Received: 27 October 2020 | Revised: 19 June 2021 | Accepted: 6 July 2021

DOI: 10.1111/vsu.13681

SHORT CASE SERIES

WILEY

Arthroscopic removal of osteochondral fragments of the cervical articular process joints in three horses

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Abstract

Objective: To report arthroscopic osteochondral fragment removal from the equine cervical spine articular process joints (APJs) including long-term follow-up.

Study Design: Case series.

Animals: Three Warmblood horses with forelimb lameness and/or reduced range of motion of the cervical spine with osteochondral fragments between the cervical vertebrae C_5/C_6 or C_6/C_7.

Method: Arthroscopy of the APJs of C_5/C_6 and C_6/C_7 was performed under general anesthesia. Following endoscopic evaluation of the joints, osteochondral fragments were removed using a rongeur.

Results: All horses recovered from anesthesia with no anesthetic or minor postanesthetic complications. One horse needed a second procedure for fragment removal. Fourteen to 31 months post-surgery the horses were sound for their intended use and neurological examination revealed no abnormalities.

Conclusion: Arthroscopic removal of osteochondral fragments can be performed safely in the equine cervical APJs of C_5/C_6 and C_6/C_7 resulting in a favorable long-term outcome.

Clinical Significance: Arthroscopic removal is a valid option for horses showing clinical signs that can be attributed to osteochondral fragments in the APJs of the neck.

1 | INTRODUCTION

The equine cervical articular process joints (APJs) are bilateral intervertebral synovial diarthroses lined with hyaline cartilage.[1–3] The APJs are located dorsal to the intervertebral foramina and extend medially towards the vertebral canal in the equine cervical spine.[4] The flat, oval-shaped osseous components of the cervical APJs accommodate movement parallel to the articular surface.[2–5] Caudal to the atlantoaxial articulation the joint surfaces are oriented obliquely, at approximately 45°–55° to the horizontal plane, which increases further caudally as it progresses.[6]

Pathological conditions of the APJs include osteochondrosis dissecans (OCD), OCD-like lesions, fracture, and osteoarthritis.[7–14] These disorders can limit athletic activity and lead to clinical signs like decreased cervical range of motion, forelimb lameness, weakness, proprioceptive deficits, and ataxia.[9,15–19]

The etiology behind osteochondral fragments of cervical APJs is not yet fully understood. OCD and OCD-like lesions, as well as osteochondromatosis and fragmentation

secondary to trauma are suggested as possible sources for these fragments.[10,13,20,21]

The treatment of choice for the majority of osteochondral fragments located in other equine joints is arthroscopic removal.[22,23] The arthroscopic approach and anatomy of the cervical APJs have been described recently.[24] Additionally, diagnostic arthroscopy of APJs (three horses) as well as a "cut down" arthroscopic approach for OCD fragment removal (one horse) have been described in clinical cases.[10,24] In three out of the four reported cases, the horses were euthanized shortly after surgery due to deteriorating clinical signs or a poor prognosis for athletic activity.[10,24] To the best of the author's knowledge, this is the first case series detailing successful arthroscopic osteochondral fragment removal in the equine cervical spine APJs including long-term follow-up.

2 | MATERIALS AND METHODS

2.1 | Case 1

2.1.1 | Clinical presentation

A 11-year-old Warmblood gelding (650 kg) was referred for further assessment of intermittent bilateral forelimb lameness of 2 years' duration, which was particularly noticeable during ridden exercise. The horse could no longer be used as a school horse. The lameness could not be localized to the forelimbs with diagnostic analgesia by the referring veterinarian and signs of neck stiffness had been observed.

Upon admission, the horse was bright, alert, and responsive. The physical examination including blood hematology and biochemistry was unremarkable. Lameness examination was performed with the support of a body-mounted inertial sensor system (lameness locator, Equinosis®). The horse did not show any sign of lameness at the walk and trot in a straight line on synthetic hard surface. Flexion tests were negative. During lunging (soft and hard surface) the horse kept the neck in a straight position and stumbled in the forelimbs. Under saddle an intermittent right forelimb lameness grade 1–2/5 (AAEP lameness score) was evident on the left rein. Symptoms were more noticeable on the right rein where the horse fell on its carpi when asked to trot on a small circle. The lateral range of motion of the cervical spine was moderately reduced to both sides. There was no heat, pain, or swelling on palpation in the area of the neck. No significant findings were revealed during a neurological examination, with the exception of stumbling while lunging with the neck flexed.

The horse was sedated (detomidine, 0.01 mg/kg intravenously [IV] and butorphanol, 0.05 mg/kg IV) and laterolateral, dorsoventral (C_1-C_2) and oblique (right 45°–55° ventral to left dorsal and left 45°–55° ventral to right dorsal) radiographs (Gierth HF400ML, Gierth X-Ray International GmbH, Riesa, Germany) of the cervical spine (C_1-T_1) were obtained.[6] Radiographic examination identified an isolated round to oval radiopaque structure of approximately 1 cm diameter that was consistent with an osteochondral fragment at the cranial margin of the right C_5-C_6 cervical APJ (Figure 1A). Additionally, ultrasonography (Aplio 500, Canon Medical Systems GmbH, Neuss, Germany, 3 cm focus) of the APJs was performed. There was marked distention of the right C_5-C_6 APJ and the osteochondral fragment could be visualized at the cranial margin of the right C_5-C_6 cervical APJ.

