

The radiographic frequency of impingement of the dorsal spinous processes at purchase examination and its clinical significance in 220 warmblood sporthorses

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Summary: A retrospective study of 220 horses was performed to investigate the association between the clinical signs and the radiological findings of impinging dorsal spinous processes (DSPs) in warmblood sporthorses. For this purpose radiographic records were assessed to identify all horses that had undergone radiographic examination of the back as part of a pre-purchase examination between January 2009 and December 2012. The dorsal spinous processes of 239 horses were assessed and each dorsal spinous process was individually graded (0–3) using a modified 4-group grading system appropriate for routine grading of dorsal spinous processes as part of a pre-purchase examination. Fifty-five percent ($n = 121$) had no radiological abnormalities of the DSPs (grade 0). However, 26,4% had at least one DSP with grade 1 impingement, 11,8% had at least one DSP with grade 2 and 6,8% had at least one DSP with grade 3. Follow-up information was obtained by telephone responses from owners or trainers. The horses were assessed at a mean follow up time after pre-purchase examination of $25,19 \pm 12,52$ months. Based on the clinical signs included in the questionnaire answers horses were divided into two groups; i) thoracolumbar back pain and ii) no thoracolumbar back pain. Only 11,5% ($N = 23$) of the 220 horses had shown thoracolumbar back pain. There was no significant association between gender, age or discipline and clinical signs of thoracolumbar back pain. High maximum DSP grade is associated with an increased risk of clinical signs. The specificity of a grade 3 DSP on radiographic screening at pre purchase examinations is high, however the sensitivity is low. This suggests that there is a high risk of clinical signs in horses with grade 3 DSPs and no warranty can be offered for absence of clinical signs for grade 0,1,2.

Keywords: back pain / horse / kissing spines / pre purchase / radiology

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Introduction

Back-pain is a common reported cause of reduced athletic performance in horses; impingement of the thoracolumbar dorsal spinous processes (DSPs) is the most common identified cause of back pain in the thoracolumbar region with most pathology being found between the 14th thoracic and 2nd lumbar vertebrae (Crowhurst 1975, Jeffcott 1975, Jeffcott 1979, Jeffcott 1980, Marks 1985, Zimmerman 2012). For these reasons radiographic examination of the dorsal spinous processes is increasingly being included in pre-purchase examination protocols (Gerhards 2007, Mitchell 2009, Jacklin 2014). However, the clinical relevance of the radiographic changes is difficult to interpret as a result of a poor correlation between radiological findings and clinical signs (Jeffcott 1979, Holmer 2007). Impingement of dorsal spinous processes is commonly identified radiologically in horses showing no clinical evidence of pathology (Crowhurst 1975, Jeffcott 1979, Geiger 2015); 37% of 110 horses had radiographic evidence of overriding spinous processes without clinical signs of back pain. Impinging or overriding dorsal spinous processes were found post mortem in between 83% (of 23 horses) and 96% (of 36 horses) showing no clinical evidence of disease or pain (Townsend 1986, Haussler 1999). Impingement of spinous processes has also been recognized in man as Bastrup disease or kissing spines syndrome. In man the clinical significance remains unresolved (Maes 2008, Kwong 2010). Clinical signs of back-pain include reduced

performance, ill-defined lameness (particularly in the pelvic limbs), bucking, resistance to saddling and sacro-iliac pain (Jeffcott 1980, Walmsley 2002, Dyson 2003, Landman 2004, Zimmerman 2012). To our knowledge no large-scale study has been performed evaluating the association between performance and radiographically abnormal spinous processes.

The aim of this study was to investigate association between clinical signs and radiological findings of impinging dorsal spinous processes in warmblood sporthorses. It was hypothesized that the incidence of radiographic abnormalities of dorsal spinous processes would be relatively high, but its morbidity would be low. Additionally we suggested that poor performance due to back pain will be almost exclusively limited to impingement and overlapping of DSPs when combined with prominent remodeling, fusion and/or radiolucency's at the dorsal aspect of the DSPs.

