Professor Peter Clegg, MA VetMB PhD CertEO DipECVS FRCVS

University of Liverpool, Professor of Equine Surgery Institute of Ageing and Chronic Disease Leahurst Campus Neston CH64 7TE. UK

p.d.clegg@liv.ac.uk

# UNDERSTANDING EXERCISE-RELATED PATHOLOGY OF THE FETLOCK IN THE COMPETITION HORSE

Subchondral bone pathology is a highly prevalent pathology of the athletic horse. It can affect many sites within joints, with the carpus and the third metacarpal/metatarsal bone being frequent sites in the racehorse, whilst the femoral condyles are also frequently affected in sport horses. Many forms of chronic osteoarthritis (OA) also affect the subchondral bone to a greater or a lesser extent, for instance in small tarsal joint OA. The condition which we refer to as palmar/plantar osteochondral disease (POD) of the third metacarpal and metatarsal (MC/MTIII) condyles has previously been referred to as traumatic osteochondrosis (Pool 1996) in the equine veterinary literature, and is an exemplar of a subchondral bone disease. Although initially considered to be a manifestation of osteochondritis dissecans (Hornof et al. 1981), this condition is now believed to be a biomechanical disorder, resulting from repetitive overload trauma in horses undergoing cyclic high intensity exercise (Pool 1996). The pathology of the condition has been described (Pool 1996; Barr et al. 2008). Early findings include a focus of bluish discolouration of the subchondral bone visible through grossly normal articular cartilage. More severe changes include physical disruption of the subchondral bone associated with varying degrees of pathology of the overlying articular cartilage. Ultimately there may be collapse of the subchondral bone with ulceration of the articular cartilage (Riggs 2006). In some cases these lesions have been reported to be associated with catastrophic condylar fracture (Krook and Maylin 1988). The pathological changes are clinically evident as a performance limiting lameness which may be bilateral or, in some cases, quadrilateral and as a result the affected horse may present with a poor action rather than overt lameness (Pilsworth 2003).

The epidemiology of the condition has so far been poorly described other than the strong belief that the disease appears to occur only in animals used for racing disciplines; however the disease has been observed in other horses used for fast galloping or other sporting disciplines, for instance eventers and show jumpers. We have shown previously in a post-mortem survey of 64 racehorses that POD had a within horse prevalence of 67%. There was a significant linear relationship between grade of POD and grades of wear lines, cartilage ulceration and dorsal impact injuries within the joint. There was a significant relationship, but this was not linear, between grade of POD and grade of linear fissures.

Using ordinal logistic regression, compared to condyles with grade 0 or grade 2 linear fissures, condyles with grade 1 linear fissures were found to be more likely to have a lower POD grade (Barr et al. 2009).

In an analysis of a separate cohort of 104 horses examined at post mortem we demonstrated through multilevel ordinal regression analysis showed that the grade of POD was significantly higher in the forelimb compared to hind limb. In the forelimb there were higher POD grades medially (P=0.005) whereas in the hind limb the grade of POD was higher in the lateral condyle (P=0.03). There appeared to be no difference between left and right forelimbs and this was consistent even after analysing fore and hind limbs separately.

There was a significant positive relationship between POD grade (i.e. as the grade of pathology increased the probability of higher grades of POD increased) and the following pathologies: grade of cartilage loss on the condyles ; grade of dorsal impact; grade of cartilage loss on the sesamoids and the grade of wear lines. Horses with signs of marginal remodelling were also more likely to have higher grades of POD (Pinchbeck et al. 2013a)

More recently we have performed epidemiological studies to identify risk factors for POD in a cohort of 164 horses euthanased at the HKJC in which the grade of POD was assessed at post-mortem examination and the horses history obtained from veterinary, training and racing records at the HKJC. Univariable analysis showed that a number of racing variables had significant associations with grade of POD. Those with odds ratio less than one and therefore associated with an increased probability of being in a higher POD grade categories were racing before import into Hong Kong; greater age at retirement; increasing number of races in Hong Kong, in lifetime, on turf, at either Happy valley or Sha tin racecourse; increasing number of racing seasons; increasing number of races per season; increasing total lifetime race distance and increasing average race distance over life career or in most recent season; increasing race earnings over lifetime and increasing number of intervals up to 16 weeks between racing (Pinchbeck et al. 2013b).

Those with odds ratio greater than one and therefore associated with a decreases probability of being in higher POD grade categories were fewer and included starting racing career at an older age; increasing time between retirement or last race and the

time of death or euthanasia; an increasing number of intervals of greater than 16 weeks duration during the lifetime racing career. Variables with no significant effect included import age or age of first race in HK, earnings and performance in the most recent racing season and the horses average or peak weight during its career (Pinchbeck et al. 2013b).