2.1.2 | Surgical procedure

Flunixin meglumine (1.1 mg/kg IV), amoxicillin (10 mg/kg IV), and gentamicin sulfate (6.6 mg/kg IV) were administered preoperatively. For induction of general anesthesia the horse received medetomidine (7 μg/kg IV), diazepam (0.02 mg/kg IV), and ketamine (2.2 mg/kg IV).

The horse was placed under general anesthesia (isoflurane minimum alveolar concentration 1.0.) and xylazine (0.8 mg/kg/h IV) and positioned in left lateral recumbency. A 5-L fluid bag was positioned under the left C_5-C_6 cervical APJ in order to achieve slight left lateral flexion. A 42 × 43 cm digital radiography detector plate was placed between the operating table and the fluid bag centered on the C_5-C_6 articulation (Figure 2). Following aseptic preparation, the patient was draped routinely. Adhesive drapes were used at the surgical site to avoid the need for towel clamps that could interfere with the surgical procedure and intra-operative imaging. A 7.5-MHz straight linear array ultrasound transducer (Aplio 500, Canon Medical Systems GmbH, 3 cm focus) was covered with a sterile sleeve.

The location and orientation of arthroscopic portal to the right C_5-C_6 cervical APJ was identified with ultrasonography and radiography (Gierth HF400ML, Gierth X-Ray International GmbH) (Figure 3A) using lateral und oblique radiographic projections.[6,25] Ultrasonography was considered necessary to improve orientation and reduce the risk of iatrogenic damage to the periarticular neurovascular structures.[24–26] A point 1 cm cranial and 1 cm ventral to the C_5-C_6 APJ was determined radiographically. A 20G × 3½″ spinal needle was inserted under ultrasonographic guidance and directed in an approximately 60° cranioventral-caudodorsal angle to