Materials and methods

Case selection

Radiographic records from the equine clinic of Veterinair Centrum Someren, the Netherlands, were assessed to identify all horses that had undergone radiographic examination of

the back as part of a pre-purchase examination between January 2009 and December 2012. Horses were only included in the study if there were no relevant remarks after the clinical part of the pre purchase examination ($n = 239$). Clinical information, including breed, age, gender, work-discipline and performance level was recorded for all horses. There were 67 mares, 116 geldings and 37 stallions. All 220 horses were Warmblood sporthorses (129 Dutch Warmbloods, 11 Holsteiners, 22 Belgian Warmbloods, 5 Rheinlanders, 12 Hannoverians, 4 Swiss Warmbloods, 5 Westfalers, 16 Oldenburgers, 2 Selle Francais, 10 Zangersheide and 4 unknown). The mean age (years) was $9,26 \pm 2,78$. The disciplines were showjumping ($n=119$), dressage ($n=97$) and eventing ($n=2$). For two horses the discipline was unknown.

Pre-purchase examination

A complete clinical examination was performed on all the identified horses by one of three experienced clinicians (A.S, E.E, P.O). This included physical examination of the horse at rest, observation of the horse on a straight line at the walk and trot, observation on the lunge at walk and trot on a hard surface and walk, trot and canter on a soft surface. Palpation and flexion tests of all four limbs were performed, as were manipulative tests to the spine and pelvic region. On forelimbs lower limb flexion and carpal flexion tests were performed, on hindlimbs a combined hindlimb flexion test was performed. Horses were inspected for atrophy of epaxial muscles and abnormal curvatures (lumbar kyphosis and thoracic lordosis). Palpation of the thoracolumbar region was performed

to identify the presence of supraspinous desmopathy, deformation of spinous processes and localized tension of muscles. Movement of thoracic spine was assessed with manipulative tests: right and left thoracolumbar lateral flexion (1), thoracolumbar and lumbosacral flexion in sagittal plane (2) and thoracic flexion and thoracic extension (3).

Radiographs were acquired immediately after the clinical examination. After light sedation with detomidine (0,01–0,02 mg/kg iv) and butorphanol (0,01–0,02 mg/kg iv), direct digital latero-lateral radiographs were obtained with the horse standing squarely on all 4 limbs and the mouth of the horse at the level of the shoulder joint. Radiographs were taken right lateral to left lateral in all cases. The cassette was placed in a bucky grid to minimize the amount of radiation scatter. The exposure values varied between 85–95 kV and 160–185 mAs, depending on the size of the horse.

Radiological grading

The dorsal spinous processes of all 239 horses were assessed and graded by a qualified radiologist (K.D.) and resident (K.G.). The previous described grading systems (Pettersson 1987, Denoix 2011, Zimmerman 2011) were modified to provide a 4-group grading system appropriate for routine grading of dorsal spinous processes as part of a pre-purchase examination.

- Grade 0 – Normal interspinous space (>5 mm), with or without a rim of increased opacity of the margins, no remodeling at dorsal or cranial margins or radiolucencies (Fig. 1).

