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Treatment of chronic or recurrent proximal suspensory desmitis using radial pressure wave therapy in the horse

O. M. CROWE*[†], S. J. DYSON[‡], I. M. WRIGHT[§], M. C. SCHRAMME[‡] and **R. K. W. SMITH[†]**

[†]Royal Veterinary College, Hawkshead Lane, North Mymms, Hatfield, Hertfordshire AL9 7TA; [‡]Animal Health Trust, Lanwades Park, Kentford, Newmarket, Suffolk CB8 7UU and [§]Reynolds House Referrals, 166 High St, Newmarket, Suffolk CB8 9AQ, UK.

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Summary

Reasons for performing study: **Proximal suspensory desmitis (PSD) is diagnosed with increasing frequency in horses and radial pressure wave therapy (RPWT) is a widely used therapy for painful orthopaedic conditions in man and dogs. There are, however, few published data as to the outcome of its use in PSD.**

Objective: **To evaluate the use of RPWT in the treatment of chronic or recurrent PSD in the horse, an injury which carries a poor prognosis for return to athletic function with conservative management alone.**

***Hypothesis*: RPWT and controlled exercise improves the prognosis of chronic or recurrent PSD in the horse when compared to previously published results of controlled exercise alone.**

Methods: **The use of RPWT in the management of chronic or recurrent proximal suspensory desmitis (PSD) was evaluated in 65 horses. Diagnosis was based on response to local analgesia, ultrasonography and radiography. Horses were classified according to severity of ultrasonographic lesions, whether fore- or hindlimbs were affected, and duration of lameness prior to diagnosis. Horses were treated 3 times at 2-week intervals and followed a controlled exercise programme; they were reassessed clinically and ultrasonographically 10–12 weeks after diagnosis, when further exercise recommendations were made dependent upon the animal's progress.**

Results: **Forty-one percent of horses with hindlimb lameness and 53% with forelimb lameness were nonlame and returned to full work 6 months after diagnosis. The prognosis was significantly affected by the ultrasonographic grade at the time of diagnosis and by ultrasonographic evidence of resolution of the lesion in hindlimb cases.**

Conclusions: **These findings, when compared to previously published results of treatment using controlled exercise alone, suggest that RPWT improves the prognosis for PSD in the hindlimb.**

Potential relevance: **RPWT is a useful treatment modality for chronic or recurrent PSD when combined with controlled exercise. Further studies are required on the effect of RPWT employing histology and biomechanics in order to fully evaluate its use on equine tissues.**

Introduction

Pain originating from the origin of the suspensory ligament (proximal suspensory desmitis; PSD) has been diagnosed in horses with increasing frequency in recent years (Dyson *et al*. 1995). In the UK, the condition has been reported most commonly in mature sport horses age 4–10 years (Dyson 1991, 1994), but it also occurs in young Thoroughbred racehorses (Pilsworth 2002).

The diagnosis of PSD depends on localisation of pain to the proximal metacarpal or metatarsal region, combined with ultrasonography, radiography and occasionally nuclear scintigraphy (Marks *et al*. 1981; Moyer *et al*. 1988; Young *et al*. 1989; Dyson 1991, 1994, 2000). To date, treatment has consisted largely of combinations of rest and controlled exercise (Dyson 1991, 1994, 2000), internal blistering with iodine and peanut oil (Marks *et al*. 1981), intralesional injections of bone marrow (Herthel 2001) and, in hindlimbs, tibial neurectomy (Dyson 2000) or fasciotomy with neurectomy of the deep branch of the lateral plantar nerve (Bathe 2001).

Initial reports suggested an overall prognosis of 86% of horses with PSD in a forelimb or hindlimb returning to full athletic function (Dyson 1991). The prognosis for acute forelimb PSD is excellent, with approximately 90% of horses resuming full athletic function (Dyson 2000). However no data exist to quantify the prognosis for chronic PSD in the forelimb. The prognosis for hindlimb PSD is much more guarded,with only 13% of horses returning to full work at 6 months after diagnosis (Dyson 1994).

