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CLINICAL COMMENTARY

Diagnostic imaging of the equine cervical spine – Are radiographs enough?

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Horses with abnormalities of the cervical spine can present with a wide variety of clinical signs such as ataxia, gait abnormalities, dysmetria, weakness, paresis, localised sweating, pain, bony or muscular asymmetry (Hoffman & Clark, 2013; Journée et al., 2019; Levine et al., 2010). Abnormal alignment of the vertebrae, such as kyphosis and subluxation, is commonly seen in horses with cervical vertebral malformation (CVM), but scoliosis as found in the horse in the case report by Fairburn et al. is rarely seen (Fairburn et al., 2023; Hoffman & Clark, 2013; Levine et al., 2010).

Due to their wide availability, radiographic examinations are commonly performed for the evaluation of potential bone abnormalities and alignment of the vertebrae. For laterolateral radiographs, horses should be evenly weight-bearing and have a straight head and neck position. The latter should be standardised as this can influence the appearance of some structures and measurement parameters (Beccati et al., 2018; Berner et al., 2012). Furthermore, as mentioned in the article by Fairburn et al., (2023), in patients presenting with abnormal alignment of the vertebrae such as scoliosis acquiring straight radiographs is more challenging and images have to be obtained with different angles to make sure they are acquired perpendicular to the vertebrae (Fairburn et al., 2023). Obtaining oblique radiographs can partially help to visualise structures with less superimposition and lateralise abnormalities (Withers et al., 2009).

For objective evaluation of abnormalities, measuring the intra- and intervertebral ratio are used diagnose cervical vertebral malformation (CVM) (Hahn et al., 2008). However, due to the variation of 5%–10% between different observers and repeated measurements, especially borderline values, these should be interpreted with caution (Hughes et al., 2014; Scrivani et al., 2011). In dogs, measurements performed on ventrodorsal radiographs were superior to distinguish between animals with and without CVM compared to ratios obtained from laterolateral radiographs (Martin-Vaquero & Da Costa, 2014). However, due to the soft tissues surrounding the cervical spine, especially in the caudal cervical area, the ventrodorsal view does not have sufficient detail in averaged sized horses.

Cross-sectional imaging, such as computed tomography (CT) can overcome the limitations of radiographs and due to the increased gantry dimensions of modern CT machines, these have become more and more common in horses (Gough et al., 2020; Lindgren et al., 2021). The case report by Fairburn et al., (2023) highlights one of the major advantages of CT compared to radiography, the higher sensitivity of bone changes. Whilst at least 30% change in mineralisation is necessary to be recognised on radiographs, CT is able to show changes of 0.5%–2% (Gielen, 2016). Furthermore, even on plain CT images, soft tissues such as the spinal cord can be visualised, but for precise evaluation of possible compression sites myelograms are necessary (Gough et al., 2020; Lindgren et al., 2021; Rovel et al., 2021a,b). The major disadvantage of these procedures is the necessity of general anaesthesia for imaging the caudal cervical spine.

If abnormal findings are seen on radiographs, a further challenge is to distinguish the clinical significance of these. Arthropathy of the articular facet joints can be identified similar to osteoarthritis (OA) in other joints, by enlargement of the joint, osteophyte formation, sclerosis of the subchondral bone and undulating articular margins with the caudal joints being more commonly affected (Dimock & Puchalski, 2010; Down & Henson, 2009). However, two independent studies found only fair to substantial interobserver agreement for grading radiographic findings, and changes may be of only low-clinical relevance (Espinosa-Mur et al., 2021; Koenig et al., 2020). Horses with clinical signs showed only one sub grade difference compared to horses without clinical signs (Koenig et al., 2020),

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furthermore, in horses competing at higher levels significant higher OA grades were found (Espinosa-Mur et al., 2021). Additionally, the sensitivity and specificity for osteophytosis of the joints in horses with CVM on radiographs were only around 65% compared to necropsy (Levine et al., 2010).