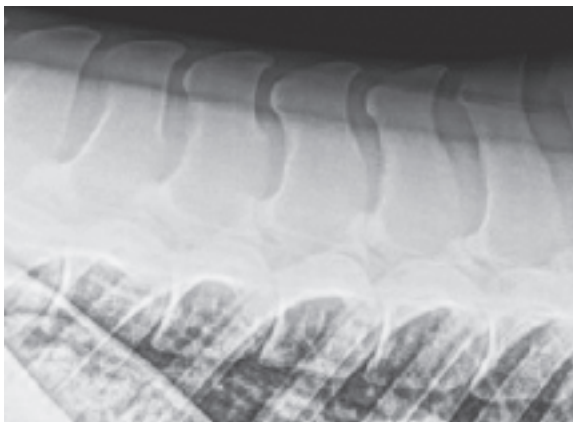


Fig. 1 Representative radiograph grade 0. *Beispiel Röntgen Grad 0*

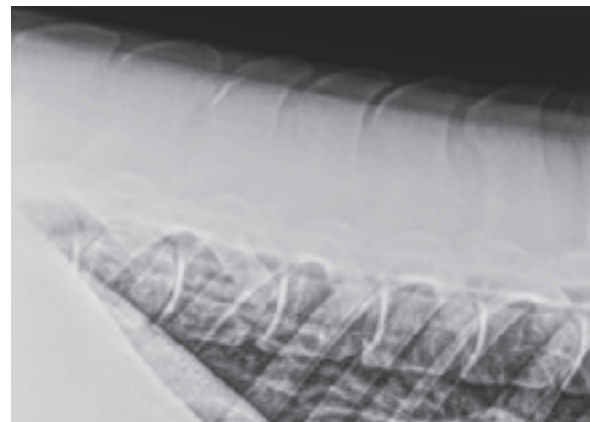


Fig. 3 Representative radiograph grade 2. *Beispiel Röntgen Grad 2*

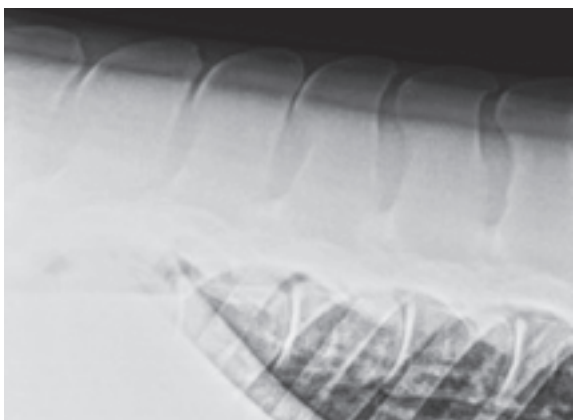


Fig. 2 Representative radiograph grade 1. *Beispiel Röntgen Grad 1*



Fig. 4 Representative radiograph grade 3. *Beispiel Röntgen Grad 3*

- Grade 1 – Narrowing of the interspinous space (<5 mm) with or without mild increased opacity of the cortical margins of the dorsal spinous processes, no remodeling at dorsal or cranial margins or radiolucencies (Fig. 2).
- Grade 2 – Impinging DSPs with moderate or severe increased opacity of the cortical margins and/or mild remodeling at the dorsal or cranial margins, without radiolucencies (Fig. 3).
- Grade 3 – Impinging or overlapping DSPs combined with (mild/moderate/severe) increased opacity, radiolucencies, severe remodeling, and/or fusion (Fig.4).

Each dorsal spinous process was individually graded on the scale 0–3. The number of abnormal DSPs in each horse was taken to be the number of DSPs >0. The maximum DSP grade was the highest individual DSP grade within each horse. The total radiographic score was the sum of all the individual grades in each horse. The maximum location is the location of the highest DSP grade.

Follow-up and data analysis

Follow-up information was obtained by telephone responses from owners or trainers. Clients were asked if the horse had shown any problems since pre-purchase examination, how often the horses competed and whether or not the horse performed as expected. They were then asked to state (yes/no) if the horse had any of a list of signs possibly indicating thoracolumbar back pain (e.g. stiffness of the back, adverse reactions when saddling, distress during riding, inconsistent shifting lameness when ridden, decreased performance). At the end of the questionnaire clients were asked if the horse had been diagnosed by a veterinarian with back problems and if these had been treated. Based on the clinical signs included in the questionnaire answers horses were divided into two groups; i) thoracolumbar back pain and ii) no thoracolumbar back pain. Horses were only categorized in group i) when the owners stated that thoracolumbar back problems were diagnosed by a veterinarian. Categorizing was done blindly, i.e. prior to and independent of the radiographic scoring.

Only horses with a known follow-up were included in the statistical analysis. Statistical analysis included descriptive summary statistics, a chi-square test and a logistic regression test. Descriptive statistics were used to describe data distribution for age,

breed, gender, discipline, follow-up time, the number of abnormal DSPs, the maximum DSP grade, the total radiographic score, the maximum location and the presence or absence of clinical signs. A chi-squared test was used to compare breed, age, gender and discipline distribution between horses with and without clinical signs. A logistic regression test was performed to test for associations and included the variables age, discipline, gender, number of abnormal DSPs, maximum DSP grade, total radiographic score and the presence or absence of thoracolumbar back pain. Significance was set at $P < 0.05$.