Radial pulse wave therapy (RPWT) is marketed as 'extracorporeal shock wave therapy'. However, its wave form and failure to cause cavitation in a passive cavitation detection system differ from the properties of a true shock wave, hence its more accurate description as a pulse wave (Cleveland and Chitnis 2002). It was developed initially for the nonsurgical management of human renal and biliary calculi (Adams and Senior 1999), first used in human orthopaedics in an attempt to disrupt dystrophic mineralisation in the tendon of origin of the *biceps brachii* muscle and is now used widely in the treatment of other painful orthopaedic conditions in man and dogs (Danova and Muir 2003). Its use in equine orthopaedics has recently been described by Boening (2001) and Palmer (2002).

Radial pressure waves are generated by compressed air pulses, which fire a projectile within a handpiece. The kinetic energy of

*Author to whom correspondence should be addressed. Present address: Willesley Equine Clinic, Byams Farm, Willesley, Tetbury, Gloucestershire GL8 8QU, UK.

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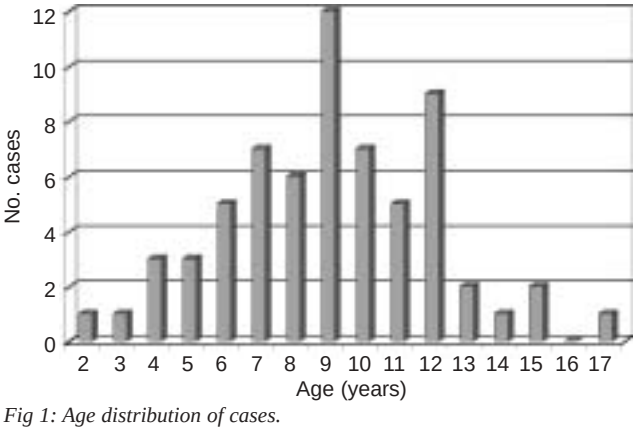

Fig 1: Age distribution of cases.

the projectile is converted into acoustic energy as it contacts an applicator portion in the hand piece, thereby generating a pressure wave with a radial waveform. This acoustic energy is transmitted to the body through coupling gel, which is applied after degreasing the skin.

In this study it was hypothesised that RPWT would improve the prognosis for PSD in the horse by decreasing lameness and encouraging lesion healing. It was evaluated in a prospective clinical trial in the treatment of chronic or recurrent PSD in the horse.

Materials and methods

Sixty-five horses were included in the trial, 20 with forelimb PSD and 43 with lesions only in the hindlimbs. Two horses had lesions in both fore- and hindlimbs. Fifty-four horses were treated at the Animal Health Trust (AHT) and 11 at the Royal Veterinary College (RVC). All horses had a history of lameness or reduced performance for at least 3 months, or had recurrence of previously diagnosed PSD. Horses were categorised according to the ultrasonographic images obtained from the lamest limb. Horses with fore- and hindlimb lameness were categorised in the hindlimb group.

Lameness was evaluated with horses walking and trotting in hand in a straight line, and lungeing on hard and soft surfaces. The response to flexion tests was assessed. When the lameness was subtle, horses were evaluated while being ridden. Lameness was graded (Dyson 1994) on a 9 point scale of 0 to 4 with half units (0 = no lameness detectable, 1 = mild, 2 = moderate, 3 = severe, 4 = nonweightbearing).

For inclusion in the study, lameness had to be substantially improved by perineural analgesia of the palmar metacarpal or plantar metatarsal nerves at a subcarpal or subtarsal site, and/ or by analgesia of the deep branch of the lateral plantar nerve. This had to follow a negative response or only mild improvement after perineural local analgesia of the palmar/plantar nerves in the mid to distal metacarpal/metatarsal region and the palmar metacarpal/plantar metatarsal nerves at the level of the distal aspect of the second and fourth metacarpal/metatarsal bones. In addition, lameness had to be unaffected or improved only slightly by intra-articular analgesia of the middle carpal or tarsometatarsal joints. All local analgesic techniques were performed using mepivacaine hydrochloride (Intra-Epicaine)[1] and standard techniques (Dyson 1984, 1985, 2000).

