

Dott. Piergiorgio Valeriani
Medico Veterinario
Specialista in ortopedia equina

Endogenous cyclotronic Ionic Resonance induced complete recovery in a severely lame Grand Prix dressage horse.

Case details

History

April 2007 – a 16-year-old castrated male Grand Prix dressage horse showed front right (FR) lameness.

When, last month, first recognized, the lameness was lighter, intermittent and improving with riding but, lately the horse was continuously and markedly lame, requiring then a thorough clinical examination.

Clinical findings

Observation: simmetry and posture

The horse rests both front feet slightly ahead of the contralateral limb, alternatively, 2 – 3 minutes apart. Effusion of front left (FL) digital flexor tendon sheath (chronic tenosynovitis), splint (proximal third of 2nd and 3rd metacarpal bone). Both front feet medio-lateral static imbalance (higher medially).

Palpation

FR fetlock – markedly enlarged lateral branch of the suspensory legament (LBSL). Pressure applied to the affected (lateral) branch elicits pain. The same pressure applied to the LBSL of the contralateral limb is not painful.

Hoof tester

Lightly painful when applied to the medial sole and frog (both front feet).

Movement (at a trot in hand)

- In straight line on hard surface: FR, intermittently lame grade 2/5;
- circling to the right on hard surface: sound, only light stiffness involving both fore limbs;
- circling to the left on hard surface: FR, continuously lame, grade 2/5;
- in straight line on soft surface: FR, continuously lame, grade 2/5;
- circling to the right on soft surface: sound;
- circling to the left on soft surface: FR, continuously lame, grade 3/5. This condition becomes “the baseline lameness” (BL).

Flexion tests

FR lower limb: marked positive response

FL lower limb: very light positive response

Diagnostic analgesia (mepivacaine 2%, 2 ml per block – the horse reevaluated 10 minutes after the injection following the same protocol used for movement).

- 1) FR. palmar digital block; just proximal to the cartilages of the foot: (+); intermittent lameness grade 1/5 became apparent on the contralateral limb, circling to the left on hard surface (FR sound).
- 2) FL. same block performed at 1): (++++).
- 3) FR. palmar digital analgesia (mid-pastern ring block): same results obtained at 1). No lameness on the contralateral limb noticed.
- 4) FR. palmar digital analgesia (high pastern): the same result as 3).
- 5) FR. abaxial sesamoid block: the same result as 3).
- 6) FR. palmar and metacarpal nerves at the level of the distal end of the 2nd and 4th metacarpal bones (low palmar analgesia): (++++); continuously lameness grade 1/5, circling to the right on soft surface noticed (FL).
- 7) FL. same block performed at 6): same result as 6); no lameness on the contralateral limb noticed.

N.B. improvement in lameness score: (+) 25%, (++) 50%, (+++) 75%, (++++) 100% (sound), (-) no improvement.

To explain the results obtained at point 1) (+), as well as the lameness on the contralateral limb, further diagnostic analgesia has been performed, 2 days later, as follows:

- 1) FR. distal interphalangeal joint (DIP) (4 ml mepivacaine 2%): (-) after 5 minutes, (+) after 10 minutes, (+) after 15 minutes along with continuous lameness on the contralateral limb, grade 1/5, circling to the left on hard surface (FR sound).
- 2) FL. the same analgesia as 1): (-) after 5 minutes, (++++) after 10 minutes.

Analgesia of lateral palmar and metacarpal nerves, at the level of the distal end of the 4th metacarpal bone resulted in the same situation described at point 6), suggesting the lateral aspect of FR fetlock as a major source of pain.

Tentative diagnosis

FR subchronic desmitis of the lateral branch of the suspensory ligament (SL).

Diagnostic Imaging

Radiography

- 1) slightly flexed FR fetlock. LM view: apical focal osteolysis involving the lateral proximal sesamoid bone (sesamoiditis).
- 2) FR. fetlock. DPa view: apical sesamoiditis involving the lateral proximal sesamoid bone.
- 3) FR. fetlock. D45°L – PaMO view: sesamoiditis involving the lateral proximal sesamoid bone.
- 4) FR and FL. pasterns and feet. DP views: bilateral medio-lateral static imbalance (higher medially). Medial narrowing of the interphalangeal joint spaces.
- 5) FR and FL. navicular bones. D60°Pr – PaDiO view: small lucent zones within the medulla and along the distal border of both navicular bones. FL: mineralized fragments distal to the navicular bone.
- 6) Distal phalanx (P3). FR and FL. D75°Pr – PaDiO view: modeling and lucent zones along the medial border of both P3, especially FL.