Results

The medical records of horses meeting the inclusion criteria ($n=239$) were evaluated. Follow-up information was available in 92% of the cases ($n=220$). Mean follow up time (months) was $25,19 \pm 12,52$. Of the 220 horses 55,0% ($n=121$) had no radiological abnormalities of the DSPs (grade 0), whereas 26,4% had at least one DSP with grade 1, 11,8% at least one DSP with grade 2 and 6,8% at least one DSP with grade 3. Data distribution and radiological findings are summarized in table 1. There was no significant association between gender, age or discipline and clinical signs of thoracolumbar back pain.

Relationship between clinical signs of back pain and the radiological findings

There was no significant correlation between the number of abnormal DSPs (Fig. 5), the total radiological score and the location of the maximum graded DSP in horses with thoracolumbar back pain compared with horses without pain. There was a significant association between the maximum DSP grade and the presence of thoracolumbar back pain ($p=0,038$), as shown in Figure 6. Comparing thoracolumbar back pain in horses with a maximum DSP grade of 0, 1 and 2 (10.7%, 1.7% and 7.7% respectively) and horses with a maximum DSP grade of 3 (46.7%) thoracolumbar back pain occurred significantly ($P < 0.05$) more in horses with a maximum DSP grade of 3 compared to horses with maximum DSP score of 0, 1 or 2. The sensitivity of a grade 3 DSP as a cause of back pain in these pre purchase examinations was 30,4%, whereas the specificity was 95,9%.

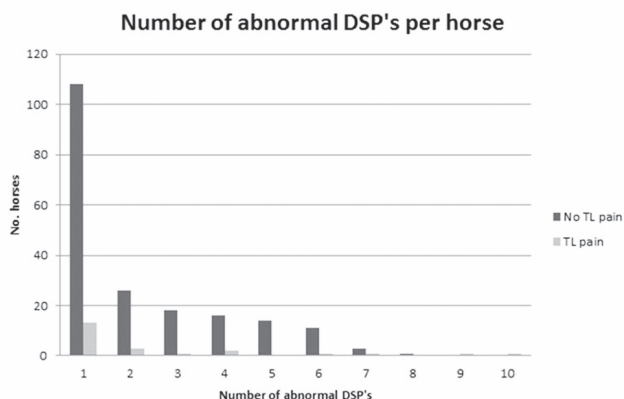


Fig. 5 The number of abnormal DSPs per horse in 220 horses with or without thoracolumbar back pain.

Zahl der anormalen DSPs pro Pferd bei 220 Pferden mit oder ohne thorakolumbalem Rückenschmerz

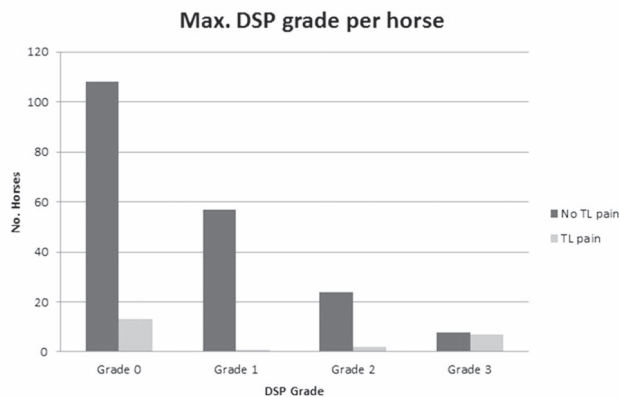


Fig. 6 The maximum DSP grade per horse in 220 horses with or without thoracolumbar back pain.

Maximaler DSP-Grad pro Pferd bei 220 Pferden mit oder ohne thorakolumbalem Rückenschmerz

Discussion

Incidence and age

In accordance with our hypotheses the incidence of radiological abnormalities of the thoracolumbar dorsal spinous processes was reasonably high. Of the 220 horses 45.0% had radiologic abnormalities of the dorsal spinous processes. A high prevalence of DSP impingement has been reported in several earlier studies in which a wide variety of abnormal findings of the DSPs was found on radiographic and scintigraphic examinations (Jeffcott 1979, Erichsen 2004, Holmer 2007). In a post-mortem study with 23 functionally normal horses 83% had impingement of the dorsal spinous processes (Townsend 1986). Another study including 36 racehorses killed on the track, showed that 92% had impingement of the dorsal spinous processes (Haussler 1999).

