol (Propofol 1%, doses by effect) was used for induction and isoflurane (Vetflurane, Virbac) for maintenance, accompanied by a fentanyl-bolus (Fentanyl-Piramal, 0.001 mg/kg i.v.).

For arthroscopy, the NanoScope (Arthrex GmbH, USA)[i] was used with conventional three arthroscopic portals (egress needle, scope portal and caudal instrument portal) (Beale et al., 2003). A pressure infusion cuff was used for saline ingress during the procedure. Needle arthroscopy showed a large osseous body connected to the joint capsule (Figure 2), inflammatory fibrillation of the synovial villi, and another caudally located smaller body. The other joint structures were unremarkable. Due to difficulties in retrieving the osseous body, a mini-arthrotomy, that is, enlargement of the caudal portal, was performed.

Skin closure was routinely performed. Radiographs confirmed the removal of both mineralised opacities; however, an ill-defined, approximately 2 × 1 mm big opacity remained visible in the caudal aspect of the glenoid (Figure 3). Post-operative care consisted of a velpeau sling for 10 days, cage rest for 6 weeks, and pain medication for 2 weeks (meloxicam, 0.05 mg/kg orally, SID). Histopathological examination of the removed bodies showed no signs of inflammation or neoplasia, and suggested an incomplete ossification as the most possible cause. The fragment consisted of various tissues. On the surface, there was a fibrocartilage merging at the edges into the hypertrophic synovial capsule, which was surrounded by striated muscle. The fibrocartilage developed irregularly into hyaline cartilage and further into trabecular bone tissue with fatty bone marrow (Figure 4). The surface of the fibrocartilage showed some fibrillation. There was no significant inflammatory infiltration in the examined areas.

Follow-up examinations after 6 and 10 weeks showed a remaining mild lameness, most likely due to the owner's noncompliance with the recommended activity restrictions. Pain medication (meloxicam, 0.05 mg/kg orally, SID) and cage rest were prescribed for another 2 weeks and 4 weeks respectively.

Nine months after surgery, orthopaedic examination revealed no visible lameness and no pain on palpation. Radiographs of both shoulder joints revealed an osseous body at the left caudal glenoid (Figure 5); the right shoulder was unchanged. Additionally, gait analysis was performed using a pressure plate Zebris FDM Type 2 (Zebris Medical GmbH, Allgäu, Germany). The 203.2 × 54.2 cm large pressure plate uses 15,360 sensors at 100 Hz to measure ground reaction forces and temporospatial parameters. A total of 5 gait cycles when the cat was walking in a straight line without stopping/turning/distraction, each with a total of 5 steps per leg, were evaluated. After calculating the symmetry index[ii] (SI) (Schnabl-Feichter et al., 2020), a mild lameness of the left thoracic limb and pelvic limb was diagnosed (Figure 6). The vertical impulse showed an SI of 7.97% in the thoracic legs, with lower vertical impulse on the left thoracic limb (left 27.35% total force [TF], right 32.08% TF). The SI of the peak vertical force (PFz) in the pelvic limb was 7.25% with lower PFz in the left pelvic limb (left 20.53% TF, right 23.74% TF).

3 | Discussion

In veterinary medicine, needle-sized arthroscopy has been commercially available since 2010, however classic arthroscopy has been the standard ever since. The first needle-sized arthroscopy being an 18ga needle arthroscope by BioVision (BioVision Technologies, USA) was using a sheath diameter of only 1.3 mm and 0°, 10°, and 30° views.

Up to this date, different companies provide equipment and software in this medical field with slightly different specifications and limitations (e.g., Miniature Straight Forward Telescope 0° by Karl Storz Veterinary Endoscopy [KARL STORZ SE & Co. KG, Germany]; Mi-eye 3 by Trice Medical [Trice Medical, USA]).

FIGURE 2 | Arthroscopic view with the NanoScope of the shoulder joint. (a) Visible is the bone fragment on the caudal aspect of the glenoid. Humerus (o), fragment (*), glenoid (+); (b) biceps tendon (*), humerus (+); and (c) medial glenohumeral ligament (*), humerus (+) (Eva Schnabl-Feichter /Vetmeduni).

FIGURE 3 | Mediolateral radiograph of the left shoulder joint, after surgery, showing successful removal of both mineralised opacities. An ill-defined, approximately 2 × 1 mm big opacity can be seen caudodistal to the caudal rim of the glenoid cavity as well as surrounding gas accumulation (arrow) (Clinical Unit of Diagnostic Imaging/Vetmeduni).

Arthroscopic examination of the shoulder joint was performed using a needle-sized chip-on-tip arthroscopy, the use of which has not yet been described in cats.