Ultrasonography

FR: chronic desmitis of the LBSL with dystrophic fibro-mineralized foci. The lateral branch is enlarged.

Fig. 1a, 1b and 1c: transverse ultrasonographic images of the SL branches (LB is to the left).

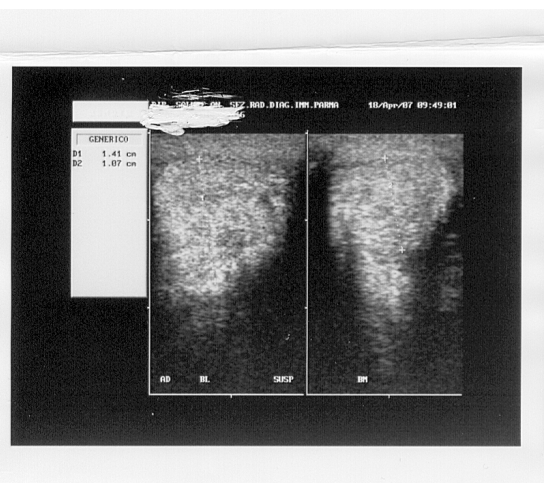
1d: longitudinal ultrasonographic image of the LB.

Both front metacarpophalangeal joints shows synovitis.

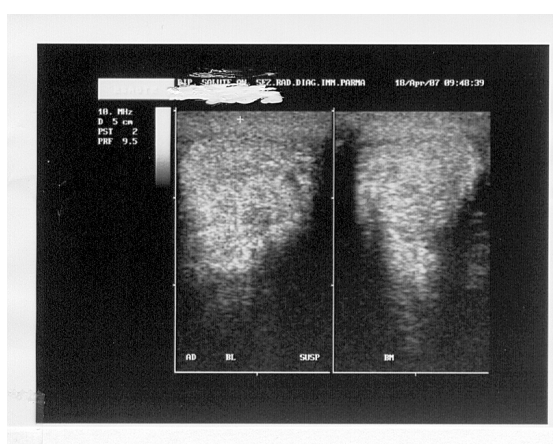
1a



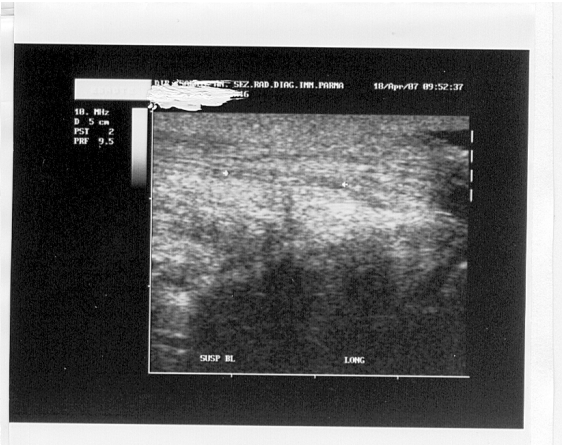
1b



1c



1d



Definitive diagnosis

FR chronic desmitis of the LBSL coupled with lateral proximal sesamoiditis (as a cause of the BL).

Belateral light navicular disease and osteitis of the distal phalanx. Tenosynovitis of the FL digital flexor tendon sheath. Both front fetlocks show light arthrosynovitis. FR splint is not painful.

Prognosis

The prognosis for a 16 year-old high level dressage horse with chronic branch SL desmitis associated with proximal sesamoiditis is poor.

Management

- appropriate trimming (correction of mediolateral imbalance);
- shoeing with egg bar shoes;
- controlled exercise;
- systemic NSAIDs.

The horse is then monitored:

1 month later: BL 2/5; deep palpation of LBSL is painful;

2 months later: BL 2/5; deep palpation of LBSL is painful;

3 months later: BL 2/5; deep palpation of LBSL is painful;

4 months later: BL 2/5; deep palpation of LBSL is painful.

August 2007

Because of the poor results obtained with the previous treatment we take into consideration endogenous cyclotronic ionic resonance (ICR) by means of the SEQEX ® medical apparatus.

We perform a test as follows: local application (rod) of ICR (intensity 100%, frequency 75 Hz, wave form 22) for 6 minutes on the involved proximal sesamoid bone, for 6 minutes on the LBSL insertion and for 6 minutes on the same branch 3 cm further proximally. This resulted in a dramatically improved lameness (grade 1/5).

We decided then for ICR by SEQEX ® (bio-impedance test, “chronic-bony program” – 9x3 minutes – updated every 20 days) applied as follows:

- total body, local application (rod) as above mentioned (every 2nd day);
- local intensive device on the lateral aspect of the FR fetlock (every 2nd day).