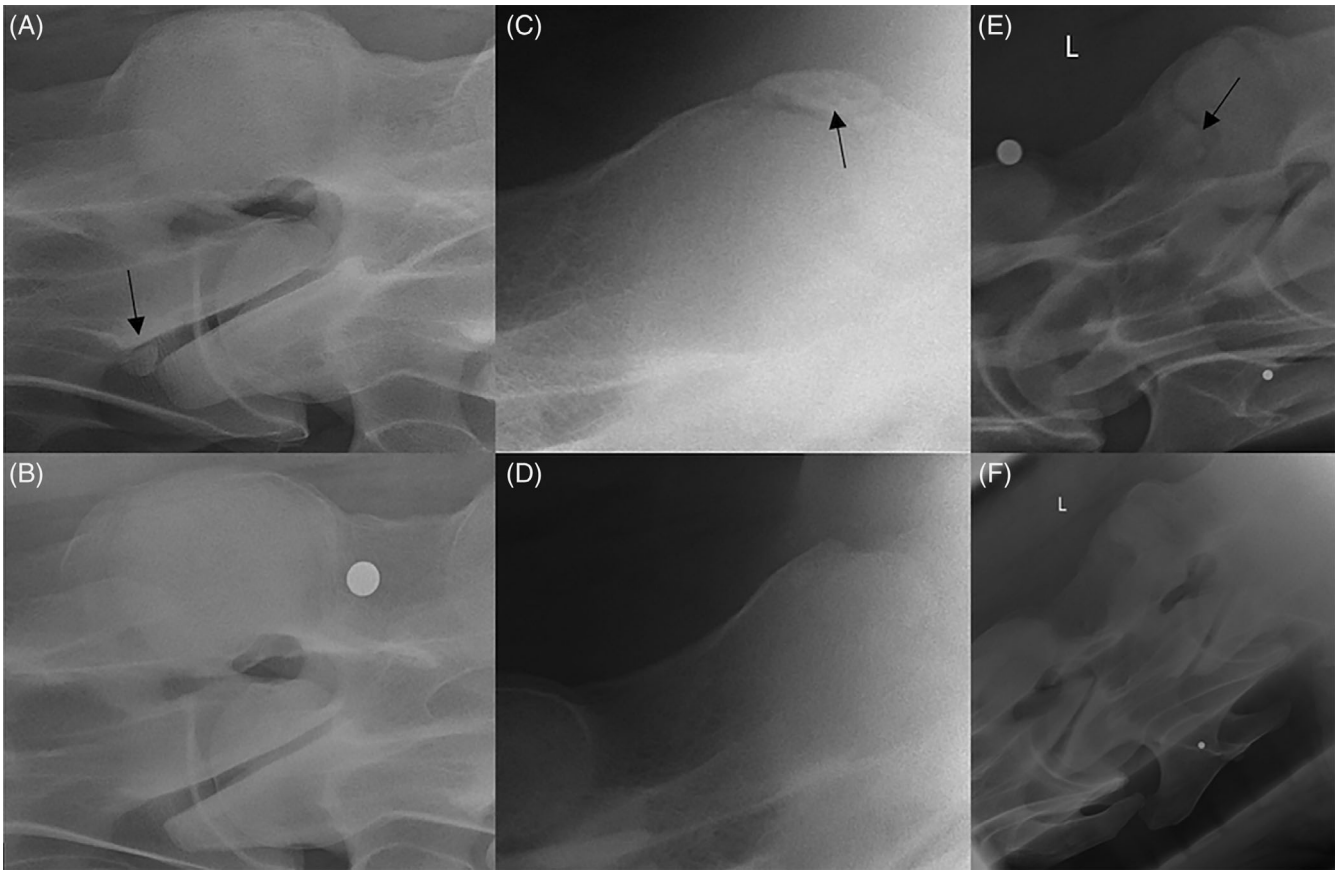

FIGURE 1 Case 1: (A) Left 45°–55° ventral to right dorsal preoperative radiograph showing isolated round to oval shaped radiopaque structure (black arrow) at the cranial aspect of the right C_5-C_6 cervical articular process joint (APJ). (B) Left 45°–55° ventral to right dorsal postoperative radiograph confirming successful removal of the OCD fragment. Case 2: (C) Left 45°–55° ventral to right dorsal preoperative radiograph highlighting isolated oval radiopaque structure (black arrow) consistent with an OCD fragment at the caudal aspect of the left C_6-C_7 cervical APJ. (D) Left 45°–55° ventral to right dorsal postoperative radiograph showing successful OCD fragment removal. Case 3: (E) Right 45°–55° ventral to left dorsal preoperative radiograph indicating OCD fragment (black arrow) at the cranial aspect of the right C_6-C_7 APJ. (F) Right 45°–55° ventral to left dorsal postoperative radiograph confirming successful fragment removal

reach the cranioventral joint recess at the visible joint space. The correct placement of the needle was confirmed radiographically and by aspiration of synovial fluid. Then, the joint was distended with 15 ml of sterile polyionic fluids. A 10-mm skin incision (No. 21 blade) was made at the point of the needle entry. The direction of the needle was subsequently followed with a No. 11 blade, creating a deep stab incision through the musculature overlying the APJ (M. cutaneous colli and longissimus cervicis).[3,24] The arthroscopic cannula (4.0 mm, 30° forward-viewing arthroscope, length 18 cm, Karl Storz) and blunt obturator were guided into the cranioventral APJ compartment using ultrasonography and the position was confirmed radiographically with lateral and oblique projections before the obturator was replaced with the arthroscope (Figures 2 and 3A). A systematic evaluation of the cranioventral compartment including the cartilage, synovia, and subchondral bone of the C_5-C_6 APJ was performed and the osteochondral fragment was located at the craniodorsal aspect of the right C_5 articular surface (Figure 4A). A second 20G × 3½″ spinal needle was inserted into the cranioventral joint recess, approximately 2 cm craniodorsal to the arthroscope, to create an instrument portal using the technique described above. The osteochondral fragment was identified and elevated with a periosteal elevator (2 mm) and removed in one piece with a Ferris-Smith rongeur (4 mm, 14 cm straight). Debridement of the fragment bed was not required (Figure 4B). Multiple wear lines as well as superficial cartilage fibrillation were visible at the cranial and caudal surfaces of the C_5-C_6 articulation. The APJ was lavaged with approximately 1 L of sterile polyionic fluids before the skin was apposed in simple interrupted fashion (USP 2-0 polypropylene). The surgical site was protected with a stent bandage and assisted recovery was uneventful.

2.1.3 | Postoperative management and outcome

The gelding recovered from anesthesia with no anesthetic or postanesthetic complications with all vital parameters within normal limits. Mild to moderate wound swelling was evident at the surgical site for 5 days. Hay and water were provided at shoulder height to avoid unnecessary neck movements. The stent was removed 4 days postoperatively. Antimicrobial therapy (amoxicillin 10 mg/kg IV every 8 h and gentamicin sulfate 6.6 mg/kg IV once daily) and Flunixin meglumine (1.1–0.5 mg/kg IV twice daily) were administered for 5 days (reducing to 0.5 mg/kg IV twice daily on day 4). Additionally, the horse received omeprazole (2 mg/kg orally once daily) during hospitalization. Repeated radiographs were obtained 1 day after surgery to confirm complete fragment removal (Figure 1B). The horse was discharged from the hospital 8 days after surgery when clinical examination revealed no abnormal findings. The owners were instructed to keep the gelding on box rest for a further 2 weeks. Hand walking commenced with 10 min twice a day and was increased by 5 min per week for the following 2 months.

Three months after surgery the gelding was re-examined at the referral hospital. The horse did not show any sign of lameness at the walk and trot in a straight line on synthetic hard surface. Flexion tests were negative. During lunging (soft and hard surface) the horse kept the neck still in a straight position, but the stumbling and the left forelimb lameness (1–2/5) were no longer visible. The lateral range of motion of the cervical spine was no longer reduced to both sides. A neurologic evaluation was within normal limits. Telephone follow-up 3 years after surgery confirmed that the gelding had remained in good general health and did not show any signs of lameness. The horse had returned to training 6 months post-surgery and was used as a riding school horse since.

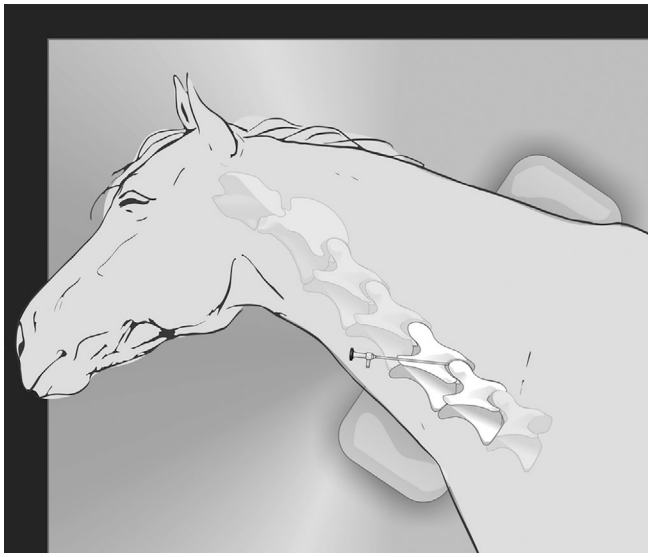

FIGURE 2 Graphic illustration of the anesthetized horse in lateral recumbency for the arthroscopic approach to the left C_5-C_6 articular process joint (APJ). A 5 L fluid bag or cushion is located under the C_5-C_6 APJ to achieve lateral joint flexion. Additionally, a digital radiography detector plate can be placed under the area of the C_5-C_6 articulation prior to surgery to facilitate intra-operative imaging. The arthroscope is positioned in the cranioventral joint compartment, inserted at a point 1 cm cranial and 1 cm ventral to the C_5-C_6 APJ and directed approximately 60° cranioventral-caudodorsal as performed for case 1 and case 3