Needle arthroscopy proved to be efficient for visualising intra-articular structures while being minimally invasive. The advantages using the NanoScope include a 63% smaller incision, less amount of rinsing fluid required, less weight, and the ability to bend without loss of video quality (Arthrex, Inc. 2024). However, it has certain limitations, as follows: 0° view, which differs from the commonly used 30°, and increased risk of iatrogenic damage due to size and weight differences (Shafi et al., 2020). Nonetheless, these limitations did not affect the accuracy of the surgeon's procedure in a recent publication in human medicine (Burt et al., 2023). Depending on the size of the intraarticular bodies, it is a common decision to convert to a mini-arthrotomy. In our case, the conversion was done by extension of the caudal portal to remove the fragment.

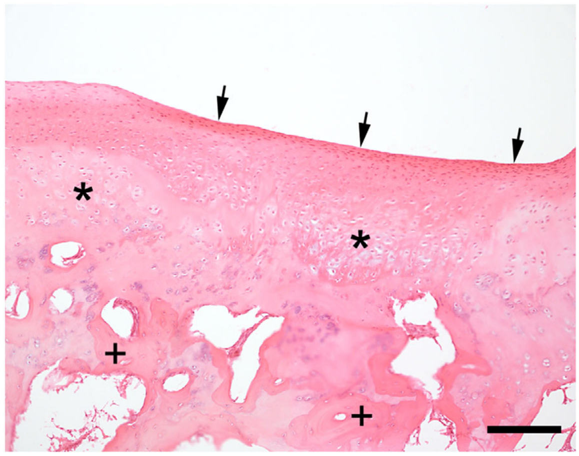

FIGURE 4 | Histological section of one intraarticular osseous body consisting of fibrocartilage (arrows), hyaline cartilage (*) and trabecular bone (+) with fatty bone marrow. No inflammatory infiltration or neoplastic tissue was found (haematoxylin and eosin, bar = 160 µm) (Institute of Pathology /Vetmeduni).

FIGURE 5 | Mediolateral radiograph of the left shoulder joint, 9 months after surgery. The glenoid cavity is remodelled extending mildly more caudodorsally. An oval to triangular mineralised opacity can be seen caudodistal to the caudal rim of the glenoid cavity. The humeral head is misshaped (Clinical Unit of Diagnostic Imaging/Vetmeduni).

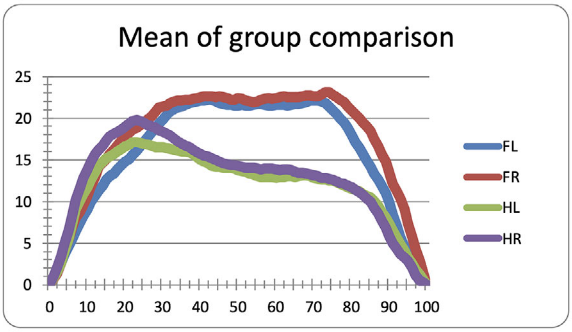

FIGURE 6 | Gait analysis of all four limbs in comparison. *X*-axis represents the normalised stance phase; *Y*-axis represents the vertical force [N]. The left forelimb (FL) shows lesser load than the right forelimb (FR) with a flatter slope. The right hind leg (HR) shows a greater peak force than the left (HL) (Section for Physical Therapy/Vetmeduni).

In the present case, severe bilateral shoulder dysplasia was present, and thus it is likely that shoulder instability and secondary degenerative joint disease will develop in the future (Roush, 1995). Scharf et al. (2004) described shoulder dysplasia in a cat in combination with bicipital tenosynovitis, while Schwarze et al. (2015) associated it with osteochondrosis dissecans. Mild symptoms can be treated conservatively with NSAIDs and chondroprotectives; conversely, severe shoulder dysplasia warrants an arthrodesis of the shoulder joint (Voss and Langley-Hobbs, 2009).

Histologically, there were no typical lesions supporting other differential diagnoses such as osteochondrosis dissecans, osteochondromatosis, fracture fragments or neoplasia.

Incomplete ossification has mainly been described in the context of an ununited anconeal process of the ulna or associated with the humerus condyle (Marcellin-Little, 2000). Although the exact aetiology is not completely resolved, possible causes such as genetics, osteochondrosis, trauma, or abnormal growth, have been found (Olivieri et al., 2004). Clinically relevant UCG has been reported in dogs (Olivieri et al., 2004) and in one cat (Serck and Wouters, 2019) but without shoulder dysplasia, and the size of the osseous body was significantly smaller.

The histopathological report of the cat from the current case report suggests an incomplete ossification. As there is no ossification centre at the caudal glenoid described in cats, it can be suggested that this osseous body was possibly part of a newly formed glenoid, a response to shoulder dysplasia and instability to increase congruity and the joint surface, which was isolated.