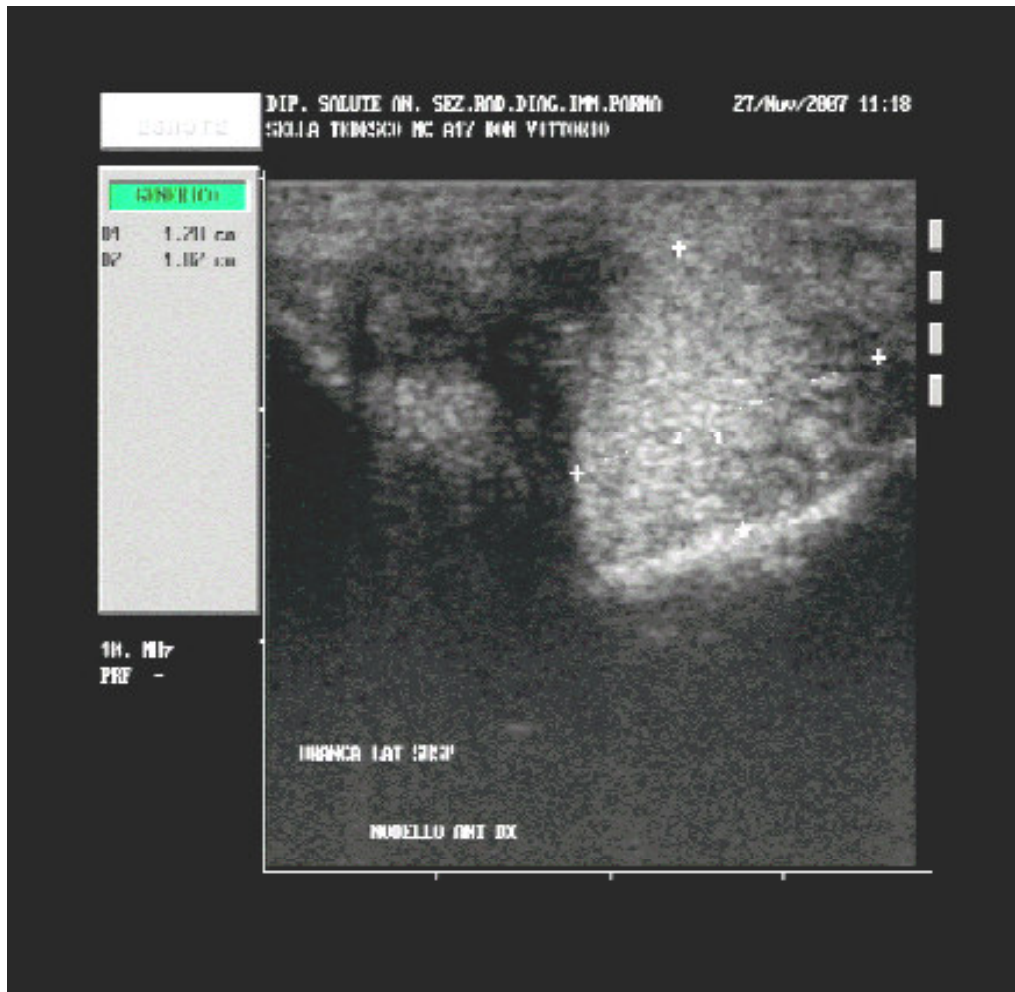
Checking

- 1 week later: BL 1.5/5, local pain (LP) by palpation improved; FL no lameness;
- 2 weeks later: BL 1/5, LP – further improvement;
- 3 weeks later: BL .5/5, LP – no more present;
- 4 weeks later: sound, LP absent;
- 5 weeks later: sound, LP absent;
- 6 weeks later: sound, LP absent;
- 8 weeks later: sound, LP absent.

After this we began an increasing controlled exercise program.

Ultrasonography

On 27/11/2007 ultrasonography showed decreased cross-sectional area of the LBSL (FR), decreased hypochoic areas and absence of dystrophic fibro-mineralized foci (fig. 2).



End of November 2007

The horse is working regularly now and, so far, neither lameness nor local pain are present. He is treated by SEQEX ® following the above mentioned protocol (August 2007).

We intend, within a few weeks, to apply ICR following a less intensive schedule coupled with “regeneration program” eventually.

ICR has been well tolerated with no negative side-effects. We have only noticed increased foot growth, a very positive effect, if confirmed in future, especially for what concern horses with “fragile foot”.

Discussion

Dressage is the ultimate athletic challenge in equestrian sports.