We have had the opportunity to examine approximately 70 condylar specimens from racehorses by a variety of techniques including confocal microscopy, back scattered electron microscopy, point source digital radiography, microCT, Clinical MRI and CT, as well as gross pathology and conventional microscopy.

These studies have obvious limitations as the data is obviously entirely cross-sectional, and thus any association with progression/regression of pathology has to be implied: however it has been possible to determine a number of specific early pathological conditions which occur within the palmar condyle, and to associate these changes with specific clinical imaging changes in certain circumstances.

As reported by many others other, training is associated with palmar sclerosis and densification of the sub-chondral bone. A variety of pathological process then become apparent in this densified bone, including microfractures which occur both perpendicular and parallel to the articular surface. Such early changes cannot be discerned with clinical MRI or CT, but may be the earliest changes observed using nuclear scintigraphy. Subsequent to these changes, bone resoprtion occurs specifically in the subchondral region, and is most obvious when the horse is removed from fast work. This bone resportion leads to a cavity overlaid by dense subchondral bone, which can either plastically deform, or fractures into this space. There appears to an ability to repair and regenerate such lesions, with apparent resolution of such pathologies. There seems to be an obvious interaction between race training and such pathologies, with work driving the presence of sclerosis/densification and microfracture, whilst rest leads to osteoclastic resorption and cavity formation.

We identified mineralised protrusions from the calcified cartilage extensind into the hyaline articular cartilage. Such protrusions were associated with microcracks in the subchondral bone, and adjacent OA. We are currently unable to diagnose such changes with clinical imaging in the horse (Boyde et al. 2011).

Our data supports the hypothesis that subchondral bone pathology in the horse occurs as a result of conflicting process that interact between strenuous race training, and resorptive processes that may occur as a result of periods of rest. Avoidance or treatment of such injuries may be best managed by developing interventions relating to duration of strenuous exercise and periods of rest. The interactions associated with bone formation and resorption, and the role of bone fatigue injuries has been the subject of a recent comprehensive review (Martig et al. 2014).

**References**


- Barr, E.D., Pinchbeck G.L., Clegg, P.D. and Riggs, C.M., (2009) Post Mortem Evaluation of Palmar Osteochondral Disease (Traumatic Osteochondrosis) of the Metacarpo-/Metatarsophalangeal Joint of Thoroughbred Racehorses – 64 Cases. *Equine Veterinary Journal*, **41**, 366-371
- Hornof W.J., O'Brien T.R., Pool R.R. et al. (1981) Osteochondritis dissecans of the distal metacarpus of the adult racing Thoroughbred horse. *Vet Radiol* **22**, 98-105
- Krook L. and Maylin G.A. (1988) Fractures in Thoroughbred racehorses. *Cornell Vet*. **78**, 7-133
- Martig S, Chen W, Lee PV, Whitton RC. (2014) Bone fatigue and its implications for injuries in racehorses. *Equine Vet. Journal*, **46**, 408-415.
- Norrdin R.W. and Stover S.M. (2006) Subchondral bone failure in overload arthrosis: a scanning electron microscopic study in horses. *J Musculoskelet Neuronal Interact*. **6**, 251-7.
- Pilsworth R.C. (2003) 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
- Pool R.R. (1996) Pathologic Manifestations of Joint Disease in the Athletic Horse. In *Joint Disease in the Horse*, Eds: CW McIlwraith and GW Trotter, W.B Saunders Co, Philadelphia, pp87-104
- Riggs C.M. (2006) Osteochondral injury and joint disease in the athletic horse. *Equine vet Educ*. **18**, 100-112
- Pinchbeck, GL, Clegg, PD, Boyde, AM, and Riggs, CM (2013) Pathological and clinical features associated with palmar osteochondral disease of the metacarpo /metatarso phalangeal joint in Thoroughbred racehorses. *Equine Vet. Journal,* **45**, 587-592
- Pinchbeck, GL, Clegg, PD, Barr, ED, Boyde, AM, and Riggs, CM (2013) Horse, training and race-level risk factors for palmar/plantar osteochondral disease in the racing Thoroughbred. *Equine Vet. Journal*, **45**, 582-586
- Boyde, AM, Riggs, CM, Bushby, AJ, Pinchbeck, GL and Clegg, PD (2011) Cartilage damage involving extrusion of mineralised matrix from the articular calcified cartilage and subchondral bone. *European Cells and Materials*, **21**, 470-478