The palmar/plantar soft tissues of the proximal metacarpus/metatarsus were evaluated ultrasonographically using a

TABLE 1: Gender and use of cases

Gender	Geldings	52
	Mares	9
	Stallions	4
Use	Dressage	23
	General purpose competition	15
	Eventing	10
	Showjumping	9
	Racing - Flat	4
	- National Hunt	2
	Showing	2

10 MHz linear-array probe (Sonotron system V[2] [RVC]; SonoAce 8800[3] [AHT]) and digitally archived. All horses had to have ultrasonographic evidence of PSD for inclusion in the trial. Lesions in the proximal suspensory ligament were categorised subjectively as mild, moderate or severe. In mild lesions, the ligament had an indistinct dorsal border and a poor longitudinal fibre pattern. Moderate lesions had a focal hypoechogenic region, with focal loss of longitudinal fibre pattern. Severe lesions were markedly hypoechogenic and/or had severe entheseophyte formation with an absence of longitudinal fibre pattern. This grading system was devised based on the authors' previous experience with clinical cases. Dorsopalmar/plantar and lateromedial radiographic views of the proximal metacarpal or metatarsal regions were obtained to assess changes in the third metacarpal/metatarsal bones and in order to exclude cases with additional disease such as osteoarthritis of the tarsometatarsal joints.

The regime for pressure wave therapy was based on the manufacturer's recommendations. All horses received 3 treatments (starting at the time of diagnosis) with 2000 impulses of radial pressure waves at a frequency of 10 Hz; 1000 impulses were applied to each of the medial and lateral aspects of the limb, directed at the origin of the suspensory ligament. Limbs were prepared by clipping, cleaning and application of a coupling gel. All horses were sedated for treatment using romifidine (Sedivet)[4] or detomidine hydrochloride (Domosedan)[5] with butorphanol tartrate (Torbugesic)[6]. The radial pressure waves were generated by a Swiss Dolorclast Vet machine[7].

Three treatments were administered at 2-week intervals. Thereafter, the horses received a controlled exercise regime based on that used by the authors prior to the introduction of pressure wave therapy and on previous reports of the condition (Dyson 1994). Horses were restricted to box-rest with daily controlled walking exercise for the first 6 weeks after diagnosis. This was achieved in-hand, on a horse-walker or by riding for 30–60 mins. Thereafter, walking was gradually replaced with trotting until re-examination 10–12 weeks after the start of treatment. Horses were re-evaluated clinically and ultrasonographically and a subjective evaluation made of any change in ultrasonographic appearance. The management programme thereafter varied according to clinical and ultrasonographic progress, but most horses followed a controlled ascending exercise programme. Follow-up data were obtained 6 months post diagnosis, by either re-evaluation (n = 55) or telephone conversation with owners (n = 2) or referring veterinary surgeons (n = 8).

The relationships between the category of ultrasonographic lesion at first diagnosis and ultrasonographic evidence of lesion improvement and outcome were tested using Yates' corrected Chi-squared (χ^2) statistics.

TABLE 2: Overall response to therapy

	12 week follow-up (%)			6 month follow-up (%)			
	Sound	Improved	Lame	Full work	Reduced work	Lame/ retired	Not yet re-exam
Forelimb	16 (80)	2 (10)	2 (10)	10 (53)	4 (21)	5 (26)	1
Hindlimb	18 (40)	10 (22)	17 (38)	18 (41)	8 (18)	18 (41)	1

Re-exam = re-examined.

TABLE 3: Effect of ultrasonographic category at initial examination on outcome

	12 week follow-up (%)			6 month follow-up (%)			
	Sound	Improved	Lame	Full work	Reduced work	Lame/ retired	Out of training
Forelimb							
Mild (2)	2 (100)	0 (0)	0 (0)	2 (100)	0 (0)	0 (0)	-
Mod (11)	10 (90.9)	0 (0)	1 (9.1)	7 (63.6)	1 (9.1)	3 (27.3)	-
Severe (7)	4 (57.1)	2 (28.6)	1 (14.3)	1 (16.7)	3 (50.0)	2 (33.3)	1
Hindlimb							
Mild (10)	6 (60)	3 (30)	1 (10)	7 (70)	1 (10)	2 (20)	-
Mod (26)	18 (69.2)	3 (11.5)	5 (19.2)	15 (58.0)	4 (15.0)	7 (27.0)	-
Severe (29)	10 (34.5)	6 (20.7)	13 (44.8)	7 (25.0)	7 (25.0)	14 (50.0)	1

Mod = moderate.