Once a dressage horse has reached Grand Prix level, the training predominantly involves repetition of movements, thus dressage horses rarely succumb to acute stress-induced traumatic injuries but more likely succumb to repetitive, acumulative subclinical injuries that may surface at irregular intervals and resulting in chronic lesions associated with disappointing therapeutical results, at least for what concern the traditional medicine.

Proximal sesamoiditis, as found in the present case, is a chronic disease with no effective therapy. No improvement has been noted after prolonged rest.

Chronic desmitis of the LBSL, especially when ultrasonography shows soft tissue metaplastic changements as in the present case, needs 12 to 14 months to stabilize but, more often, the horse shows some degree of permanent lameness and, even when it looks sound, proximal suspensory desmitis easily relapses despite a proper gradually increased exercise program.

In this case, the most important evidence is the fact that, BL moved to 2/5 after the first month, with no further improvement over time. Interestingly, the lameness degree gradually decreased only after the first week of SEQEX ® therapy and the horse was sound in 3 weeks with no relapse. This horse is returned successfully to full training.

This new therapy in the horse needs further investigation in order to discover all the therapeutical opportunities that SEQEX ® offers. In this case we’ve got very encouraging results with no negative side-effects. Furthermore SEQEX ® could be a very interesting therapeutic tool considering its no doping effect. This fact will give us a chance to apply antiinflammatory-analgesic therapy during competitions when needed. A big thing!