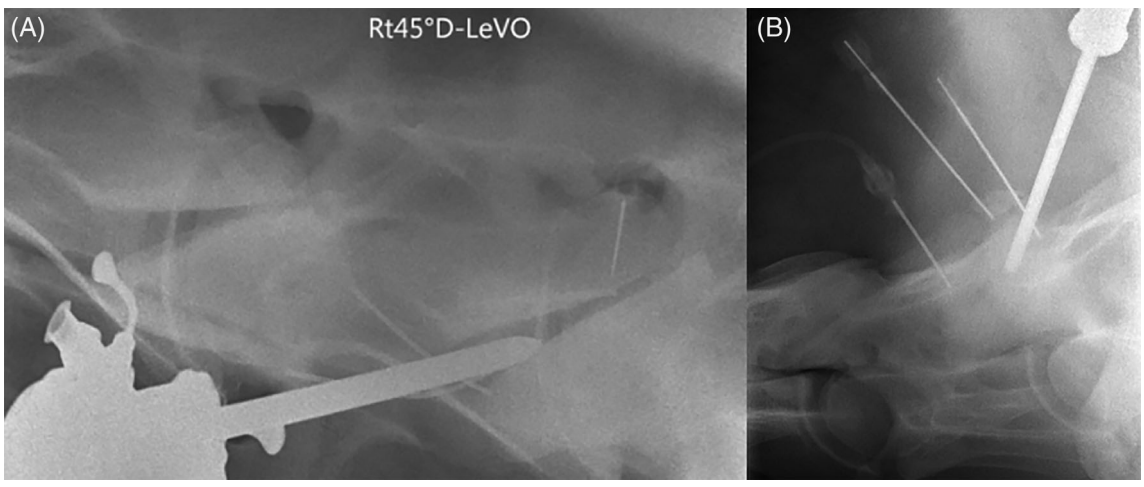

FIGURE 3 (A) Right 45°–55° dorsal to left ventral intra-operative radiograph of the C_5-C_6 articular process joint (APJ) with the arthroscopic cannula and blunt obturator in the cranioventral APJ compartment (case 1). Intra-operative radiography was used to confirm the correct position of the arthroscopic cannula before the obturator was replaced with the arthroscope. (B) Left 45°–55° ventral to right dorsal intra-operative radiograph of the C_6-C_7 APJ with the arthroscopic cannula in the caudodorsal APJ compartment (case 2)