Results

The majority of animals were sport horses, geldings being most commonly affected (Table 1); age range was 2–17 years, most (78%) age 6–12 years (Fig 1); degree of lameness was 0.5–2.5 out of 4 and 31% of hindlimb and 20% of forelimb cases were affected bilaterally.

None of the horses with forelimb PSD had radiographic abnormalities of the proximal third metacarpal bone. Twenty-four percent of horses with hindlimb PSD had radiographic abnormalities of the proximoplantar aspect of the third metatarsal bone, which consisted of sclerosis and disruption of the normal trabecular pattern of the bone. There was no significant relationship between the presence of these abnormalities and outcome.

Treatments were generally well tolerated and the only adverse effects noted were occasional excoriation of the skin along the line of application of the handpiece and the development of small circular areas of hair loss and subsequent development of white hairs after treatment. These circular areas were often slightly removed from the actual area of treatment.

None of the horses deteriorated clinically or ultrasonographically during the trial. The overall results are presented in Table 2. Fifty-three percent of horses with chronic or recurrent forelimb PSD had returned to full work 6 months after treatment, while 41% of horses with hindlimb PSD had resumed full work at that time. The relationships between ultrasonographic findings and outcome are presented in Tables 3 and 4. One horse with forelimb and one with hindlimb lameness were sound by 6 months but, because of competition seasons, neither had returned to full training at the time of data collection; they have therefore been excluded from calculations relating to final outcome. Two additional horses with hindlimb lameness were lame at 6 months but, at the time of submission of this paper, have subsequently improved and resumed work; again, these are excluded from analysis.

Ten horses were not re-examined by the authors at 6 months; of those, 3 were still lame at 10–12 weeks and remained lame or were retired at 6 months (long-term follow-up consisted of telephone conversations with owners in 2 of these cases). A further 2 horses in this group had improved initially but deteriorated by 6 months and were persistently lame. The remaining 3 were not lame on re-examination at 10–12 weeks and had returned to full work by 6 months.

TABLE 4: Effect of improvement of ultrasonographic appearance on outcome

	12 week follow-up (%)			6 month follow-up (%)			
	Sound	Improved	Lame	Full work	Reduced work	Lame/ retired	Not yet re-exam
Forelimb							
Improved	12 (92.3)	1 (7.7)	0	8 (66.7)	2 (16.7)	2 (16.7)	1
No change	4 (57.1)	1 (14.3)	2 (28.6)	2 (28.6)	2 (28.6)	3 (42.9)	
Hindlimb							
Improved	13 (72.2)	5 (27.7)	0	9 (50.0)	6 (33.3)	3 (16.6)	
No change	3 (12.0)	5 (20.0)	17 (68.0)	7 (29.2)	2 (8.3)	15 (62.5)	1

Grouping the mild and moderate ultrasonographic categories together to create bivariant groupings, there was significant correlation between severity of initial lesion and outcome for both forelimbs (Yates' corrected χ^2 P = 0.05) and hindlimbs (Yates' corrected χ^2 P = 0.009). There was no significant difference between the outcomes of the mild and moderate groups in the forelimbs (Yates' corrected χ^2 P = 0.9) or hindlimbs (Yates' corrected χ^2 P = 0.8).

Improvement in ultrasonographic appearance had no significant effect on outcome in horses with forelimb lameness. In the hindlimb, however, there was a significant association between ultrasonographic improvement and return to soundness at 12 weeks (Yates' corrected χ^2 P = 0.0002) and being nonlame or improved at 6 months (Yates' corrected χ^2 P = 0.008). The duration of lameness prior to treatment had no significant effect on outcome.

Discussion

The distribution of age, gender and occupation was similar in this study to previous series of PSD. In addition, the similarity between subject details, diagnosis and management of cases in this series and previous studies of hindlimb PSD is considered to validate a comparison of results (Dyson 1991, 1994).