References

- Dyson S: The suspensory apparatus. In Rantanen N, McKinnon A, editors: *Equine diagnostic ultrasonography*, ed 1, Baltimore, 1998, Williams & Wilkins.
- Muyllé S, Desmet P, Simoens P, et al: Histological study of the innervation of the suspensory ligament of the forelimb of the horse, *Vet Rec* 142:606, 1998.
- Ford T, Ross M, Orsini P: A comparison of methods for proximal metacarpal anaesthesia in horses, *Vet Surg* 18:146, 1988.
- Dyson S, Romero J: An investigation of injection techniques for local analgesia of the equine distal tarsus and proximal metatarsus, *Equine Vet J* 25:30, 1993.
- Denoix JM: Functional anatomy of tendon and ligaments in the distal limbs (manus and pes), *Vet Clin North Am Equine Pract* 10:273, 1994.
- Bramlage L, Buckowiecki C, Gabel A: The effect of training on the suspensory apparatus of the horse, *Proc Am Assoc Equine Pract* 35:245, 1989.
- Patterson-Kane J, Firth E, Parry D, et al: Effects of training on collagen fibril populations in the suspensory ligament and deep digital flexor tendon of young thoroughbreds, *Am J Vet Res* 59:64, 1998.
- Marks D, Mackay-Smith M, Leslie A, et al: Lameness resulting from high suspensory disease (HSD) in the horse, *Proc Am Assoc Equine Pract* 24:493, 1981.
- Genovese R, Rantanen N, Hauser M, et al: Diagnostic ultrasonography of equine limbs, *Vet Clin North Am Equine Pract* 2:145, 1986.
- Huskamp B, Nowak M: Insertion desmopathies in the horse, *Pferdheilkunde* 4:3, 1988.
- Dyson S: Some observations on lameness associated with pain in the proximal metacarpal region, *Equine Vet J Suppl* 6:43, 1988.
- Dyson S: Proximal suspensory desmitis: clinical, ultrasonographic and radiographic features, *Equine Vet J* 23:25, 1991.
- Dyson S: Proximal suspensory desmitis in the forelimb and the hindlimb, *Proc Am Assoc Equine Pract* 46:137, 2000.
- Ross M, Ford T, Orsini P: Incomplete longitudinal fracture of the proximal palmar cortex of the third metacarpal bone in horses, *Vet Surg* 17:82, 1988.
- Lloyd K, Kobluk P, Ragle C, et al: Incomplete palmar fracture of the proximal extremity of the third metacarpal bone in horses: ten cases (1981-1986), *J Am Vet Med Assoc* 192:798, 1988.
- Pleasant R, Baker G, Muhlbauer M, et al: Stress reactions and stress fractures of the proximal palmar aspect of the third metacarpal bone in horses: 58 cases (1980-1990), *J Am Vet Med Assoc* 201:1918, 1992.
- Bramlage L, Gabel A, Hackett R: Avulsion fractures of the origin of the suspensory ligament in the horse, *J Am Vet Med Assoc* 176:1004, 1980.
- Dyson S: *Problems encountered in equine lameness diagnosis with special reference to local analgesic techniques, radiology and ultrasonography*, Newmarket, England, 1995, R & W Publications.
- Butler J, Colles C, Dyson S, et al: The metacarpus and metatarsus. In *Clinical radiology of the horse*, ed 2, Oxford, 2000, Blackwell Science.
- Martin F, Herthel D-J, Snow V, et al: Scintigraphic osseuse et diagnostic des desmites proximales du muscle interosseux III chez le cheval: a propos de 28 cas (1990-1992), *Point Vet* 26:1061, 1995.
- Edwards R, Ducharme N, Fubini S, et al: Scintigraphy for the diagnosis of avulsions of the origin of the suspensory ligament in horses: 51 cases (1980-1993), *J Am Vet Med Assoc* 207:608, 1995.
- Dyson S: Unpublished data, 1980-2002.
- Dyson S, Arthur R, Palmer S, et al: Suspensory ligament desmitis, *Vet Clin North Am Equine Pract* 11:177, 1995.
- Genovese R: Unpublished data, 2001.
- Boening J, Liffeld S, Matuschek S: Radial extracorporeal shock wave therapy for chronic insertion desmopathy of the proximal suspensory ligament, *Proc Am Assoc Equine Pract* 46:203, 2000.
- Crowe O, Dyson S, Schramme M, et al: Treatment of chronic or recurrent proximal suspensory desmitis using radial extracorporeal shockwave therapy, *Equine Vet Educ* (in press.)
- Dyson S: Proximal suspensory desmitis in the hindlimb: 42 cases, *Br Vet J* 150:279, 1994.
- Dyson S: Proximal suspensory desmitis in the hindlimb, *Equine Vet Educ* 7:275, 1995.
- Soule S: Personal communication, 2000.
- Bathe A: Personal communication, 2001.
- Ross M: Personal communication, 2000.
- Rick M: Personal communication, 2000.
- Colbourne C, Yovich J: Suspensory ligament injuries in racing horses: ultrasonographic diagnosis and long term follow up, *Aust Equine Vet* 12:119, 1994.
- Enzerink E, Dik K: Palmar/plantar annular ligament insertion injury: a report of 4 cases, *Equine Vet Educ* 13:75, 2001.
- Denoix J-M, Busoni V, Olalla M-J: Ultrasonographic examination of the proximal scutum in the horse, *Equine Vet J* 29:136, 1997.
- Winberg F, Petterson H: Diagnosis and treatment of lesions in the intersesamoidean ligament and its adjoining structures, *Vet Surg* 23:215, 1994.
- Dabereiner R, Watkins J, Carterm G, et al: Osteitis/osteomyelitis of the axial border of the proximal sesamoid bone in horses, *Proc Am Assoc Equine Pract* 45:156, 1999.
- Wisner E, O'Brien T, Pool R, et al: Osteomyelitis of the axial border of the proximal sesamoid bones in seven horses, *Equine Vet J* 23:383, 1991.
- Dyson S, Denoix J-M: Tendon, tendon sheath and ligament injuries in the pastern, *Vet Clin North Am Equine Pract* 11:217, 1995.
- Dik K, van den Belt A, Enzerink E, et al: The radiographic development of the distal and proximal double contours of the equine navicular bone on dorsoproximal-palmaro-distal oblique (upright pedal) radiographs from age 1 to 11 months, *Equine Vet J* 33:70, 2001.
- Dik K, van den Broek J: Role of navicular bone shape in the pathogenesis of navicular disease: a radiological study, *Equine Vet J* 27:390, 1995.
- Rijkenhuizen A, Nemeth F, Dik K, et al: The arterial supply of the navicular bone in adult horses with navicular disease, *Equine Vet J* 21:418, 1989.
- Colles C, Hickman J: The arterial supply of the navicular bone and its variations in navicular disease, *Equine Vet J* 9:150, 1977.
- MacGregor C: Studies on the pathology and treatment of navicular disease, PhD Thesis, University of Edinburgh, 1984.
- Ostblom L, Lund C, Melsen F: Histological study of navicular bone disease, *Equine Vet J* 14:199, 1982.
- Pool R, Meagher D, Stover S: Pathophysiology of navicular syndrome, *Vet Clin North Am Equine Pract* 5:109, 1989.
- Wright I, Kidd L, Thorp B: Gross, histological and histomorphometric features of the navicular bone and related structures in the horse, *Equine Vet J* 30:220, 1998.
- Wright I, Douglas J: Biomechanical considerations in the treatment of navicular disease, *Vet Rec* 133:109, 1993.
- Wilson A, McGuigan M, Fouracre L, et al: The force and contact stress on the navicular bone during trot locomotion in sound horses and horses with navicular disease, *Equine Vet J* 33:159, 2001.

