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Research Article

A Retrospective Review of Physiotherapy Findings in Thoroughbred Racehorses with Confirmed Diagnoses of Impinging Dorsal Spinous Processes

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Abstract

Background: Overriding or impinging dorsal spinous process' is the most common diagnosis of primary back pain in the sports horse population with confirmed links to loss of performance. Racehorses may be predisposed to this condition due to the nature of the work performed from a young age.

Objectives: The current study aimed to establish whether 5 non-invasive clinical assessment measures routinely used within physiotherapy were able to predict underlying symptomatic overriding dorsal spinous processes (ORDSP) or osseous pathology prior to confirmation via veterinary diagnostics.

Study Design: This study was conducted as a retrospective study of 11 horses treated between September 2018 and April 2019. Horses were in training at stables in the Sydney metropolitan area.

Methods: Physiotherapy assessment comprised 5 objective measures inclusive of epaxial and hindlimb atrophy scores (0 - 3 via modified muscle condition score WSAVA), lumbopelvic flexion (inclinometer measurements), thoracolumbar epaxial pressure algometry scores (Wagner Pain Test scores Kgf/cm2), presence of dorsal spinous pain (DSP) (yes/no), presence of hindlimb asymmetry (yes/no) as well as performance reports from Racing New South Wales (0 - 2 race ratings). Veterinary diagnostics utilising 1 or a combination of ultrasonography, radiography or scintigraphy were employed post physiotherapy assessment to either confirm or deny the presence of ORDSP or osseous pathology.

Results: The 5 objective measures were not statistically significant when employed independently for detecting the presence of ORDSP. Collectively, the 5 measures did, however, identify pathological osseous changes in all 11 horses. Although not specific for ORDSP, the 5 measures may provide improved objective sensitivity to inform clinical assessment of performance limiting back pain in the racehorse.

Main Limitations: Results should be interpreted as indicative given the small sample size and the retrospective nature of objective data collection. Furthermore, sampling bias may have occurred due to including horses only from stables that are routinely serviced by both physiotherapists and veterinarians.

Conclusion: Despite veterinary diagnostics providing information regarding pathoanatomical issues and metabolic activity of osseous lesions, the inclusion of physiotherapy assessment may provide further objective information regarding pain and function.

Keywords: Horse; Thoroughbred; Racehorse; Imaging; Spinous Process; Kissing Spines; Physiotherapy

Introduction

Thoracolumbar back pain affecting the equine athlete is known to be a common cause of poor performance; but its diagnosis and management within the racehorse population provides a challenging environment for both veterinarians and veterinary physiotherapists [1-5]. Narrowing, impinging or overriding dorsal spinous process' (ORDSP) is the most common diagnosis of primary back pain in the sports horse population [6]. Abnormal findings such as; narrowing of the interspinous spaces, enthesophytes and increased radio pharmaceutical uptake are common findings within horse populations both with and without clinical signs of thoracolumbar back pain [7]. Despite poor correlation between diagnostic imaging results and clinical signs of thoracolumbar back pain diagnostics inclusive of scintigraphy, radiography and ultrasonography remain the methods of choice to confirm the presence of such lesions [8,9]. A combination of physiotherapy objective findings in conjunction with veterinary diagnostics may improve the gap between differentiating horses with clinical, performance limiting signs of back pain and those with incidental findings.

To our knowledge there has been no physiotherapy specific study investigating the relationship between objective assessment findings and diagnostic imaging results in relation to racehorses with performance limiting thoracolumbar back pain. Current physiotherapeutic clinical practice recognises that although horses are increasingly diagnosed with ORDSP, the management of this condition within the racehorse population is underestimated. The aims of this study were to A) Establish whether 5 non-invasive clinical assessment measures were able to predict underlying symptomatic ORDSP, inclusive of 1) muscle atrophy scores, 2) pelvic rounding measurements, 3) pressure algometry scores, 4) presence of dorsal spinous process (DSP) pain upon palpation and 5) hindlimb gait asymmetry. Recent racing performance was also noted. B) Prior to diagnosis of ORDSP performed by a qualified experienced veterinarian using either radiography, ultrasonography, scintigraphy or a combination of the three diagnostic tools. It was hypothesised that horses with clinical signs of thoracolumbar back pain would exhibit epaxial and upper hindlimb muscle atrophy, reduced thoracolumbar flexion, lower mechanical nociceptive threshold (MNT) scores upon pressure algometry testing, central DSP pain and hindlimb gait asymmetry. This was correlated with recent racing performance as it was the authors suggestion that performance would decline in those horses with symptomatic ORDSP. Furthermore, the frequency of horses diagnosed with ORDSP was expected to be higher than the occurrence of other osseous pathology found within this group.