It is recognised that spinal movements can alter the intervertebral DSP distances (Jeffcott 1980). The intervertebral DSP distances can also be altered by changing the head and neck position of a horse (Bernier 2012). Flexion of the cranial spine and extension of the caudal spine, which is achieved by low-

ring the head position, leads to reduction of the distances between adjacent dorsal spinous processes (Bernier 2012). Penell et al. (2007) reported this effect after sedation, which is commonly used to facilitate radiography of the equine thoracolumbar spine. It is therefore important to standardize the radiologic protocol to allow comparison of radiographs between horses and between the same horses at different times. In this study radiographs of all horses were taken with mild sedation, but with the head held with the mouth of the horse at shoulder level. This standardised the intervertebral DSP distances and prevented over/under-estimation of the radiologic abnormalities of the DSPs. The location of radiologic abnormalities (mainly T14–L2) was comparable with the previous reports (Jeffcott 1979, 1980; Townsend 1986; Kreling 1996; Haussler 1999, Erichsen 2004).

The lack of association between age and impinging spinous processes in our study was comparable to some previous studies (Jeffcott 1979, Haussler 1999), but was contradictory to the result of others (Erichsen 2004, Zimmerman 2011, Geiger 2015). Zimmerman et al. (2011) found that horses with thoracolumbar pain were significantly older than those without pain.

Table 1 Gender, Age, Discipline, Follow-up and radiological findings of 220 horses that underwent radiographic examination of the thoracolumbar (TL) spine as part of a pre purchase examination.

Geschlecht, Alter, Disziplin, Verlauf und Röntgenbefunde von 220 Pferden, deren thorakolumbale (TL) Wirbelsäule im Rahmen einer Kaufuntersuchung röntgenologisch untersucht wurde

		No TL pain (n=197)	TL pain (n=23)
Gender	Mare	57	10
	Gelding	106	10
	Stallion	34	3
Age (years)	Mean	9,18 ± 2,85	9,35 ± 2,33
	<4	4	0
	5-8	81	10
	9-12	88	11
	13-18	23	2
	>18	1	0
Discipline	Showjumping	103	16
	Dressage	91	6
	Eventing	1	1
Follow-up time (mo) Mean		25,38 ± 12,56	23,61 ± 12,36
# of abnormal DSP's	Mean	1,25 ± 1,74	1,70 ± 2,74
	0	108	13
	1-3	60	6
	>3	29	4
Maximum DSP grade	Mean	0,66 ± 0,85	1,13 ± 1,39
	0	108	13
	1	57	1
	2	24	2
	3	8	7
Total radiologic score	Mean	1,57 ± 2,28	2,74 ± 4,43
	0	108	13
	1-3	49	3
	4-7	35	4
	>7	5	3
Location max DSP grade > 0	Withers (T2-T10)	1	0
	Saddle (T11-T16)	48	7
	Caudal (T17-L4)	12	3
	Saddle-Caudal (T15- T18)	28	0

Geiger et al. (2015) found that with increasing age the radiographic abnormalities increase, as was the case for an increase in bodyweight and height. To date there are no prospective studies available demonstrating the development of DSP abnormalities with age. In the studies by Jeffcott (1979, 1980) most of the horses were thoroughbreds, instead of warmbloods, the different breed and/or work discipline could explain the age differences. Progressive extension of the spine with age may also increase impingement of DSPs (Erichsen 2004) but the mean age in our study was higher than in the study of Zimmerman et al. (2012), so this alone does not explain the difference in age association between the studies, but possibly also relates to the breed and discipline of the horse. In the study by Geiger et al. (2015) the age distribution (2–31 years) was different from ours and not all breeds included were warmblood sport-horses. This may explain the difference in association between age and radiographic abnormalities.