- Denoix JM: Les origines du syndrome podotrochleaire en relation avec la biomechanique, Proceeding of the Sixth Geneva Congress on Equine Medicine and Surgery, 1999.
- Bowker R, Atkinson P, Atkinson T, et al: Effect of contact stress in bones of the distal interphalangeal joint on microscopic changes in articular cartilage and ligaments, *Am J Vet Res* 62:414, 2001.
- Denoix JM: Functional anatomy of the equine interphalangeal joints, *Proc Am Assoc Equine Pract* 45:174, 1999.
- McGuigan M, Wilson A: The effect of bilateral palmar digital nerve analgesia on the compressive force experienced by the navicular bone in horses with navicular disease, *Equine Vet J* 33:166, 2001.
- Dik K, Van den Belt A, Van den Broek J: Relationships of age and shape of the navicular bone to the development of navicular disease: a radiological study, *Equine Vet J* 33:172, 2001.
- Wright I: A study of 118 cases of navicular disease: radiological features, *Equine Vet J* 25:493, 1993.
- Van Wulfen K, Bowker R: Intersection of the DSIL and the DDFT and its relationship to navicular syndrome, *Proc Am Assoc Equine Pract* 43:405, 1997.
- Van Wulfen K: Normal anatomy of navicular bone suspensory ligaments and its relationship to navicular syndrome, master's thesis, East Lansing, 1999, Michigan State University.
- Svalastoga E, Neilsen K: Navicular disease in the horse: the synovial membrane of bursa podotrochlearis, *Nord Vet Med* 35:28, 1983.
- Svalastoga E, Smith M: Navicular disease in the horse: the subchondral bone pressure, *Nord Vet Med* 35:31, 1983.
- Pleasant S, Baker G, Foreman J, et al: Intraosseous pressure and pathologic changes in horses with navicular disease, *Am J Vet Res* 54:7, 1993.
- Bowker R, Linder K, Van Wulfen K: Anatomy of the distal interphalangeal joint of the mature horse: relationships with the navicular suspensory ligaments, sensory nerves and neurovascular bundle, *Equine Vet J* 29:126, 1997.
- Valdez H, Adams O, Peyton L: Navicular disease in the hindlimb of the horse, *J Am Vet Med Assoc* 172:291, 1978.
- Dyson S: Unpublished data, 1980-2002.
- Ackerman N, Johnson J, Dorn C: Navicular disease in the horse: risk factors, radiographic changes and response to therapy, *J Am Vet Med Assoc* 170:183, 1997.
- Mey G, Kleyn E, Watering C: Een onderzoek naar de eifalljke aanleg voor podotrochlitis, *Tijdschr Diergeneesk* 92:1261, 1967.
- Colles C: The pathogenesis and treatment of navicular disease in the horse. PhD Thesis, University of London, 1987.
- Turner T: Role of hoof balance on navicular disease, International Symposium on Podotrochlosis, Dortmund, 1993.
- Wright I: A study of 118 cases of navicular disease: clinical features, *Equine Vet J* 25:488, 1993.
- Beeman M: The diagnosis of navicular disease (navicular syndrome), *Proc Am Assoc Equine Pract* 31:477, 1985.
- Hertsch von B: Untersuchung des strahlbeines, Proceedings of Sixth Geneva Congress on Equine Medicine and Surgery, 1999.
- Dyson S, Kidd L: A comparison of responses to analgesia of the navicular bursa and intra-articular analgesia of the distal interphalangeal joint in 59 horses, *Equine Vet J* 25:93, 1993.
- Turner T: Predictive value of diagnostic tests for navicular pain, *Proc Am Assoc Equine Pract* 42:201, 1996.
- Schumacher J, Steiger R, Schumacher J, et al: Effects of analgesia of the distal interphalangeal joint or palmar digital nerves on lameness caused by solar pain in horses, *Vet Surg* 29:54, 2000.
- Bowker R, Rockerhouser S, Vex K, et al: Immunocytochemical and dye distribution studies of nerves potentially desensitized by injections into the distal interphalangeal joint or the navicular bursa of horses, *J Am Vet Med Assoc* 203:1708, 1993.