This theory is corroborated by the fact that after 9 months, the shoulder radiographs revealed an osseous body approximately in the same area as the surgically removed osseous body. Possible differential diagnosis are further mineralisation of a missed ossifying body, mineralisation of the joint capsule or proliferation of leftover cartilage or arthritis. Loose cartilage, supported by synovial fluid, can proliferate and enlarge via endochondral ossification (Bianchi and Martinoli, 1999).

The joint mouse is assumed to be a reaction to joint instability or a break-away part of the glenoid due to a traumatic event. The concurrent synovitis is likely a result of the instable osseous body or an unnoticed trauma.

The lameness of the left thoracic limb may have multifactorial origins, caused by the inflammation, osseous body's mobility, and a possible pinch pain. The gait significantly improved after successfully removing the osseous body, which is the preferred therapy in dogs (Olivieri et al., 2004), proving the osseous body as the cause of lameness in this cat. In case of a stable fragment, it should not be considered as the cause of the lameness (Rochat, 2005) as it can be also an incidental finding in dogs (Beale et al., 2003).

In addition to the orthopaedic examination, a gait analysis using a ground measure plate can reliably detect lameness in cats and dogs (Guillot et al., 2012, 2013; Schnabl-Feichter et al., 2017, 2020). In this case, a visually undetected lameness was found in the left thoracic and pelvic limb. Cats tend to walk more cautiously and in a crouched posture in unfamiliar surroundings. They can distribute their weight more evenly on all limbs compared to dogs, making it difficult to detect mild lameness in the consultation room (Schnabl-Feichter et al., 2020). The mild lameness in the thoracic limb could be caused by the reformed osseous body and the already described pathologies. The perceived left pelvic limb lameness is suspected to be either due to a coxarthrosis, which was hinted at initially taken pelvic radiography suggested, or an unknown orthopaedic cause of the left pelvic limb (e.g., trauma, tendinopathy, myositis). As orthopaedic examination was unremarkable, the lameness was not further investigated at the time of presentation.

An additional removal was not recommended yet, as the likelihood of a recurrence was considered and discussed with the owner. Therefore, a regular clinical examination (e.g., orthopaedic examination, gait analysis, shoulder radiographs) was recommended to the owner for monitoring.

4 | Conclusion

This case report is the first to describe the use of needle arthroscopy in the shoulder joint in a cat. It demonstrated efficiency in visualising all intra-articular structures while being minimally invasive. The lameness in this cat was likely caused by the unstable osseous body caudal to the glenoid, a possible response to joint incongruity and instability. This theory is supported by the recurrence of the osseous body following surgery. Therefore, removal of the osseous body is recommended in cases of unstable fragments causing pain on palpation and while walking.

Author Contributions

Julian Hauer: Conceptualisation (supporting), data curation (supporting), formal analysis (lead), methodology (equal), visualisation (equal), writing—original draft preparation (lead), writing—review & editing (lead). **Barbara Bockstahler**: Data curation (supporting), formal analysis (supporting), resources (supporting), visualisation (equal), writing—review & editing (equal). **Carina Strohmayer**: Data curation (equal), resources (supporting), visualisation (equal), writing—review & editing (supporting). **Sabine Breit**: Data curation (equal), resources (supporting), visualisation (equal), writing—review & editing (supporting). **Barbara Richter**: Data curation (equal), resources (supporting), visualisation (equal), writing—review & editing (supporting). **Eva Schnabl-Feichter**: Conceptualisation (lead), data curation (lead), project administration (lead), resources (lead), supervision (lead), visualisation (equal), writing—original draft preparation (supporting), writing—review & editing (supporting), writing—review & editing (supporting).

Ethics Statement

The authors have nothing to report.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Peer Review

The peer review history for this article is available at https://publons.com/publon/10.1002/vms3.70203.

Endnotes

[i] NanoScope specifications: Single use sterile camera with chip-on-tip technology and an integrated LED light source Outer scope diameter: 1.9 mm. Working length: 125 mm. Straight sheath kit with outer sheath diameter: 2.4 mm. 0° direction of view, 120° field of view.

[ii] Symmetry index: (%) = 100 × (ABS(left–right)/(left + right)).

References

Arthrex, Inc. Nano Arthroscopy. 2024. Accessed January 5, 2024. https://www.arthrex.com/imaging-resection/nano-arthroscopy.

Beale, B., D. Hulse, and K. Shulz. 2003. "Incomplete Fusion of the Caudal Glenoid Ossification Center". In *Small Animal Arthroscopy*, edited by B. S. Beale, D. A. Hulse, K. S. Schulz, and W. O. Whitney, 46–47. Saunders Elsevier.