In man a correlation between abnormalities of the spinous processes (Baastrup Disease) and age has been reported ($P = 0,001$) (Maes 2008). A decade-on-decade increase in frequency of radiologic abnormalities of the spinous processes was found by Kwong et al. (2010), with a peak in man above 80 years of age. The aetiopathogenesis is thought to be repetitive strain on the interspinous ligaments, which leads to degeneration and collapse of the ligaments, allowing contact between adjacent spinous processes (Sartoris 1985). It is suggested that Baastrup disease is part of the expected degenerative changes in the aging spine and clearly associated with other degenerative changes, such as spondylolisthesis and loss of disk width (Kwong 2010). In our study radiographic exposures were focused on clear visualization of the DSPs without accurate assessment of facet joint or vertebral body abnormalities. Therefore, concurrent pathologies were not recorded. However, Girodroux et al. (2009) documented that horses with concurrent osseous pathology (i.e. osteoarthritis of synovial intervertebral articulations or spondylosis) are more likely to have thoracolumbar pain than horses with only abnormalities of the DSPs.

In the present study only 11,5% of the horses showed thoracolumbar back pain, while 55% had radiologic abnormalities of one or more DSP, indicating that the presence of radiographic abnormalities of the DSP is poorly correlated with the presence of clinically detectable signs. This was in accordance with previous studies (Jeffcott 1980, Haussler 1999, Walmsley 2002, Henson 2009, Denoix and Dyson 2011).

Work discipline has previously been reported to significantly affect the presence of thoracolumbar pain (Zimmerman 2012). Ninety percent of flat racehorses and 85% of national hunt racehorses exhibited clinical signs, whereas 48–54% of the horses in other disciplines (dressage, showjumping, eventing or general purpose) showed signs of back pain. In our study 13.4% of showjumpers had thoracolumbar pain compared to 6,2% of the dressage horses. This difference however was not significant. In the study by Zimmerman et al. (2012) breed was significantly associated with back pain since 76% of the Thoroughbreds had back pain. All the horses in our study were warmblood sport-horses. The backs of showjumpers and dressage horses are subjected to very different demands but neither gallop at high speed for long periods of time. This has been stated as a potential cause for the high incidence in racehorses (Haussler 2001, Zimmerman 2012).

There was no significant association between the number of abnormal DSPs, the total radiologic score or the location of the maximum DSP score and the presence of clinical signs. This is in contrast with a previous study that reported that horses with clinical signs had significantly more abnormal DSPs and the total radiologic score was higher (Zimmerman 2012). Another study, compared horses that required surgical intervention for treatment of impingement of DSP with horses that received conservative (medical) treatment and showed that the total radiographic grade per case was significantly higher in the surgical group than in the medical group (Coomer 2012).

The maximum DSP grade was significantly associated with the presence of clinical signs ($P = 0,001$). Forty-eight percent of horses with a maximum score of 3 had thoracolumbar pain, compared to 8% of horses with maximum grade 0,1 or 2. This is supported by the study of Zimmerman et al. (2012). They found that higher radiographic (and scintigraphic) grades were associated with thoracolumbar pain, although abnormalities were also detected in horses without back pain. The specificity of radiographic grade 3 was high (95,5%) and the sensitivity low (30,4%). This suggests that there are only a few false positive grade 3 cases, but many false negative grade 0,1 and 2. For pre-purchase examination purposes this implies a high performance risk of grade 3 and no warranty of soundness for grade 0, 1 and 2.

In man the clinical significance of impingement of spinous processes also remains unclear. The potential of impingement to cause back pain has been described (Lin 2008, Lamer 2008). However, in a study by Beks (1989) with 64 patients that were treated with surgical excision of the abnormal spinous processes, the outcome was disappointing. Only 17% of the patients were free of complaints after surgery. Several studies (Beks 1989, Maes 2008, Kwong 2010) urge caution before diagnosing impingement of spinous processes as the cause of back pain. Based upon our study this suggestion also applies to equine warmblood athletes and illustrates the necessity to prove a causal relationship between the radiologically identified DSP changes and clinical complaints. This was a population of warmblood sport horses that were routinely radiographed in a standard manner during pre-purchase examination and therefore may not be representative for an average warmblood population. It is likely that horses exhibiting signs of back pain and/or lameness would not have been presented for examination; this may have resulted in an underestimation of horses with clinical signs of thoracolumbar pain. The follow-up relied upon a telephonic questionnaire and was therefore reliant upon information perceived by the owner or trainer of the horse. This may have resulted in false negatives or false positives. Follow-up examination by a veterinarian might have been somewhat more reliable. Only abnormalities to the dorsal spinous processes were examined at in this study, however concurrent bone and joint pathologies may also have an effect on the clinical signs of back pain.