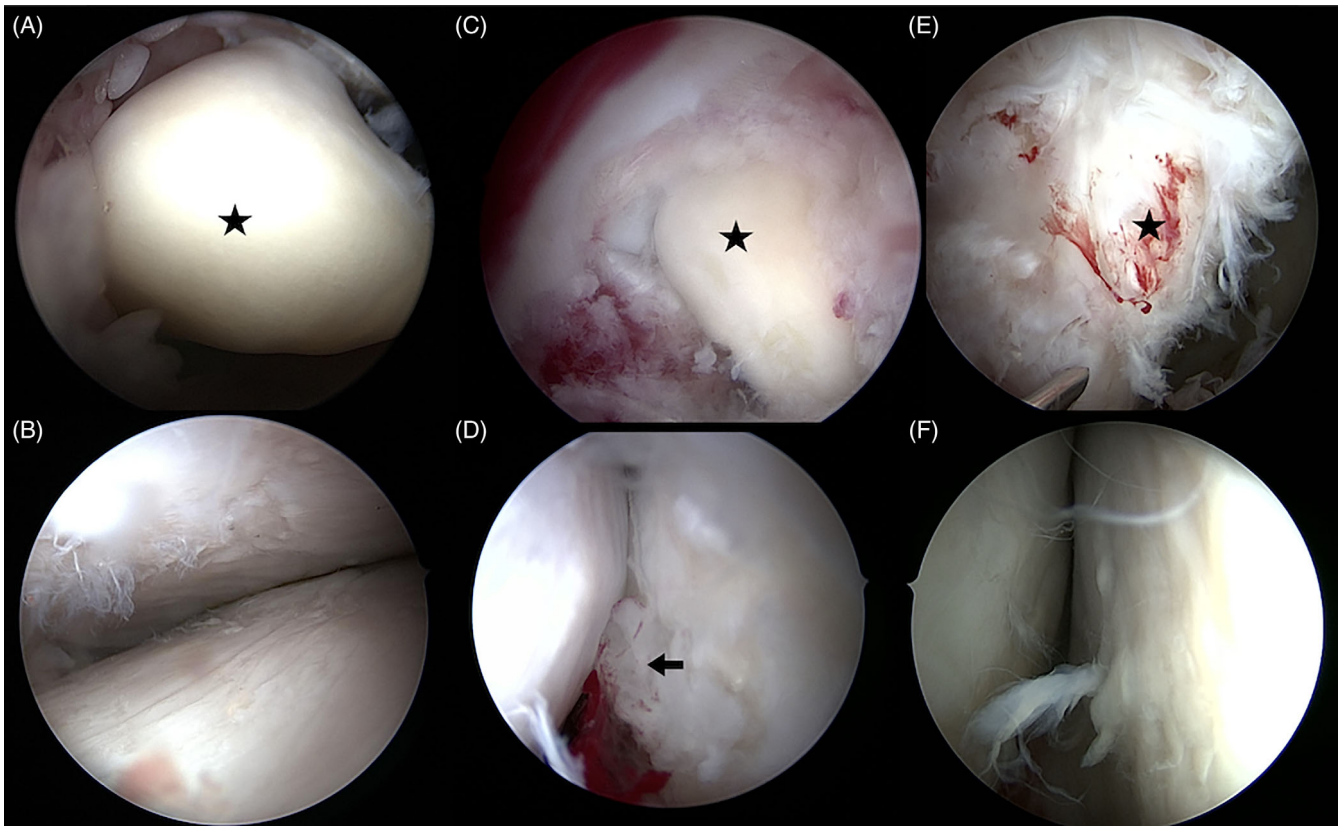

FIGURE 4 Case 1: (A) Arthroscopic view of the cranioventral recess of the right C_5-C_6 cervical articular process joint (APJ) showing a rounded osteochondral fragment (asterisk) associated with the craniodorsal aspect of the C_5 articular process. (B) Arthroscopic view of the cranioventral C_5-C_6 articular recess following fragment removal. Multiple wear lines as well as some mild cartilage fibrillations are evident at the right C_5-C_6 articular processes. Case 2: (C) Arthroscopic view of the caudodorsal recess of the left C_6-C_7 APJ. An osteochondral fragment (asterisk) is attached to the caudal aspect of the C_7 articular surface. (D) Arthroscopic view of the C_7 cranial articular surface after fragment removal. The fragment bed (arrowhead) was not debrided. Case 3: (E) Arthroscopic view of the cranioventral recess of the right C_6-C_7 cervical APJ. There is an oval shaped osteochondral fragment at the craniolateral aspect of the C_7 articular surface. (F) Arthroscopic view of the cranioventral C_6-C_7 articular recess following fragment removal showing multiple wear lines and superficial cartilage fibrillation at the surface of the C_6-C_7 articular processes. C_6 = right caudal articular process of C_6; C_7 = right cranial articular process of C_7

2.2 | Case 2

2.2.1 | Clinical presentation

A 6-year-old Warmblood showjumper gelding (660 kg) was referred for further assessment of left forelimb lameness of several weeks' duration that could not be eliminated with diagnostic analgesia. The referring veterinarian performed a complete perineural and intra-articular analgesia of the lame left forelimb up to the scapulohumeral joint.

The gelding presented bright, alert, and responsive. Physical examination was unremarkable with all vital parameters within normal limits. Dynamic examination identified grade 1–2/5 left forelimb lameness in a straight line on synthetic hard surface. The lameness was slightly more evident on the left rein (grade 2/5 left fore) when compared to the right rein (grade 1–2/5 left fore) on a soft and hard surface. A moderate reduction in cervical range of motion was noted on both sides. There was no heat, pain, or swelling on palpation in the area of the neck or forelimbs. A full neurological examination was performed which was within normal limits.

Radiographic examination was performed based on the previously described protocol and confirmed the presence of an isolated round to oval shaped, radiopaque fragment at the caudodorsal aspect of the left C_6-C_7 cervical APJ (Figure 1C). Additionally, an ultrasonographic examination was performed based on the previously described protocol. There was marked distention of the left C_6-C_7 APJ and the osteochondral fragment could be visualized at the caudal margin of the left C_6-C_7 cervical APJ.

2.2.2 | Surgical procedure

The general setup including preoperative medication, induction and maintenance of general anesthesia,

positioning of the horse, aseptic preparation, draping, and intra-operative imaging were performed as detailed for case 1. The horse was however placed in right lateral recumbency as the left C_6-C_7 APJ was affected. The joint was distended (20 ml of sterile polyionic fluids) via needle insertion in the cranioventral recess under ultrasonographic guidance as described.[24] To access the caudodorsal recess of the C_6-C_7 APJ, a second 20G × 3½″ spinal needle was inserted at a point approximately 4 cm caudal and 1 cm dorsal to the point where the first needle was placed. The needle was inserted in a 60° caudodorsal-cranioventral direction and fluid egress was noted from the needle hub. Subsequently, a stab incision for the arthroscopic portal was created using the needle as a guide for direction. However, placement of the arthroscopic cannula using the blunt obturator was not possible, despite ultrasonographic and radiographic guidance. After three unsuccessful attempts, the surgical procedure was aborted, and the horse was recovered from anesthesia without incident. A second attempt for arthroscopic fragment removal was made 4 weeks later. The clinical symptoms were unchanged from the initial examination. For the following surgery, the preoperative preparation and approach were as described as in the first case using the cranioventral approach. The creation of a caudodorsal approach was achieved by inserting a switching stick under arthroscopy guidance. Under arthroscopic guidance, the arthroscopic sleeve was inserted over the switching stick in the caudal compartment of the left C_6-C_7 APJ without difficulty (Figure 3B).

A systematic evaluation of the caudodorsal joint compartment was performed to localize the osteochondral fragment at the caudal aspect of the left C_7 articular surface (Figure 4C). A 20G × 3½″ inch spinal needle was inserted into the caudodorsal APJ recess at a position approximately 2 cm cranial to the arthroscope, to indicate the direction for an instrument portal. A periosteal elevator was used to loosen the fragment that was subsequently removed with a Ferris-Smith rongeur in one piece. Debridement of the fragment bed was not required (Figure 4D). The joint was lavaged with polyionic fluids and skin closure and wound protection were performed as for case 1. Hand-assisted recovery was uneventful with no anesthetic or postanesthetic complications.