Materials and Methods

Case selection

Thoroughbred racehorses were retrospectively selected from the case notes of patients treated by the principal investigator (H.B) between September 2018 and April 2019. Clinical information including age and gender were recorded for all horses (n = 11). All cases were in current training at racing stables located within the Sydney metropolitan region, Australia. Horses were identified and referred to the treating physiotherapist as having 'back pain' via rider complaint such as dipping when mounting, high head carriage and reluctance to increase speed during pace work; or behavioural complaint from ground staff such as biting, kicking, ear pinning and tail swishing when grooming and saddling. Performance was crosschecked via obtaining ratings as race results for each horse from the Racing New South Wales website and recorded as stable (2), variable (1) or declining (0). The authors acknowledge that broad inclusion criteria were employed, owing to the difficulty in both accessing horses in work who have obtained veterinary diagnostics, as well as the costs involved.

Clinical examination

All horses were examined by the principal investigator (H.B) who carried out the objective methods in the same order as per part of routine physiotherapy clinical assessment for back pain to ensure standardisation between cases.

Horses were first examined statically in their box/stall at least 4 hours post exercise to allow for adequate recovery. Muscle atrophy was assessed and graded from 0 - 3 utilising a modified muscle condition score WSAVA (with 0 normal, 1 mild, 2 moderate and 3 severe) for gluteal, biceps femoris, semimembranosus, semitendinosus and thoracolumbar epaxial muscle groups included [10]. Photographs were taken of each horse standing squarely in their box/stall from directly behind and from each side to allow for increased objectivity and cross referencing between each horse.

Manual palpation of the DSP's was then undertaken to determine if any segments of the thoracolumbar spine were more prominent than others due to possible pain mediated, segmental muscle atrophy as well as detection of osseous sensitivity to pressure. Palpation pressure was applied starting at the withers and progressing centrally to the lumbosacral junction. A yes/no response was then assigned for each horse with respect to presence of pain determined via local fasciculation of the epaxial musculature, dipping away from palpation pressure, attempting to kick/bite as a pain response and not behavioural or aversion tactics from the horse.

Horses were then assessed for their response to direct epaxial muscular pressure using the 1 cm^2 rubber tip Wagner Pain test algometer FPX 100. Modified criteria as discussed by Varcoe-Cox and colleagues [11] was employed, which included 12 locations in total, 6 on either side of the spine. Location 1 was measured and marked with chalk 5 cm lateral to both the left and right tuberscarale. Location 2 was marked 10 cm cranial to location 1 and 10 cm lateral to the dorsal spinous process' to ensure that each equivalent point was located within the epaxial musculature. This system was repeated for locations 3 - 6 respectively on both the left and right. Pressure measurements were obtained in the horses' box/stall at least 4 hours post exercise to allow for adequate muscular recovery. Measurements were repeated 3 times respectively at each point and averaged to obtain 1 score for that point. The pressure algometer was held perpendicular to the point marked, with the pressure slowly increased over a 2 second period to ensure a constant pressure rate until fasciculation, spasm or discomfort (moving away, turning to look, bite or kick) was noted. All readings recorded by a second investigator in kgf/cm^2, with the principal investigator carrying out the manual testing to allow for standardisation.

Active range of motion was subsequently tested for by measuring lumbopelvic flexion in relation to a pelvic rounding response in horses standing squarely on an even surface. Measurements were recorded by a second investigator whilst the principal investigator stood directly behind the horse and elicited a pelvic rounding reflex response via direct, constant pressure to each side of the horses tubersacrale progressing down the hamstring complex simultaneously on either pelvic limb at a constant speed until maximum lumbopelvic flexion was obtained. The second investigator was also responsible for holding an inclinometer (digital bubble inclinometer) calibrated to 0 degrees between the tubersacrale to maintain a standardised location for measurements. The amount of lumbopelvic flexion in degrees was measured and recorded. Measurements were repeated 3 times and averaged to allow for improved objectivity and accuracy of measurement.