Beale, B. S., D. A. Hulse, K. S. Schulz, and W. O. Whitney. 2003. "Chapter 3—Arthroscopically Assisted Surgery of the Shoulder Joint". In *Small Animal Arthroscopy*, edited by B. S. Beale, D. A. Hulse, K. S. Schulz, and W. O. Whitney, 23–49. Philadelphia: W.B. Saunders. Available at: https://doi.org/10.1016/B978-0-7216-8969-2.50009-2.

Bianchi, S., and C. Martinoli. 1999. "Detection of Loose Bodies in Joints." *Radiologic Clinics of North America* 37, no. 4: pp. 679–690.

Burt, J., V. Smith, C. W. Gee, J. V. Clarke, and A. J. Hall. 2023. "The Role of Outpatient Needle Arthroscopy in the Diagnosis and Management of Musculoskeletal Complaints: A Systematic Review of the Arthrex NanoScope." *The Knee* 42: pp. 246–257.

Butteworth, S. 1994. "Manual of Small Animal arthrology". In *BSAVA-Manual of Small Animal Arthrology*, edited by J. Houlton, and R. Collinson, 154. British Small Animal Veterinary Association.

Cawley, A. J., and J. Archibald. 1959. "Ununited Anconal Processes of the Dog." *Journal of the American Veterinary Medical Association* 134, no. 10: pp. 454–458.

Guillot, M., M. Moreau, M.-A. D'anjou, J. Martel-Pelletier, J.-P. Pelletier, and E. Troncy. 2012. "Evaluation of Osteoarthritis in Cats: Novel Information From a Pilot Study." *Veterinary Surgery* 41, no. 3: pp. 328–335.

Guillot, M., M. Moreau, M. Heit, J. Martel-Pelletier, J.-P. Pelletier, and E. Troncy. 2013. "Characterization of Osteoarthritis in Cats and Meloxicam Efficacy Using Objective Chronic Pain Evaluation Tools." *The Veterinary Journal* 196, no. 3: pp. 360–367.

Marcellin-Little, D. J. 2000. "Incomplete Ossification of the Humeral Condyle in Dogs." *Kirks Current Veterinary Therapy* 13: pp. 1000–1003.

Olivieri, M., A. Piras, D. J. Marcellin-Little, P. Borghetti, and A. Vezzoni. 2004. "Accessory Caudal Glenoid Ossification Centre as Possible Cause of Lameness in Nine Dogs." *Veterinary and Comparative Orthopaedics and Traumatology* 17, no. 03: pp. 131–135.

Rochat, M. C. 2005. "Emerging Causes of Canine Lameness." *Veterinary Clinics: Small Animal Practice* 35, no. 5: pp. 1233–1239.

Roush, J. K. 1995. "A Comparison of Two Surgical Approaches to the Scapulohumeral Joint in Dogs." *Veterinary Surgery* 24, no. 3: pp. 207–214.

Scharf, G., S. Steinbüchl, M. Messmer, and S. Ohlerth. 2004. "Glenoid Dysplasia and Bicipital Tenosynovitis in a Maine Coon Cat." *Journal of Small Animal Practice* 45, no. 10: pp. 515–520.

Schnabl-Feichter, E., A. Tichy, and B. Bockstahler. 2017. "Coefficients of Variation of Ground Reaction Force Measurement in Cats." *PLoS ONE* 12, no. 3: p. e0171946..

Schnabl-Feichter, E., A. Tichy, and B. Bockstahler. 2020. "Evaluation of a Pressure Plate for Detection of Hind Limb Lameness in Cats." *PLoS ONE* 15, no. 4: p. e0231904..

Schwarze, R. A., C. A. Tano, and V. W. Carroll. 2015. "Glenoid Dysplasia and Osteochondritis Dissecans in a Cat." *The Canadian Veterinary Journal* 56, no. 7: p. 749.

Serck, B. M. A., and E. E. G. Wouters. 2019. "Ununited Accessory Caudal Glenoid Ossification Centre and Associated Joint Mouse as a Cause of Lameness in a Cat." *Journal of Feline Medicine and Surgery Open Reports* 5, no. 2: p. 2055116919879255..

Shafi, N., S. D. Lang, H. Kassam, and B. B. Gilmer. 2020. "Diagnostic and Therapeutic Shoulder Arthroscopy Using a Small-Bore Needle Arthroscope." *Arthroscopy Techniques* 9, no. 8: pp. e1087–e1093.

Trout, T. E., and D. Resnick. 1996. "Glenoid Hypoplasia and Its Relationship to Instability." *Skeletal Radiology* 25, no. 1: pp. 37–40.

Voss, K., and S. J. Langley-Hobbs. 2009. "28 - Shoulder joint." In *Feline Orthopedic Surgery and Musculoskeletal Disease*, edited by P.M. Montavon, K. Voss, and S.J. Langley-Hobbs, 337–342. Edinburgh: W.B. Saunders. Available at: https://doi.org/10.1016/B978-070202986-8.00040-9.