The results of this study demonstrate and quantify the improved prognosis for chronic forelimb PSD compared to that of hindlimb PSD, as demonstrated previously in acute PSD (Dyson 1991, 2000; Dyson *et al*. 1995). Forty-one percent of horses with chronic hindlimb PSD were in full work 6 months after treatment with RPWT. This is substantially better than previously reported results, using controlled exercise alone. Dyson (1994) reported that none of 29 horses with hindlimb PSD that had been lame for more than 5 weeks returned to soundness and full athletic function. The similarities between this and the current study, in terms of case selection and use of controlled exercise after diagnosis, suggest that RPWT is responsible for the improved prognosis. RPWT may also reduce the time for return to soundness and resumption of work. Studies assessing controlled exercise alone have described a programme lasting 36 weeks (Dyson 1994; Dyson *et al*. 1995) for hindlimb PSD, whereas some of the horses in this trial were nonlame at trot by the time of the second or third treatment.

The situation with forelimb PSD is less clear. Although 80% of horses were nonlame at the 12-week re-examination, only 53%

were nonlame and in full work 6 months after diagnosis. There are few reliable published data for the prognosis of chronic forelimb PSD for comparison. However, in a case-controlled study of the use of RPWT in chronic forelimb PSD, 58% of horses resumed full work 6 months after treatment, which was an improved outcome over untreated controls (Boening 2001).

In the current study, horses with severe ultrasonographic changes at presentation were less likely to be in full work at 6 months than those with mild or moderate lesions. This was particularly marked in the forelimb; only 17% of horses with severe lesions here returned to full work. There was also a marked reduction in the proportion of sound horses at 6 months, compared to 12 weeks, despite recommendations to control exercise strictly if obvious ultrasonographic lesions persisted. These observations suggest that prognostication may be possible on the basis of initial ultrasonographic examinations.

Radiography was not sensitive in detecting PSD. Its most important function was to differentiate PSD from osseous lesions, such as fractures of the palmar cortices of the third metacarpal bones, which would have a similar response to local analgesic techniques (Dyson 1988; Lloyd *et al*. 1988; Ross *et al*. 1988; Dyson *et al*. 1995). Avulsion fractures at the origin of the suspensory ligament were excluded from this study.

In this series, radiographic evidence of PSD and duration of lameness prior to treatment did not affect the outcome, unlike in previous reports of the condition which suggested they worsened the prognosis (Dyson 1991, 1994). The reason for the discrepancy between this and previous studies is unclear. It has been suggested that radiographic changes at the origin of the PSD result from enthesiophyte formation, which is a reflection of chronicity (Dyson 1994). It is possible that RPWT is more beneficial for more chronic lesions where enthesiophytosis is present than for those of a shorter duration, thereby reducing the detrimental effects of delayed treatment and enthesiopathy in conservatively managed cases.

The mechanism of action of RPWT in the horse has not been investigated. The rapid reduction in lameness seen in some cases suggests that the treatment may be analgesic. No horse suffered exacerbation of the condition after treatment, indicating that, in spite of this potential mode of action, the treatment is safe. However, in the hindlimb, when there was no ultrasonographic evidence of healing, the risk of the horse remaining lame was increased. This suggests that, while at least some of the clinical improvement may have been associated with analgesia of the proximal suspensory ligament, some healing of lesions did occur and contributed to the positive outcomes. In cases of forelimb PSD, the marked reduction in the proportion of nonlame horses at 6 months, compared to 12 weeks, may have resulted from decreasing analgesic effects of RPWT, without adequate healing of lesions.

It is concluded that the use of RPWT in chronic PSD of the hindlimb appears to improve the prognosis for return to soundness when compared to previously published cases using controlled exercise alone. This method of treatment appears to be safe for use in the forelimb, but the treatment protocol may need to be modified for horses with severe ultrasonographic lesions. Further studies on the difference between fore- and hindlimb PSD may also be useful in determining the most effective treatment methods for both. Histological and biomechanical investigations into the effect of RPWT on equine tissues are also required to evaluate its use fully.

Manufacturers' addresses

[1]Arnolds Veterinary Products Ltd., Shrewsbury, Shropshire, UK.
[2]Diasonics Sonotron Ltd., Bedford, Bedfordshire, UK.
[3]Medison, Seoul, Korea.
[4]Boehringer Ingelheim Ltd., Bracknell, Berkshire, UK.
[5]Pfizer Ltd., Sandwich, Kent, UK.
[6]Fort Dodge Animal Health, Southampton, Hampshire, UK.
[7]EMS Electromedical Systems, Nyon, Switzerland.