Gait assessment was then carried out. Each horse was assessed via trotting on a firm surface, in a straight line away from the investigator and then returning. Horses involved in this study were assigned either a yes or no if a hindlimb gait asymmetry/lameness was detected. Descriptive gait irregularities were also recorded, such as plaiting. No grading scale was utilised due to the retrospective nature of the study.

Veterinary diagnostics

Post physiotherapy assessment, veterinary diagnostics were carried out by the treating veterinarian as per routine clinical protocol for the stables included. Choice of diagnostics utilised was determined by the treating veterinarian at the time of investigation. Scintigraphy was cost prohibitive and was only employed for 1 horse within this study upon trainer/owner discretion. All other horses received either ultrasonography and/or radiography to determine the presence of thoracolumbar osseous pathology. Radiography and scintigraphy are both routinely utilised in the diagnosis of ORDSP, however, ultrasonography has also been shown to be cost effective, safe and effective in detecting ORDSP, osseous lesions as well as ligamentous pathology [7,12,13]. Thus, the treating veterinarian utilised ultrasonography alone to investigate 6 horses, radiography alone to investigate 3 horses, a combination of radiography and ultrasonography to investigate 1 horse, and a combination of ultrasonography and scintigraphy to investigate the remaining horse. An osseous grading scale for ORDSP was not utilised by the treating veterinarians, which limited reporting of osseous pathology detected to location, number and type of lesions. This information was recorded from both the images collected and reports provided. Horses found to exhibit a positive diagnosis of ORDSP (8/11) were compared to horses without ORDSP (3/11) post veterinary diagnosis. Given the unbalanced nature of the 2 groups, an improved control group is needed for future comparisons.

Results

Veterinary diagnostics

The veterinary diagnostics determined that of the 11 horses included within this study 73% were found to exhibit ORDSP, a subgroup of 45% of these horses found to exhibit both ORDSP and concurrent articular osseous pathology (Refer to table 1). Furthermore, 37.5% of those horses diagnosed with ORDSP exhibited lesions affecting between 6 - 10 DSP levels; which is in keeping with a study conducted by Zimmerman., *et al.* (2011) [7] who reported findings of 40% of thoroughbreds with 6-10 DSP's affected.

The remaining 27% of horses were diagnosed with articular osseous pathology only. Given that veterinary diagnosis was obtained after physiotherapy assessment was performed the positive diagnosis of osseous pathology in all of the horses included for symptomatic back pain analysis is a promising sign for the clinical applicability of the objective outcomes used within this study for determining the presence of osseous pathology.

Physiotherapy variables

The relationship between ORDSP and the categorical variables were explored using tabulation analyses. Overall statistical testing of the relationship for categorical variables was performed using a Fisher's exact test. This testing method was deemed appropriate for these variables given the small sample size of 11 horses, some cells in the table may be expected to contain either less than 5 or in some cases zero observations.

For continuous variables (pelvic rounding reflex and algometry scores) logistic regression was used due to the small sample size and the response variable is binary (ORDSP or No ORDSP).

Overall, the statistical testing within this study can only be considered indicative. A larger sample would be needed for reliable results. In summary, the statistical tests conducted with this sample are likely to be underpowered. However, the authors believe that they provide a solid grounding for further studies with larger sample sizes.

Lameness

Of the horses with no ORDSP only 33% were found to exhibit a hindlimb asymmetry, in comparison to 75% of the horses with a positive ORDSP diagnosis (Refer to appendix 1). These results, however, are not statistically significant (Fisher's exact p value = 0.49). Furthermore, objective record keeping noted that hindlimb plaiting was the most prevalent descriptor assigned to the horses with ORDSP (Refer to table 1).