Conclusions

This study confirms our hypothesis that the incidence of radiographic abnormalities of dorsal spinous processes is high, but that its morbidity is low. Clinical signs due to thoracolumbar back pain are predominantly associated with grade 3 abnor-

malities. The specificity of a grade 3 DSP on radiographic screening at pre-purchase examinations is high, however the sensitivity low.

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Erweiterte Zusammenfassung

Häufigkeit der anlässlich einer Ankaufsuntersuchung röntgenologisch diagnostizierten "sich berührenden Dornfortsätze und die klinische Signifikanz bei 200 Warmblutsporthengsten

Rückenschmerzen bedingen beim Sportpferd häufig eine verminderte Leistungsfähigkeit und sich berührende thorakolumbale dorsale Dornfortsätze (kissing spines, DFSs) sind oft auslösend. Pathologische Befunde werden in der Regel im Bereich zwischen dem 14. Brustwirbel und 2. Lendenwirbel erhoben. Aus diesem Grund werden bei Ankaufsuntersu-

chungen immer häufiger Röntgenaufnahmen der Dornfortsätze dieses Bereichs angefertigt. Die klinische Relevanz der Befunde ist umstritten, da zwischen radiologischen und klinischen Befunden nur eine geringe Korrelation besteht. Sich berührende dorsale Dornfortsätze werden oft bei klinisch unauffälligen Pferden röntgenologisch diagnostiziert. Die Studienergebnisse variieren, 37% bis zu 96% der untersuchten Pferde zeigten entsprechende Röntgenbefunde ohne klinische Anzeichen. Für Rückenschmerzen charakteristische Symptome umfassen reduzierte Leistung, Hinterhandslahmheiten sowie sakro-iliakale Schmerzen. Ziel dieser Studie war die Assoziation zwischen klinischen Symptomen und radiologischen Befunden der dorsalen Dornfortsätze bei Warmblutsporthpferden zu beurteilen. Es wurde angenommen, dass die Inzidenz von radiologischen Befunden relativ hoch sei, deren Morbidität allerdings gering. Des Weiteren nahmen die Autoren an, dass eine Reduzierung der Leistungsbereitschaft aufgrund von Rückenschmerzen bei sich berührenden und überlappenden Dornfortsätzen nur dann auftritt, wenn gleichzeitig ein deutliches Remodeling, eine Fusion und/oder Rarefizierung im dorsalen Bereich des DSF zu beobachten sei.

Für die Studie wurden Röntgenaufnahmen des Rückens angefertigt im Rahmen einer Ankaufuntersuchung aus den Jahren 2009 bis 2012 erneut befundet. Die Studienpopulation umfasste 239 Pferde, welche bei der durchgeführten Ankaufuntersuchung keine klinisch relevanten Befunde aufwiesen. Die Ankaufuntersuchung umfasste eine Untersuchung in Ruhe, sowie im Schritt und Trab sowohl auf der Geraden auf harten Boden als auch in der Wendung auf harten und weichen Boden. Palpation und Beugeproben der Vorder- und Hintergliedmaßen erfolgten ebenfalls, als auch Adspektion, Palpation sowie manipulative Untersuchungen der Brust- und Lendenwirbelsäulenregion. Bei diesen manipulativen Tests wurden die thorakolumbale Lateroflexion, thorakale Extension sowie Flexion als auch die thorakolumbale und lumbosakrale Flexion in sagittaler Ebene geprüft. Die Röntgenaufnahmen wurden unter leichter Sedation, alle vier Gliedmaßen voll belastend, mit Maul auf Höhe des Schultergelenks im latero-lateralen Strahlengang aufgenommen. Zur Verringerung der Streustrahlung wurde ein Streustrahlenraster eingesetzt. Die Beurteilung der Aufnahmen erfolgte über ein Graduierungsschema (0–3), bei welchem Grad 0 einem interspinalen Abstand von < 5 mm ohne weitere Veränderungen der DFSs entsprach. Bei Grad 1 war dieser Abstand verringert und mit oder ohne geringgradiger erhöhter Röntgendichte an den kortikalen Ränder des DFS, ohne Remodeling an den dorsalen oder kranialen Ränder oder Rarefizierung kombiniert. Der Grad 2 entsprach sich berührenden DFSs mit mittelgradigen Veränderungen der kortikalen Ränder und/oder geringgradigem Remodeling an