That might be explained by the fact that axial enlargement of the articular processes with subsequent compression of the spinal cord can be easily identified on CT images, whilst recognising modelling at this location is challenging on radiographs (Gough et al., 2020; Lindgren et al., 2021; Rovel et al., 2021a). Similar to radiographs, degenerative joint disease was the most common abnormality and most often found in the caudal cervical spine in CT examinations. Furthermore, obliteration of the intervertebral foramina was commonly observed in horses included in these studies (Gough et al., 2020; Rovel et al., 2021a). Interestingly enough, no such impingement was found during necropsy in horses without clinical signs of neck pain or ataxia (Haussler et al., 2019), which might highlight the potential clinical relevance of these findings.

Besides bone abnormalities, soft tissue masses within the vertebral canal leading to compression of the spinal cord can be visualised on CT images (Garcia et al., 2015; Hellige et al., 2021; Lindgren et al., 2021). Neoplastic lesions can cause compression of the spinal cord but are rare in horses and prevalence in the musculoskeletal system is less than 1.5%. In a recent retrospective study, besides having included cases from multiple institutions, only 11 horses with neoplasia of the spine were found (Manso-Díaz et al., 2020). However, only lesions that were confirmed via biopsy or pathological examination were included, which could have led to underestimation of the prevalence of the disease. Nevertheless, as in the current case report of Fairburn et al., (2023) and multiple others, these lesions should be considered as a differential diagnosis in horses presenting with clinical abnormalities of the cervical spine (Biervliet et al., 2004; Fairburn et al., 2023; Kannegieter et al., 1987; Raes et al., 2014; Rodríguez et al., 1998; Zeman et al., 1989).

Whilst intervertebral disc diseases are quite commonly found in small animals (Smolders et al., 2013), they are only sparsely reported in horses (Foss et al., 1983; Furr et al., 1991; Speltz et al., 2006; Stadler et al., 1988). However, disc protrusion leading to spinal cord compression were also found in CT examinations of ataxic horses (Rovel et al., 2021b). Furthermore, recent studies have investigated the anatomical and pathological features of equine intervertebral discs as well as their appearance on magnetic resonance imaging (MRI) (Bergmann et al., 2018; Veraa et al., 2019). Similar to abnormalities of the facet joints, the caudal cervical spine appears more commonly affected and MR images provided great detail of the discs themselves. However, MRI examinations in these studies were only possible after disarticulating the spine and studies as well as facilities to image the caudal cervical spine in live horses are still lacking.

In the last decade, studies investigating abnormalities of the equine cervical spine have increased in numbers and hopefully ongoing research will shed more light on common as well as uncommon diseases of the cervical spine. Some of these studies have challenged the clinical importance of radiographic findings reported in the past and CT can help to distinguish better between clinical relevant and incidental findings. Nevertheless, due to their availability and ease of use, radiographic examinations still have their value as first line diagnostic imaging modality.

CONFLICT OF INTEREST

No conflicts of interest have been declared.

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REFERENCES

Beccati, F., Santinelli, I., Nannarone, S. & Pepe, M. (2018) Influence of neck position on commonly performed radiographic measurements of the cervical vertebral region in horses. *American Journal of Veterinary Research*, 79, 1044–1049.

Bergmann, W., Bergknut, N., Veraa, S., Gröne, A., Vernooij, H., Wijnberg, I.D. et al. (2018) Intervertebral disc degeneration in warmblood horses: morphology, grading, and distribution of lesions. *Veterinary Pathology*, 55, 442–452.

Berner, D., Brehm, W. & Gerlach, K. (2012) The influence of head and neck position on radiographic examination of the intervertebral foramina of the neck of horses on latero-lateral projection. *Pferdeheilkunde*, 28, 9–45.

Biervliet, J.V., Alcaraz, A., Jackson, C.A., Njaa, B., de Lahunta, A. & Divers, T.J. (2004) Extradural undifferentiated sarcoma causing spinal cord compression in 2 horses. *Journal of Veterinary Internal Medicine*, 18, 248–251.

Dimock, A.N. & Puchalski, S.M. (2010) Cervical radiology. *Equine Veterinary Education*, 22, 83–87.

Down, S.S. & Henson, F.M. (2009) Radiographic retrospective study of the caudal cervical articular process joints in the horse. *Equine Veterinary Journal*, 41, 518–524.