Horse	Gender	Age	Hindlimb Gait Asymmetry	Atrophy	Pelvic rounding reflex and degrees of range	Presence of central DSP pain	ORDSP diagnosis	Amount/type of lesions identified	Diagnosis method	Racing Performance
Horse 1	Gelding	3	Yes Plaiting	2/4	8 degrees	Yes	Yes	Yes ORDSP T14,15, 16, 17	Ultrasound - 1 Radiography - 2	Declining - 0
Horse 2	Filly	4	Yes I/T offhind	2/4	14 degrees	Yes	Yes	Yes ORDSP T14, 15, 16, 17, 18 Sclerotic change Articular osteophytes T15, 16	Ultrasound - 1 Scintigraphy - 3	Variable - 1
Horse 3	Filly	3	Yes Plaiting	3/4	11 degrees	Yes	Yes	Yes ORDSP T13,14, 15, 16 Articular osteophytes T13, 14, 15, 16	Ultrasound - 1	Declining - 0
Horse 4	Filly	3	No	3/4	18 degrees	Yes	No	No ORDSP Significant articular osteophytes T16,17,18	Ultrasound - 1	Stable - 2
Horse 5	Filly	3	No	3/4	12 degrees	Yes	No	No ORDSP Significant articular osteophytes T13, 14, 15, 16, 17,	Ultrasound - 1	Variable - 1
Horse 6	Filly	3	Yes I/T offhind	1/4	19 degrees	No	Yes	Yes ORDSP T14, 15, 16, 17, 18, L1	Ultrasound - 1	Stable - 2
Horse 7	Gelding	5	No	3/4	14 degrees	Yes	Yes	Yes ORDSP T13, T14, 15, 16, 17, 18 Sclerotic change and articular osteophytes T17, 18	Radiography - 2	Stable - 2
Horse 8	Filly	3	Yes Plaiting	2/4	18 degrees	Yes	Yes	ORDSP T13, 14, 15, 16, 17, 18 Sclerotic change and articular osteophytes T16, 17, 18	Radiography - 2	Declining - 0
Horse 9	Gelding	3	No	2/4	14 degrees	Yes	Yes	ORDSP T14,15, 16, 17, 18	Radiography - 2	Declining - 0

Horse 10	Filly	3	Yes Plaiting	2/4	14 degrees	Yes	No	No ORDSP Articular osteophytes T14, 15, 16	Ultrasound - 1	Stable - 2
Horse 11	Filly	2	Yes Plaiting	2/4	17 degrees	Yes	Yes	ORDSP T13, 14, 15, 16, 17 Articular osteophytes T16, 17	Ultrasound - 1	Stable - 2

Table 1

Atrophy

Of the horses who exhibited articular pathology and no ORDSP, most (2 out of the 3) displayed level 3 atrophy (Refer to appendix 2). Despite no ORDSP diagnosis, these horses were found to exhibit articular pathology with articular process osteophytes being present at multiple levels bilaterally for all 3 horses. This finding is interesting given that osseous pathology was still evident. As such, more severe atrophy may be representative of pain inhibition and disuse in these individuals than the ORDSP group (Fisher's exact p value = 0.636).

Interestingly, this data suggests that horses diagnosed with ORDSP primarily exhibit level 2 atrophy (Refer to appendix 2). Given that this was a one point in time study, it is difficult to determine whether affected horses would display increased atrophy scores over time; or whether moderate atrophy of the epaxials and hindlimb musculature is a hallmark sign of underlying, symptomatic ORDSP's in the active racehorse.

Presence of DSP Pain (binary Yes/No)

Of the horses within this sample, 10/11 horses were found to be suffering from central DSP pain (Refer to appendix 3). There is clearly no relationship between the presence of ORDSP and DSP pain within this sample (Fisher's exact p value = 1.000). Although this finding is not sensitive for determining the presence of ORDSP, it may be suggested that it is specific for indicating the presence of osseous spinal pathology. This finding is interesting given that palpation of the DSP's to ascertain the presence of central back pain is often employed as an initial objective assessment.

Racing performance (categorical variable with 3 levels)

With regards to performance, 50% of horses with ORDSP were showing a decline in their racing performance at the time of physiotherapy assessment, compared to the horses showing no decline in the No ORDSP group (Refer to appendix 4). This result, however, is not statistically significant (Fisher's exact p value = 0.33). Nonetheless, the results may be indicative that horses with ORDSP's may be more likely to perform poorly under race conditions than those with articular osseous pathology.

Pelvic rounding reflex (degrees of range)

The set of variables used to examine both pelvic rounding and pressure algometry scores were quantitative and were summarised by means, medians, SD, upper quartiles (Upper Q) and lower quartiles (Lower Q). As the response variable is binary (ORDSP and No ORDSP), a univariate logistic regression was used to assess the relationship between the continuous independent variable and the binary response. The logistic regression chi square was used to assess the overall relationship.

The descriptive statistics shown in appendix 5 clearly shows that there are no differences between the two groups in terms of pelvic rounding reflex for this sample with almost equal means and medians found (Means = No ORDSP 14.67 - Yes ORDSP 14.75; Medians = No ORDSP 14.0 - Yes ORDSP 14.0). This result could be due to both groups exhibiting limited ability to flex through both the thoracolumbar and lumbosacral spine which may be due to the underlying osseous changes, nonetheless no statistical significance was found (P value = 0.9).