den dorsalen oder kranialen Randbereichen ohne Rarefizierung. Bei Grad 3 lagen sich berührende oder überlappende DFSs vor in Kombination mit mindestens mittelgradig erhöhter Strahlendichte, Rarefifikationen und hochgradigem Remodeling der DFS-Ränder und/oder Fusion. Jeder DFS wurde individuell graduiert. Der totale röntgenologische Score entsprach der Summe aller individuellen Grade jedes Pferdes. In die statistische Auswertung wurden nur Pferde aufgenommen, bei welchen eine Verlaufsinformation telefonisch erfolgt war. Diese Befragung wurde ohne Wissen um die Röntgenbefunde durchgeführt und umfasste Fragen zu Leistung, Auftreten von Rückenschmerzen entsprechenden Symptomen, Konsultation eines Tierarztes aufgrund von Rückenschmerzen und Fragen zu etwaiger Therapie. Aufgrund der Antworten erfolgte eine Gruppeneinteilung der Tiere.

Von 92% der untersuchten Pferde konnte nach durchschnittlich $25,19 \pm 12,52$ Monaten ein Follow-Up erhoben werden. Es handelte sich um 67 Stuten, 116 Wallache und 37 Hengste mit einem durchschnittlichen Alter von $9,26 \pm 2,78$ Jahren. Bei 55% der Pferde lagen keine radiologischen Veränderungen (Grad 0) der DFSs vor, bei 26,4% wurde bei mindestens einem DFS Veränderungen entsprechend des Grad 1 diagnostiziert, bei 11,8% des Grad 2 und bei 6,8% der Pferde zeigte mindestens ein DFS Veränderungen entsprechend des Grad 3. Es lag keine Korrelation zwischen Geschlecht, Alter, Leistungsrichtung oder klinischen Symptomen vor. Ebenso konnte keine signifikante Korrelation zwischen Anzahl der veränderten DFSs, dem totalen radiologischen Score und der Lokalisation der DFSs mit höchstem Grad bei Pferden mit thorakolumbalen Schmerzen im Vergleich zu solchen ohne Schmerzen nachgewiesen werden. Es zeigte sich eine Korrelation zwischen der höchsten Graduierung der DFSs und dem Vorhandensein von thorakolumbalen Schmerzen. Pferde mit Veränderungen entsprechend Grad 3 wiesen zu 46,7% thorakolumbale Rückenschmerzen auf, bei Veränderungen des Grad 0 zu 10,7%, des Grad 1 zu 1,7% und des Grad 2 zu 7,7%. Somit hatten Pferde mit Veränderung des Grad 3 signifikant öfter Rückenschmerzen. Die Sensitivität des Grad 3 als Ursache für Rückenschmerzen lag bei 30,4% und die Spezifität bei 95,9%. Pferde dieser Untersuchung zeigten zu 11,5% thorakolumbale Rückenschmerzen. Gleichzeitig wiesen 55% radiologische Veränderungen bei mindestens einem DFS auf. Die Ergebnisse zeigen, dass die Inzidenz von röntgenologischen Befunden der DFSs hoch ist, die Morbidität allerdings gering. Klinische Symptome entsprechend thorakolumbalen Rückenschmerzen waren in erster Linie mit Veränderungen des Grad 3 korreliert. Die Spezifität dieser bei einer Ankaufuntersuchung erhobenen Befunde war hoch, die Sensitivität dagegen niedrig.