2.2.3 | Postoperative management and outcome

Successful fragment removal was confirmed radiographically (Figure 1D). The horse showed mild stiffness of the neck following surgery and additionally displayed subtle signs of colic with reduced appetite and fecal output after the second surgery. All vital and blood parameters, transrectal palpation, and abdominal ultrasonographic examination were within normal limits and the horse responded rapidly to systemic analgesia (metamizole 40 mg/kg IV). Antimicrobial and anti-inflammatory medication including gastric protection was the same as in case 1. The horse was discharged from the hospital 2 weeks after surgery, with physical examinations remaining within normal limits. Rehabilitation instructions were as described above for case 1. Follow-up examinations were performed by the referring veterinarian 3, 7, and 17 months postoperatively.

The horse was in full training and performing according to expectations as a showjumper. Dynamic examination identified no lameness. The moderate reduction of the cervical range of motion was no longer evident on both sides.

2.3 | Case 3

2.3.1 | Clinical presentation

A 6-year-old Warmblood dressage horse gelding (550 kg) was admitted with a reduced range of motion of the neck that was particularly noticeable in flexion and when ridden on the right rein. A moderate reduction in lateral range of motion of the cervical spine to the right was evident.

The gelding was bright, alert, and responsive with all vital parameters within normal limits. Lameness and a complete neurological examination did not identify any significant findings. Radiographic (Figure 1E) as well as computed tomographic examination (Figure 5) showed an osteochondral fragment at the ventrolateral aspect of the right cranial articular surface of C_7. Computed tomography was performed by the referral clinic with the patient under general anesthesia with the neck in an extended position without myelography. The computed tomographic examination revealed a large defect in the subchondral bone of the right cranial articular process of C_7 that was in connection to the osteochondral fragment. A mild arthropathy of the right and left APJs between C_7/Th1 was diagnosed. No other findings in the cervical spine were detected.

2.3.2 | Surgical procedure

Surgery was performed as detailed for cases 1 and 2 with the horse placed in left lateral recumbency. A cranioventral approach was chosen due to the location of the fragment and aided by needle placement, joint

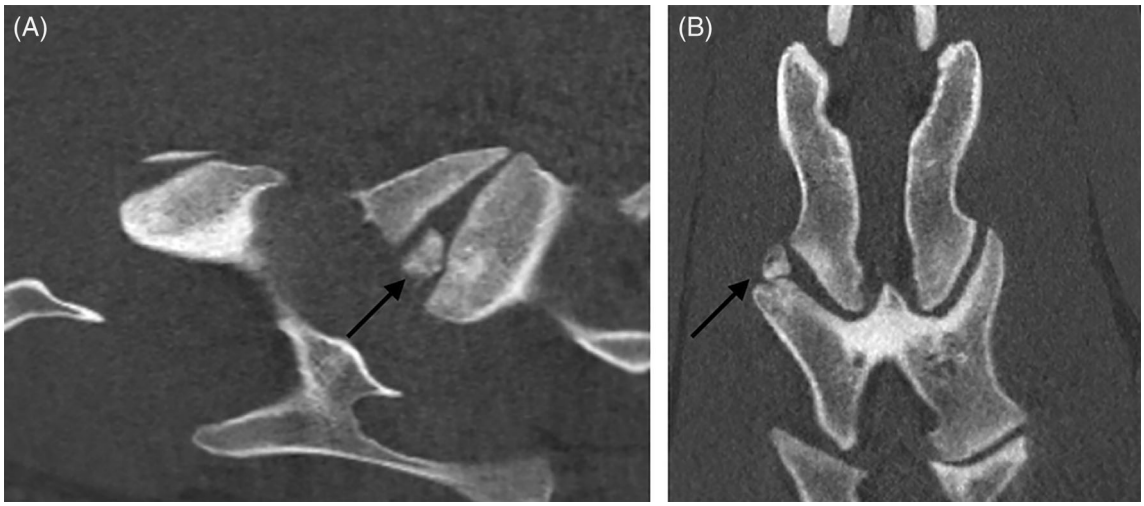

FIGURE 5 Sagittal (A) and frontal (dorsal) (B) computed tomographic images (32-detector-row CT scanner, Aquilion One, Canon Medical Systems) of the right C_6-C_7 articular process joint showing an osteochondral fragment (black arrow) associated with the craniolateral aspect of the right C_7 articular surface (case 3)

distention, and intra-operative imaging as described (Figure 2). The osteochondral fragment was localized at the ventrolateral aspect of the right cranial articular surface of C_7 (Figure 4E). An instrument portal was created cranial to the arthroscope and the fragment was elevated (periosteal elevator; 2 mm) and removed in one piece (Ferris-Smith rongeur; 14 cm straight; 4 mm). Moderate fibrillation and wear lines were noted in the hyaline cartilage of the cranial C_6-C_7 APJ (Figure 4F) and a large defect in the subchondral bone of C_7. Joint lavage, skin closure, wound protection, and recovery were performed as described for the above cases.