Espinosa-Mur, P., Phillips, K.L., Galuppo, L.D., DeRouen, A., Benoit, P., Anderson, E. et al. (2021) Radiological prevalence of osteoarthritis of the cervical region in 104 performing Warmblood jumpers. *Equine Veterinary Journal*, 53, 972–978.

Fairburn, A.J., Fews, D. & Mair, T.S. (2023) Acquired scoliosis of the cervical spine secondary to vertebral neoplasia in an aged pony gelding. *Equine Veterinary Education*, 35, 22, e37-e44.

Foss, R.R., Genetzky, R.M., Riedesel, E.A. & Graham, C. (1983) Cervical intervertebral disc protrusion in two horses. *Canadian Veterinary Journal*, 24, 188–191.

Furr, M.O., Anver, M. & Wise, M. (1991) Intervertebral disk prolapse and diskospondylitis in a horse. *Journal of the American Veterinary Medical Association*, 198, 2095–2096.

Garcia, E.B., Biller, D.S., Beard, L., Bawa, B., Nuth, E. & Goravanahally, M. (2015) Computed tomographic myelography of a foal with diskospondylitis and extradural spinal cord compression due to a vertebral abscess. *Equine Veterinary Education*, 27, 75–80.

Gielen, I. (2016) Basics of musculoskeletal computed tomography. In: Kirberger, R.M. & McEvoy, F.J. (Eds.) *BSAVA Manual of Canine and Feline Musculoskeletal Imaging*. 2nd edn., UK: BSAVA Gloucester. pp. 28-32.

Gough, S.L., Anderson, J.D.C. & Dixon, J.J. (2020) Computed tomographic cervical myelography in horses: Technique and findings in 51 clinical cases. *Journal of Veterinary Internal Medicine*, 34, 2142–2151.

Hahn, C.N., Handel, I., Green, S.L., Bronsvoort, M.B. & Mayhew, I.G. (2008) Assessment of the utility of using intra- and intervertebral minimum sagittal diameter ratios in the diagnosis of cervical

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vertebral malformation in horses. *Veterinary Radiology & Ultrasound*, 49, 1–6.

Haussler, K.K., Pool, R.R. & Clayton, H.M. (2019) Characterization of bony changes localized to the cervical articular processes in a mixed population of horses. *PLoS One*, 14(9), e0222989. https://doi.org/10.1371/journal.pone.0222989

Hellige, M., Warnken, T., Puff, C. & Feige, K. (2021) CT myelographic diagnosis of ligamentum flavum hypertrophy in a Warmblood gelding with progressive ataxia. *Veterinary Radiology & Ultrasound*, 62, E44–E47.

Hoffman, C.J. & Clark, C.K. (2013) Prognosis for racing with conservative management of cervical vertebral malformation in thoroughbreds: 103 cases (2002–2010). *Journal of Veterinary Internal Medicine*, 27, 317–323.

Hughes, K.J., Laidlaw, E.H., Reed, S.M., Keen, J., Abbott, J.B., Trevail, T. et al. (2014) Repeatability and intra- and inter-observer agreement of cervical vertebral sagittal diameter ratios in horses with neurological disease. *Journal of Veterinary Internal Medicine*, 28, 1860–1870.

Journée, S.L., de Meeus d'Argenteuil, C., De Maré, L., Boshuizen, B., Vanderperren, K., Journée, L.H. et al. (2019) State-of-the-Art diagnostic methods to diagnose equine spinal disorders, with special reference to transcranial magnetic stimulation and transcranial electrical stimulation. *Journal of Equine Veterinary Science*, 81, 102790. https://doi.org/10.1016/j.jevs.2019.102790

Kannegieter, N.J. & Alley, M.R. (1987) Ataxia due to lymphosarcoma in a young horse. *Australian Veterinary Journal*, 64, 377–379.