Algometry scores for 6 locations

The descriptive statistics for the algometry scores consisted of a total of 12 scores comprising 6 different locations, each with a left and right value (Refer to appendices 6.1 and 6.2).

None of the Logistic regressions were found to be statistically significant. However, horses with a negative ORDSP diagnosis did appear (for most algometry locations) to show lower scores. This difference was most marked for location 5 (right) and location 2 (bilaterally). These findings are only indicative and within a small sample group, leading to a finding by chance; or the MNT differences may reflect tissue sensitivity with increasing proximity to articular osseous pathology in conjunction with more severe atrophy scores.

Discussion

Thoroughbred racehorses are a unique subgroup of the performance horse population who appear to be at risk of developing symptomatic performance limiting ORDSP and concurrent osseous pathology [7] especially when considering that all 11 horses included in this study exhibited thoracolumbar osseous pathology. Although, the objective measures considered were not statistically significant for detecting ORDSP in isolation, leading the authors to reject the null hypothesis. They may provide improved objective sensitivity to inform a collective clinical framework for assessing performance limiting thoracolumbar pain in the racehorse, in conjunction with veterinary diagnostics.

The authors believe that screening early within the racing preparation should be performed. Particularly as racehorses are relatively young in comparison to older sports horses who have been found to exhibit similar performance limiting osseous changes [14]. This may provide a clearer clinical picture regarding the onset and progression of ORDSP and concurrent osseous pathology in the racehorse population. In conjunction with, monitoring whether the cumulative effects of training a physically immature horse or spikes in training load from repetitive thoracolumbar flexion and extension at high speeds are considered to be provocative or contributory to progression of the osseous disease process [7,8].

The veterinary diagnostics indicated that the caudal thoracic spine was most affected by ORDSP lesions, particularly between the levels of T14-17 which is in agreeance with previous findings [7]. Interestingly 5 horses were found to exhibit ORDSP; lesions caudal to T17; these horses also displayed more severe atrophy scores of the epaxial and hindlimb musculature in conjunction with descriptive gait abnormalities. As such, larger sample sizes need to be obtained to determine whether there is a relationship between the subgroup of horses displaying caudal thoracic and lumbar lesions, atrophy and intermittent offhind lameness/plaiting at the trot. Furthermore, a relationship was also noted within 45% of the horses involved in this study who were found to exhibit both ORDSP's and concurrent osseous pathology. Which is important given that concurrent osseous lesions inclusive of articular process osteophytes has been correlated by other studies to coexist with the presence and number of ORDSP's [7,8].

Additionally, the results of this study may indicate that for horses with ORDSP racing performance is more limited than for those with articular osseous pathology despite the later exhibiting more pronounced muscular atrophy. As such, the presence of axial osseous pathology within this population of racehorses may impact upon performance capacity due to the accumulative influences of hindlimb gait asymmetry, decreased nociceptive thresholds upon palpation and increased spinal stiffness leading to negative behavioural traits whilst under saddle rather than one particular physical deficit in isolation. This is in keeping with human research into low back pain, indicating that spinal pain is multifactorial; often existing without one specific structure being found responsible for an individual's pain and dysfunction [15]. At present, the diagnosis and treatment of equine back pain in the racehorse appears to be approached via a reductionist biomedical manner, however a sports medicine team approach inclusive of veterinarians, physiotherapists and farriers would be better placed to address equine athletic dysfunction [16].

Limitations of the Study

Given that this was a referral population of horses treated within proactive metropolitan stables regularly serviced by veterinarians and veterinary physiotherapists, this group may not be reflective of the entire equine racing population. Furthermore, results should be interpreted with care given the small sample size and the retrospective nature of objective data collection. The 11 horses included in this study were referred due to the 'perception' they were exhibiting back pain, as such some horses may not have been identified as they may not have been perceived by the stable staff to exhibit any issues. Furthermore, the authors acknowledge that comparisons utilising a control group as well as subgroups including ORDSP, ORDSP + osseous pathology, osseous pathology only, myopathy/muscle pain (primary or secondary), supraspinous ligament strain and lame only (+/- secondary back pain) would be preferable for future studies.