2.3.3 | Postoperative management and outcome

The gelding recovered from anesthesia with no anesthetic or postanesthetic complications and with all vital and blood parameters within normal limits. Antimicrobial therapy was discontinued. Flunixin meglumine (1.1–0.5 mg/kg IV twice daily) was administered for 5 days postoperatively (reducing to 0.5 mg/kg IV twice daily on day 4) and removal of the fragment was confirmed radiographically (Figure 1F). The horse was discharged from the hospital 12 days after surgery with examination parameters within normal limits. The owners were instructed to keep the gelding on box rest for further 3 weeks. Hand walking was started at 4 weeks (10 min twice a day) and increased by 5 min per week for the following 2 months.

Telephone follow-up 14 months after surgery with the referring veterinarian confirmed that the horse was still in good general health and did not show any signs of lameness. The initial symptoms were no longer recognizable, and the horse was back in training and used as a dressage horse.

3 | DISCUSSION

This study outlines the arthroscopic evaluation of the caudal APJs (C_5/C_6 and $C_{6/7}$) with successful osteochondral fragment removal in three clinical cases.

The implications of osteochondral fragments in the equine cervical APJs are the subject of ongoing research.[10,13,21] Clinical signs in pathological conditions of the APJs include decreased cervical range of motion, forelimb lameness, or ataxia.[9,15–19]

The three cases outlined here all presented with a moderate reduction in cervical spine range of motion. In addition, cases 1 and 2 showed grade 1–2/5 forelimb lameness that did not respond to diagnostic analgesia and case 1 had additional neurological symptoms, noted as stumbling on the lunge line.

The clinical symptoms associated with the appearance of osteochondral fragments have not yet been clarified. Two recently published studies found osteochondral fragments in 22% and 24% of horses presented with cervical dysfunction.[21,27] However, most of the cases also showed concurrent vertebral pathology. It would be all the more important to clarify the clinical significance by means of diagnostic anesthesia, but so far there is little information on this. Recently an ultrasonographic-guided injection of the medial branch of the dorsal ramus of the cervical spinal nerves in cadaveric equine necks was

developed.[26] However, clinical studies in this field are still lacking.[17,18] Until then, it will remain difficult to definitively identify the clinical significance of these osteochondral fragments. In the three cases presented here, the initial symptoms improved postoperatively and all horses were sound for their intended use. None of the horses received additional treatments postoperatively.

CT examination was performed to further assess the osteochondral fragment including its exact location and concurrent cervical spinal pathology in case 3 by the referral clinic. Apart from a mild arthropathy of the APJs between C_7/Th_1, there were no other findings that could have questioned the clinical significance of the symptoms in this case. Nevertheless, it is not uncommon in horses with APJs Osteochondral fragmentation to find additional cervical pathology, which can complicate the interpretation of clinical significance.[21]

The increasing availability of large gantry CT apertures in equine referral practice as well as detailed reports on the use of CT and CT myelography for the detection of cervical spinal lesions facilitate a comprehensive evaluation of APJ osteochondral fragments and associated pathology in equine patients.[21,27] A myelogram to rule out stenosis may additionally be indicated in some cases.

The horses were positioned with the affected APJ in lateral flexion to achieve slight opening of the joint space and optimize arthroscopic access to the cranioventral joint.[5,10,24] Mechanical distraction of the APJ to avoid collapse of the joint capsule caused by fluid extravasation as described for other joints was not performed.[24] It is however likely that extravasation has complicated the approach to the caudodorsal C_6-C_7 APJ during the initial surgical attempt in case 2. In line with the first report detailing the technique, the arthroscopy of the most caudal APJs (C_6-C_7) was also considered more difficult when compared to the C_5-C_6 articulation.[24] The overlying musculature of the shoulder region impaired on the movability of the arthroscopic sleeve, particularly during the approach to the caudodorsal C_6-C_7 APJ recess (case 2), where it is required to manipulate the arthroscope at 60°–80° to the long axis of the neck in a caudodorsal-cranioventral direction. Based on this experience we would recommend to use the cranioventral approach to place the first arthroscopic portal irrespective of the location of the osteochondral fragment.

One limitation for this case series is that the lameness examinations did not include the use of local anesthesia to further localize the lesion to the affected APJ. The inconsistent nature of the lameness in two of the horses as well as lack of lameness in the third would have made the evaluation the effects of diagnostic analgesia in these horses difficult. The addition of a CT examination as well as mylography may have also improved localization of the neck abnormalities to the APJ in the first two cases; however, it was not available for use at the time of the exam. Finally, histologic evaluation of the fragments removed may have been useful to establish a diagnosis and should be recommended in future cases to provide evidence for a possible etiology of APJ fragments.

In conclusion, arthroscopic removal of osteochondral fragments in the equine cervical APJs can be performed safely, with a good prognosis for return to athletic function in horses with low-grade lameness and mild neurologic deficits. In the horses in this report, no negative effects were associated with the surgical procedure, and the clinical signs noted prior to surgery were improved allowing return to their intended use. Arthroscopic removal of APJ fragments may be considered as an approach to treat these lesions, but a clear link between clinical signs and the fragments has not yet been proven. Therefore, operating a larger number of horses will also help establish the clinical significance of these fragments.

ACKNOWLEDGMENTS

The authors would like to acknowledge the support staff and students involved in the horses' care and the referring veterinary surgeons for sending the cases. Open Access funding enabled and organized by Projekt DEAL.

CONFLICT OF INTEREST

None of the authors has any financial or personal relationships that could inappropriately influence or bias the content of the paper.

AUTHOR CONTRIBUTIONS

All authors were actively involved in the management of the cases and preparation of the manuscript.