- Schumacher J, Schumacher J, De Graves F, et al: A comparison of the effects of 2 volumes of local anaesthetic solution in the distal interphalangeal joint of horses with lameness caused by solar toe or solar heel pain, *Equine Vet J* 32:43, 2000.
- Butler J, Colles C, Dyson S, et al: Foot, pastern and fetlock. In Butler JA, Colles JM, Dyson SJ, et al: *Clinical radiology of the horse*, ed 2, Oxford, 1999, Blackwell Science.
- Dik K: Radiographic examination. In Wagenaar G: *The pre-purchase examination of the horse*, ed 2, Utrecht, 1992, Bunge.
- Kaser-Hotz B, Ueltschi G: Radiographic appearance of the navicular bone in sound horses, *Vet Radiol Ultrasound* 33:9, 1992.
- Turner T, Kneller S, Badertscher R, et al: Radiographic changes in the navicular bones of normal horses, *Proc Am Assoc Equine Pract* 32:309, 1986.
- Toth J: Ein Beitrag zu den Insertionsmopathien des Strahlbeins, *Pferdheilkunde* 5:111, 1989.
- Berry C, Pool R, Stover S, et al: Radiographic/morphologic investigation of a radiolucent crescent within the flexor central eminence of the navicular bone in Thoroughbreds, *Am J Vet Res* 53:1604, 1992.
- Turner T: Use of navicular bursography in 97 horses, *Proc Am Assoc Equine Pract* 44:227, 1998.
- Ueltschi G: Radiography and scintigraphy in podotrochlosis syndrome, Proceedings of the Sixth Geneva Congress on Equine Medicine and Surgery, 1999.
- Keegan K, Wilson D, Lattimer J, et al: Scintigraphic evaluation of ^{99m}Tc-methylene diphosphonate uptake in the navicular area of horses with lameness isolated to the foot by anesthesia of the palmar digital nerves, *Am J Vet Res* 57:415, 1996.
- Trout D, Hornhof W, O'Brien T: Soft tissue- and bone-phase scintigraphy for diagnosis of navicular disease in horses, *J Am Vet Med Assoc* 198:73, 1991.
- Lauk H, Wanschura C: Scintigraphic evaluation of the navicular bone compared to the distal toe angulation, hoof geometry, clinical and radiographic findings of navicular disease in 105 horses, Proceedings of the Fifth Annual Conference of the European Association of Diagnostic Imaging, 1998.
- Dyson S: Subjective and quantitative scintigraphic assessment of the equine foot and its relationship with hoof pain, *Equine Vet J* 34:164, 2002.
- Ueltschi G: Personal communication, 1998.
- Tiejte S: Die Computertomographie im Strahlbeinbereich des Pferdes: ein Vergleich mit der konventionellen Röntgendaufstellung, *Pferdheilkunde* 11:51, 1995.
- Whitton C, Buckley C, Donovan T, et al: The diagnosis of lameness associated with distal limb pathology in a horse: a comparison of radiography, computed tomography and magnetic resonance imaging, *Vet J* 155:223, 1998.
- Whitton C: Personal communication, 1998.
- Widmer W, Buckwalter K, Fessler J, et al: Use of radiography, computed tomography and magnetic resonance imaging for evaluation of navicular syndrome in the horse, *Vet Radiol Ultrasound* 41:108, 1999.
- Wright I: Personal communication, 1997.
- Bowker R, Van Wulfen K, Springer S, et al: Functional anatomy of the cartilage of the distal phalanx and digital cushion in the equine foot and a hemodynamic flow hypothesis of energy dissipation, *Am J Vet Res* 59:961, 1998.
- Dyson S, Murray R, Schramme R, et al: Magnetic resonance imaging of the equine foot: 15 horses, *Equine Vet J* 2002 (in press).
- Dyson S: The puzzle of distal interphalangeal joint pain, *Equine Vet Educ* 10:119, 1998.
- Dyson S: Unpublished data, 1997-2002.
- Wilson A, McGuigan M, Fouracre L, et al: The force and contact stress on the navicular bone during trot locomotion in sound horses and horses with navicular disease, *Equine Vet J* 33:159, 2001.