Conclusion

Despite veterinary diagnostics being able to provide information regarding potential structural issues and metabolic activity of osseous lesions, the inclusion of physiotherapy assessment may provide further objective information regarding pain and function for that individual [14]. As such, a sports medicine team approach highlighting diagnostic abnormalities in conjunction with coinciding clinical signs of symptomatic ORDSP may be more appropriate in determining which individuals require further management and which are coincidental findings upon diagnostic imaging.

Future research into clinical patterns of symptomatic ORDSP in larger populations with better subgrouping including a control group is needed in order to elucidate the clinical applicability and repeatability of the 5 physiotherapeutic assessments within the racehorse population. In doing so, the creation of clinical pattern recognition of racehorses with primary back pain may afford clinicians the ability to identify affected individuals leading to earlier veterinary diagnostics and, thus intervention [17].

Acknowledgements

Randwick Equine Centre and Dr David Garth from Sydney Equine Practice.

Appendix 1

The following appendix illustrates the relationship between ORDSP and Lameness.

| Key |
| frequency |
| row percentage |
| column percentage |

ORDSP	Lameness: No	Lameness: Yes	Total
No	2	1	3
	66.67	33.33	100.00
	50.00	14.29	27.27
Yes	2	6	8
	25.00	75.00	100.00
	50.00	85.71	72.73
Total	4	7	11
	36.36	63.64	100.00
	100.00	100.00	100.00

Fisher's exact = 0.491

Figure 1

Appendix 2

The following appendix illustrates the relationship between ORDSP and Atrophy.

Appendix 3

The next appendix illustrates the relationship between ORDSP and Presence of DSP pain.

Appendix 4

The next appendix illustrates the relationship between ORDSP and Racing Performance as ratings.

| Key |
| frequency |
| row percentage |
| column percentage |

ORDSP	Atrophy: 1	2	3	Total
No	0	1	2	3
	0.00	33.33	66.67	100.00
	0.00	16.67	50.00	27.27
Yes	1	5	2	8
	12.50	62.50	25.00	100.00
	100.00	83.33	50.00	72.73
Total	1	6	4	11
	9.09	54.55	36.36	100.00
	100.00	100.00	100.00	100.00

Fisher's exact = 0.636

Figure 2

| Key |
| frequency |
| row percentage |
| column percentage |

ORDSP	DSP Pain: No	Yes	Total
No	0	3	3
	0.00	100.00	100.00
	0.00	30.00	27.27
Yes	1	7	8
	12.50	87.50	100.00
	100.00	70.00	72.73
Total	1	10	11
	9.09	90.91	100.00
	100.00	100.00	100.00

Fisher's exact = 1.000

Figure 3

```
| Key          |
| frequency    |
| row percentage  |
| column percentage |

      |     Performance
ORDSP | Declining   Stable  Variable |   Total
----------+-----------------------------------+----------
   No |     0        2        1 |      3
      |   0.00    66.67    33.33 |  100.00
      |   0.00    40.00    50.00 |   27.27
----------+-----------------------------------+----------
  Yes |     4        3        1 |      8
      |  50.00    37.50    12.50 |  100.00
      | 100.00    60.00    50.00 |   72.73
----------+-----------------------------------+----------
Total |     4        5        2 |     11
      |  36.36    45.45    18.18 |  100.00
      | 100.00   100.00   100.00 |  100.00
   Fisher's exact =          0.333
```

Figure 4

Appendix 5

The next appendix illustrates the degree of pelvic rounding between the two groups of ORDSP and No ORDSP.

```
-------+----------------------------------------------------
   No |  14.67   3.06    14.0    12.0    18.0
  Yes |  14.75   3.66    14.0    12.5    17.5
-------+----------------------------------------------------

LR chi square = 0.02
p-value = 0.9
```

Figure 5

Appendix 6.1

Pressure algometry scores for locations 1 to 3.

The key to the table headings is as follows:

- Loc 1: Tuberscarale (Left; Right)
- Loc2: 10 cm from cranial tuberscarale (Left; Right)
- Loc3: 20 cm from cranial tuberscarale (Left; Right)