References

Adams, L.G. and Senior, D.F. (1999) Electrohydraulic and extracorporeal shock-wave lithotripsy. *Vet. Clin. N. Am.: Small Anim. Pract*. **29**, 293-302.

Bathe, A. (2001) Neurectomy and fasciotomy for the surgical treatment of hindlimb proximal suspensory desmitis. In: *Proceedings of the 40th British Equine Veterinary Association Congress*, Equine Veterinary Journal Ltd., Newmarket. p 118.

Boening, J. (2001) Radial extracorporeal shock wave therapy for chronic insertion desmopathy of the proximal suspensory ligament: a controlled study. In: *Proceedings of the 40th British Equine Veterinary Association Congress*, Equine Veterinary Journal Ltd., Newmarket. pp 116-117.

Cleveland, R.O. and Chitnis, P.V. (2002) Comparison of the acoustic and cavitation fields produced by SWT devices with different generating principles. In: *Proceedings of the 5th International Congress of the International Society of Musculoskeletal Shockwave Therapy*, Winterthur, Switzerland. p 2.

Danova, N.A. and Muir, P. (2003) Extracorporeal shock wave therapy for supraspinatus calcifying tendinopathy in two dogs. *Vet. Rec.* **152**, 208-209.

Dyson, S.J. (1984) Nerve blocks and lameness in the horse. *In Pract.* **6**, 102-107.

Dyson, S.J. (1985) Intra-articular anaesthesia of the equine hock. *In Pract.* **7**, 92-96.

Dyson, S.J. (1988) Some observations on lameness associated with pain in the proximal metacarpal region. *Equine. vet. J., Suppl.* **6**, 43-52.

Dyson, S.J. (1991) Proximal suspensory desmitis: clinical, ultrasonographic and radiographic features. *Equine vet. J.* **23**, 25-31.

Dyson, S.J. (1994) Proximal suspensory desmitis in the hindlimb: 42 cases. *Br. vet. J.* **150**, 279-291.

Dyson S.J., (2000) Proximal suspensory desmitis in the forelimb and the hindlimb. *Proc. Am. Ass. equine Practnrs*. **46**, 137-142.

Dyson, S.J. Arthur, R.M., Palmer, S.E. and Richardson, D. (1995) Suspensory ligament desmitis. *Vet. Clin. N. Am.: Equine Pract*. **11**, 177-215.

Herthel, D.J. (2001) Enhanced suspensory ligament healing in 100 horses by stem cells and other bone marrow components. *Proc. Am. Ass. equine Practnrs*. **47**, 319-321.

Lloyd, K.C., Koblick, P., Ragle, C., Wheat, J.D. and Lakritz, J. (1988) Incomplete palmar fracture of the proximal extremity of the third metacarpal bone in horses: ten cases (1981-1986). *J. Am. vet. med. Ass.* **192**, 798-803.

Marks, D., Mackay-Smith, M.P., Leslie, J.A. and Soule, S.G. (1981) Lameness resulting from high suspensory disease in the horse. *Proc. Am. Ass. equine Practnrs.* **27**, 493-497.

Moyer, W., Ford, T.S. and Ross, M.W. (1988) Proximal suspensory desmitis. *Proc. Am. Ass. equine Practnrs.* **34**, 409-412.

Palmer, S.E. (2002) Treatment of dorsal metacarpal disease in the Thoroughbred racehorse with radial extracorporeal shockwave therapy. *Proc. Am. Ass. equine Practnrs.* **48**, 318-321.

Pilsworth, R. (2002) The European Thoroughbred. In: *Diagnosis and Management of Lameness in the Horse*, Eds: M.W. Ross and S.J. Dyson, W.B. Saunders Co., Philadelphia. pp 879-894.

Ross, M.W., Ford, T.S. and Orsini, P.G. (1988) Incomplete longitudinal fracture of the proximal palmar cortex of the third metacarpal bone in horses. *Vet. Surg.* **17**, 82-86.

Young, R.L., O'Brien, T.R. and Craychee T.J. (1989) Examination procedures for the diagnosis of suspensory desmitis in the horse. *Proc. Am. Ass. equine Practnrs.* **35**, 233-241.