REFERENCES

1. Henson FMD. *Equine Neck and Back Pathology*. 2nd ed. Oxford: John Wiley & Sons Ltd; 2018.
2. O'Leary SA, White JL, Hu JC, Athanasiou KA. Biochemical and biomechanical characterization of equine cervical facet joint cartilage. *Equine Vet J*. 2018;50:800-808.
3. Nickel R, Schummer A, Seiferle E. *The Locomotor System of the Domestic Mammals*. Berlin: Verlag Paul Parley; 1986.
4. Claridge HAH, Piercy RJ, Parry A, Weller R. The 3D anatomy of the cervical articular process joints in the horse and their topographical relationship to the spinal cord. *Equine Vet J*. 2010;42:726-731.
5. Clayton HM, Townsend HG. Kinematics of the cervical spine of the adult horse. *Equine Vet J*. 1989a;21:189-192.
6. Whithers JM, Voute LC, Hammond G, Lischer CJ. Radiographic anatomy of the articular process joints of the caudal cervical vertebrae in the horse on lateral and oblique projections. *Equine Vet J*. 2009;41:895-902.

7. Pool RR. Difficulties in definition of equine osteochondrosis; differentiation of developmental and acquired lesions. *Equine Vet J Suppl*. 1993;16:5-12.
8. Rooney JR. Osteochondrosis in the horse. *Mod Vet Pract*. 1975; 56:41-43.
9. Powers BE, Stashak TS, Nixon AJ, Yovich JV, Nordin RW. Pathology of the vertebral column of horses with cervical static stenosis. *Vet Pathol*. 1988;23:392-399.
10. Tucker R, Piercy RJ, Dixon JJ, et al. Arthroscopic treatment of cervical articular process joint osteochondrosis in a thoroughbred horse. *Equine Vet Educ*. 2018;30:116-121.
11. Beck C, Middleton D, Maclean A, Lavelle R. Osteochondrosis of the second cervical vertebra of a horse. *Equine Vet J*. 2002; 34:210-212.
12. Bergmann W, de Mik-van Mourik M, Veraa S, et al. Cervical articular process joint osteochondrosis in Warmblood foals. *Equine Vet J*. 2020;52(5):664-669.
13. Lim CK, Hawkins JF, Vanderpool AL, Heng HG, Gillespie Harmon CC, Lenz SD. Osteochondritis dissecans-like lesions of the occipital condyle and cervical articular process joints in a Saddlebred colt horse. *Acta Vet Scand*. 2017;59(1):76.
14. Janes JG, Garrett KS, McQuerry KJ, et al. Cervical vertebral lesions in equine stenotic myelopathy. *Vet Pathol*. 2015;52(5): 919-927.
15. Trostle S, Dubielzig R, Beck K. Examination of frozen cross sections of cervical spinal intersegments in nine horses with cervical vertebral malformation: lesions associated with spinal cord compression. *J Vet Diagn Invest*. 1993;5:423-431.
16. Stewart RH, Reed SM, Weisbrode SE. Frequency and severity of osteochondrosis in horses with cervical stenotic myelopathy. *Am J Vet Res*. 1991;52:873.
17. Ricardi G, Dyson SJ. Forelimb lameness associated with radiographic abnormalities of the cervical vertebrae. *Equine Vet J*. 1993;25(5):422-426.
18. Dyson SJ. Lesions of the equine neck resulting in lameness or poor performance. *Vet Clin North Am Equine Pract*. 2011;27(3): 417-437.
19. García-López JM. Neck, back, and pelvic pain in sport horses. *Vet Clin North Am Equine Pract*. 2018;34(2):235-251.
20. Moore BR, Holbrook TC, Stefanacci JD, Reed SM, Tate LP, Menard MC. Contrast-enhanced computed tomography and myelography in six horses with cervical stenotic myelopathy. *Equine Vet J*. 1992;24:197-202.
21. Tucker R, Hall YS, Hughes TK, Parker RA. Osteochondral fragmentation of the cervical articular process joints. *Equine Vet J*. 2022;54:106-113. https://doi.org/10.1111/EVJ.13410
22. McIlwraith CW. Surgical versus conservative management of osteochondrosis. *Vet J*. 2013;197:19-28.
23. McIlwraith CW, Foerner JJ, Davis DM. Osteochondritis dissecans of the tarsocrural joint: results of treatment with arthroscopic surgery. *Equine Vet J*. 1991;23:155-162.
24. Pepe M, Angelone M, Gialletti R, Nannarone S, Beccati F. Arthroscopic anatomy of the equine cervical articular process joints. *Equine Vet J*. 2014;46:345-351.
25. Berg LC, Nielsen JV, Thoefner MB, Thomsen PD. Ultrasonography of the equine cervical region: a descriptive study in eight horses. *Equine Vet J*. 2003;35:647-655.
26. Corraretti G, Vandeweerd JM, Hontoir F, Vanderperren K, Palmers K. Anatomy and ultrasound-guided injection of the medial branch of the dorsal ramus of the cervical spinal nerves in the horse: a cadaveric study. *Vet Comp Orthop Traumatol*. 2020;33:377-386. https://doi.org/10.1055/s-0050-1714301
27. Gough SL, Anderson JDC, Dixon JJ. Computed tomographic cervical myelography in horses: technique and findings in 51 clinical cases. *J Vet Intern Med*. 2020;33:377-386. https://doi.org/10.1111/jvim.15848

How to cite this article: Schulze N, Ehrle A, Beckmann I, Lischer C. Arthroscopic removal of osteochondral fragments of the cervical articular process joints in three horses. *Veterinary Surgery*. 2023;52(6):801-809. doi:10.1111/vsu.13681