ORDSP	Statistic	Loc1L	Loc1R	Loc2L	Loc2R	Loc3L	Loc3R
Yes	Mean	2.67	2.90	2.88	2.90	2.53	2.50
	SD	0.75	0.10	0.29	0.36	0.55	0.82
	Median	3.10	2.90	3.00	3.00	2.80	2.70
	Lower Q	1.80	2.80	2.55	2.50	1.90	1.60
	Upper Q	3.10	3.00	3.10	3.20	2.90	3.20
No	Mean	2.75	2.53	2.55	2.50	2.31	2.21
	SD	0.52	0.82	0.50	0.65	0.68	0.69
	Median	2.95	2.65	2.58	2.60	2.25	1.98
	Lower Q	2.35	1.80	2.05	1.90	1.85	1.65
	Upper Q	3.15	3.20	3.00	3.10	2.93	2.85
	Chi Square (1df)	0.05	0.74	1.36	1.20	0.31	0.42
	Prob > chi^2	0.82	0.40	0.24	0.27	0.58	0.51

Table A

- Loc4: 30 cm from cranial tuberscarale (Left; Right)
- Loc5: 40 cm from cranial tuberscarale (Left; Right)
- Loc6: 50 cm from cranial tuberscarale (Left; Right).

Appendix 6.2

Pressure algometry scores for locations 4 to 6.

Appendix 7 - Layout/instructions for Equine *Veterinary Journal*

Target audience – Veterinarians working with racehorses or performance horses, veterinary physiotherapists working with horses and potentially racehorse trainers.

ORDSP	Statistic	Loc4L	Loc4R	Loc5L	Loc5R	Loc6L	Loc6R
Yes	Mean	2.13	2.37	2.13	2.53	2.05	2.37
	SD	0.60	0.65	0.21	0.50	0.39	0.38
	Median	1.95	2.40	2.20	2.60	1.85	2.20
	Lower Q	1.65	1.70	1.90	2.00	1.80	2.10
	Upper Q	2.80	3.00	2.30	3.00	2.50	2.80
No	Mean	2.01	1.94	2.03	2.00	1.94	2.22
	SD	0.56	0.64	0.79	0.56	0.50	0.46
	Median	2.10	1.85	1.90	1.90	1.85	2.20
	Lower Q	1.50	1.60	1.50	1.60	1.55	1.85
	Upper Q	2.30	2.35	2.15	2.50	2.20	2.58
	Chi Square (1df)	0.12	1.10	0.06	2.24	0.15	0.29
	Prob > chi^2	0.73	0.29	0.80	0.13	0.70	0.59

Table B

A summary, no more than 300 words in total, should be provided with the following headings:

- **Background**: The background behind the decision to choose this subject to study.
- **Objectives**: The statement that is being tested and is testable by the methods (below); or the original aims and study deliverables.
- **Study design:** Concise statement of the study design§
- **Methods**: Brief description of materials and methods, and methods of testing hypotheses.
- **Results**: Brief highlights of the results obtained.
- **Main limitations**: Concise statement of limitations and sources of bias.
- **Conclusions**: Conclusions drawn from results.

General Articles should describe experimental or clinical studies, including systematic reviews and metanalyses. To minimise publication bias, *EVJ* encourages authors to publish negative results, providing the study had adequate power to detect differences and study design is robust.

General Articles should normally be around 4000 words including figure legends, table legends and references, with up to 3 tables and 6 figures. Manuscripts exceeding 5000 words will not be sent to external peer reviewers. Each figure can consist of up to 6 sub-panels. Figures must be selected carefully and each must enhance the article. Our reviewers and editors will assess the value of each and where individual figures are not considered essential they may be deleted or moved to online only. In all but exceptional circumstances, we are unlikely to publish 6 x 6 sub-panels in print. Our typesetters may choose to set out larger and composite figures across 2 columns but the author must consider the size of the resultant print images particularly where diagnostic images are included in sub-panels. Images will be scaled to fit the page layout by the typesetters.

The introduction should be limited to around 400 words. The introduction should be succinct (approximately two paragraphs), conveying why the subject is important and briefly describing what information is known. It is not necessary to provide references for widely accepted clinical practices or knowledge. Bear in mind that most *EVJ* readers have a comprehensive knowledge of equine disease and avoid statements of a basic nature. A comprehensive review of the literature is unnecessary but do state clearly the rationale for your study along with your hypothesis or research question and specific objectives. Summarise how your approach will help fill the gaps in information previously stated. Do not summarise the study findings.

The remainder of the manuscript should be presented in the following sections: Materials and Methods, Results, and Discussion, with subheadings, including data analysis, as appropriate. Additional tables, figures, video material or text describing further details of methods or results can be submitted as Supplementary items. Where questionnaires or other similar instruments have been used to collect data a copy of these must be included for online publication, translated into English and with identifying features removed if appropriate. All quantitative results should be analysed by appropriate statistical methods

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