Koenig, J.B., Westlund, A., Nykamp, S., Kenney, D.G., Melville, L., Cribb, N. et al. (2020) Case-control comparison of cervical spine radiographs from horses with a clinical diagnosis of cervical facet disease with normal horses. *Journal of Equine Veterinary Science*, 92, 103176. https://doi.org/10.1016/j.jevs.2020.103176

Levine, J.M., Scrivani, P.V., Divers, T.J., Furr, M., Mayhew, I.J., Reed, S. et al. (2010) Multicenter case-control study of signalment, diagnostic features, and outcome associated with cervical vertebral malformation-malarticulation in horses. *Journal of the American Veterinary Medical Association*, 237, 812–822.

Lindgren, C.M., Wright, L., Kristoffersen, M. & Puchalski, S.M. (2021) Computed tomography and myelography of the equine cervical spine: 180 cases (2013–2018). *Equine Veterinary Education*, 33, 475–483.

Manso-Díaz, G., Malalana, F., Geburek, F., Onkels, A.-K., Marr, C., Morgan, R. et al. (2020) *Radiographic features of equine vertebral neoplasia*. In: *Proceedings ECVDI online conference 2020*, 17/18th September 2020. p 18.

Martin-Vaquero, P. & Da Costa, R.C. (2014) Evaluation of traditional and novel radiographic vertebral ratios in great Danes with versus without cervical spondylomyelopathy. *Veterinary Radiology & Ultrasound*, 55, 488–495.

Raes, E.V., Durie, I., Wegge, B., Gielen, I., Vanderperren, K. & Saunders, J.H. (2014) Imaging findings of a haemangiosarcoma in a cervical vertebra of a horse. *Equine Veterinary Education*, 26, 548–551.

Rodríguez, F., Forga, J., Herráez, P., Andrada, M. & Fernandez, A. (1998) Metastatic melanoma causing spinal cord compression in a horse. *Veterinary Record*, 142, 248–249.

Rovel, T., Zimmerman, M., Duchateau, L., Delesalle, C., Adriaensen, E., Mariën, T. et al. (2021a) Computed tomographic examination of the articular process joints of the cervical spine in warmblood horses: 86 cases (2015–2017). *Journal of the American Veterinary Medical Association*, 259, 1178–1187.

Rovel, T., Zimmerman, M., Duchateau, L., Adriaensen, E., Mariën, T., Saunders, J.H. et al. (2021b) Computed tomographic myelography for assessment of the cervical spinal cord in ataxic warmblood horses: 26 cases (2015–2017). *Journal of the American Veterinary Medical Association*, 259, 1188–1195.

Scrivani, P.V., Levine, J.M., Holmes, N.L., Furr, M., Divers, T.J. & Cohen, N.D. (2011) Observer agreement study of cervical-vertebral ratios in horses. *Equine Veterinary Journal*, 43, 399–403.

Smolders, L.A., Bergknut, N., Grinwis, G.C., Hagman, R., Lagerstedt, A.S., Hazewinkel, H.A. et al. (2013) Intervertebral disc degeneration in the dog. Part 2: chondrodystrophic and non-chondrodystrophic breeds. *The Veterinary Journal*, 195, 292–299.

Speltz, M.C., Olson, E.J., Hunt, L.M., Pool, R.R., Wilson, J.H. & Carlson, C.S. (2006) Equine intervertebral disk disease: A case report. *Journal of Equine Veterinary Science*, 26, 413–419.

Stadler, P., van den Berg, S.S. & Tustin, R.C. (1988) Cervical intervertebral disk prolapse in a horse. *Journal of the South African Veterinary Association*, 59, 31–32.

Veraa, S., Bergmann, W., Wijnberg, I.D., Back, W., Vernooij, H., Nielen, M. et al. (2019) Equine cervical intervertebral disc degeneration is associated with location and MRI features. *Veterinary Radiology & Ultrasound*, 60, 696–706.

Withers, J.M., Voute, L.C., Hammond, G. & Lischer, C.J. (2009) Radiographic anatomy of the articular process joints of the caudal cervical vertebrae in the horse on lateral and oblique projections. *Equine Veterinary Journal*, 41, 895–902.

Zeman, D.H., Snider, T.G. & Mcclure, J.J. (1989) Vertebral lymphosarcoma as the cause of hind limb paresis in a horse. *Journal of Veterinary Diagnostic Investigation*, 1, 187–188.

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