- Dejardin L, Arnoczky S, Cloud G, et al: Photoelastic stress analysis of strain patterns in equine hooves after four-point trimming, *Am J Vet Res* 62:467, 2001.
- Willemens M, Savelberg H, Barneveld A: The effect of orthopaedic shoeing on the force exerted by the deep digital flexor tendon on the navicular bone in horses, *Equine Vet J* 31:25, 1999.
- Ostblom L, Lund C, Melsen F: Navicular bone disease: results of treatment using egg-bar shoeing technique, *Equine Vet J* 16:203, 1984.
- Ostblom L, Lund C, Melsen F: Navicular bone disease: a comparative histomorphometric study, *Equine Vet J* 21:431, 1989.
- Rohde C, Andersen D, Bertone A, et al: Effects of phenylbutazone on bone activity and formation in horses, *Am J Vet Res* 61:537, 2000.
- Matthews N, Gleed RD, Short CE, et al: Cardiovascular and pharmacokinetic effects of isoxsuprine in the horse, *Am J Vet Res* 47:2130, 1986.
- Ingle-Fehr J, Baxter G: Effect of oral isoxsuprine and pentoxifylline on digital and laminar blood flow in healthy horses, *Proc Am Assoc Equine Pract* 42:214, 1996.
- Deumer J, de Haan F, Tulp M, et al: Effect of an isoxsuprine-resin preparation on blood flow in the equine thoracic limb, *Vet Rec* 129:427, 1991.
- Belloli C, Carcano R, Arioli F, et al: Affinity of isoxsuprine for adrenoreceptors in equine digital artery and implications for vasodilatory action, *Equine Vet J* 32:119, 2000.
- Turner A, Tucker C: The evaluation of isoxsuprine hydrochloride for the treatment of navicular disease: a double blind study, *Equine Vet J* 21:338, 1989.
- Verschooten F, Desmet P, Peremans K, et al: Navicular disease in the horse: the effect of controlled intrabursal corticoid injection, *J Equine Vet Sci* 10:316, 1990.
- Colles C: Anticoagulant therapy for navicular disease, *Vet Rec* 108:107, 1982.
- Dyson S: Unpublished data, 1982-1986.
- Kirker-Head K: Use of propentofylline for the treatment of equine navicular disease, *Proc Eur Coll Vet Surg* 2:10, 1993.
- Verschooten F, Ooms L, Desmet P, et al: Metrenperone treatment of navicular disease in horses compared with isoxsuprine: a clinical study, *J Equine Vet Sci* 10:230, 1990.
- Crisman M: Evaluation of polysulfated glycosaminoglycan for the treatment of navicular disease: a double blind study, *Proc Am Assoc Equine Pract* 39:219, 1993.
- Wright I: Navicular suspensory desmotomy in the treatment of navicular disease: technique and preliminary results, *Equine Vet J* 18:443, 1986.
- Diehl M: Desmotomy of the navicular collateral ligaments in horses with navicular disease, *Proc Eur Soc Vet Surg* 16:53, 1986.
- Wright I: A study of 118 cases of navicular disease: treatment by navicular suspensory desmotomy, *Equine Vet J* 25:501, 1993.
- Bell B, Bridge I, Sullivan S: Surgical treatment of navicular syndrome in the horse using navicular suspensory desmotomy, *N Z Vet J* 44:26, 1996.
- Turner T: Inferior check desmotomy as a treatment for navicular disease, *Proceeding of the International Symposium on Podotrochosis*, Dortmund, 1993.
- Litzke LF, Dietz O, Nagel E: Angiographie als diagnostisches hilfsmittel und periarterielle sympathektomie mit oder ohne neurektomie in der lahmheitstherapie beim pferd, *Pferdheilkunde* 3:3, 1987.
- Taylor T, Vaughan J: Effects of denervation of the digit in the horse, *J Am Vet Med Assoc* 177:1033, 1980.
- Rendano V: Radiographic interpretation: pedal osteitis, *Calif Vet* 33:27, 1979.
- Linford R, O'Brien T, Trout D: Qualitative and morphometric radiographic findings in the distal phalanx and distal soft tissues of sound Thoroughbred racehorses, *Am J Vet Res* 54:38, 1993.
- Butler J, Colles C, Dyson S, et al: Foot, pastern and fetlock. In Butler JA, Colles CM, Dyson SJ, et al, editors: *Clinical radiology of the horse*, ed 2, Oxford, 2000, Blackwell Scientific.
- Dyson S, Ross M.: Unpublished data, 2001.
- Moyer W, O'Brien T, Walker M: Nonseptic pedal osteitis: a cause of lameness and a diagnosis? *Proc Am Assoc Equine Pract* 45:178, 1999.
- Nickel R, Schummer A, Bewegungsapparat S: Zehegelenke des Pferdes. In Nickel R, Schummer A, editors: *Lehrbuch der Anatomie der Haustiere*, Band 1, ed 2, Berlin, 1961, Paul Parey.
- Bowker R, Van Wulven K, Springer S, et al: Functional anatomy of the cartilage of the distal phalanx and digital cushion in the equine foot and a hemodynamic flow hypothesis of energy dissipation, *Am J Vet Res* 59:961, 1998.
- Ruohoniemi M: Ossification of the collateral cartilages of the distal phalanx in the front feet of Finnhorses, doctoral thesis, Helsinki, Finland, 1997, University of Helsinki.
- Butler J, Colles C, Dyson S, et al: The foot, pastern and fetlock. In Butler JA, Colles CM, Dyson SJ, et al, editors: *Clinical radiology of the horse*, ed 2, Oxford, 2000, Blackwell Scientific.
- Denoux J-M: Personal communication, 2000.