Recent developments made in reducing the prevalence of catastrophic fractures in racehorses

Investigates recent developments made in identifying reliable pre-fracture markers and screening tests to detect horses at greater risk of fracture and reduce the incidence of euthanasia associated with catastrophic fracture

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Musculoskeletal injuries, particularly fractures of the third metacarpus, are the main reason for early retirement and mortality in racehorses (Loughridge *et al.,* 2017). Although the rate of equine fatalities resulting from fractures is slowly decreasing, it still represents a significant welfare concern in horseracing worldwide (Australian Veterinary Association, 2016; Loughridge *et al.,* 2017). Evidence suggests that equine fractures most commonly result from fatigue injuries. Chronic exposure leads to cumulative changes in the bone, affecting its structural integrity and increasing the risk of fracture (Noble *et al.,* 2016). As subchondral bone and calcified cartilage are major sites of stress absorption within a joint, measuring changes in their properties may allow us to predict when fractures are most likely to occur (Williamson *et al.,* 2017). The research articles reviewed investigate the use of these properties in developing diagnostic methods to prevent equine fatalities resulting from fractures.

Loughridge *et al* (2017) conducted a study that aimed to investigate the association between bone density gradients and lateral condylar fractures of the third metacarpus (MC3) in horses. Through the use of computed tomography (CT), subchondral bone density could be compared in the limbs of racehorses with and without fractures of the contralateral limbs (Loughridge *et al.,* 2017). A total of 89 thoroughbred racehorses were divided into three groups: fractured (42), non-fractured contralateral condyle (42) and control condyles (94) (Loughridge *et al.,* 2017). Subchondral bone density was measured in six regions and analysed for both variances in bone density patterns and differences related to lateral condyle condition (Loughridge *et al.,* 2017). The results of the study revealed that bone density was significantly higher in fracture and non-fracture groups compared to the control group (Loughridge *et al.,* 2017). Additionally, limbs with lateral condylar fractures of the MC3 had increased heterogeneity in density in comparison to non-fractured and control groups (Loughridge *et al.,* 2017). Therefore, racehorses with lateral condylar fractures of the third metacarpal bone developed characteristic, pathological changes in subchondral bone density (Loughridge *et al.,* 2017). This study yielded two notable limitations. Bone density was qualitatively calculated, which had the potential to introduce bias. Secondly, variations in sampling contributed to the differences in bone density between fractured and non-fractured groups (Loughridge *et al.,* 2017). These results provide evidence of the link between changes in bone density, high intensity exercise and the increased risk for fractures in racehorses (Loughridge *et al.,* 2017). This research provides the foundations for the development of a pre-screening tool that uses pathological changes in bone density to detect horses at risk of fracture.

In light of this, Tranquille *et al.,* (2017) developed a study to determine whether magnetic resonance imaging (MRI) could be used as a pre-screening tool to identify pre-fracture pathology and detect horses at risk of catastrophic fracture. A total of 192 MC3s were split into three cohorts: fractured (47), non-fractured contralateral limbs (47) and non-fractured control condyles, before undergoing MR imaging (Tranquille *et al*., 2017). The depth of subchondral/trabecular bone was measured at several sites and analysis was conducted to determine whether there was an association between bone depth and risk of fracture (Tranquille *et al*., 2017). The results concluded that increases in the depth of dense subchondral bone was associated with the increased likelihood of lateral condyle fracture (Tranquille *et al*., 2017). The test yielded a high specificity (98%), which indicates the potential for MRI to be utilised as a reliable prescreening tool to identify truly negative horses within the population (Tranquille *et al*., 2017). The inability to blind the status of the fractured bones to the individual performing the measurements was a significant limitation of this study. Whether these results could be extrapolated to horses training but not racing was another issue raised. This study has made significant developments in research by identifying detectable pre-fracture markers that could be exploited in future screening programs and could be used effectively to rule out a large population of horses from being at risk of fracture (Tranquille *et al*., 2017).

Although, the above studies provide evidence for the association between subchondral bone thickness and increased fracture risk, the biomechanical changes that subchondral bone and calcified cartilage undergo during injury pathogenesis remains largely unknown (Williamson *et al.,* 2017). Williamson *et al*. (2017) set out to determine the correlation of joint surface mechanical properties with training history and microstructure of the MC3 of Thoroughbred racehorses. MC3s from 31 Thoroughbred horses of varying age, sex and training histories, were examined via micro-computed tomography, for analysis of microstructure properties (mineral density, connectivity density and trabecular pattern), and via reference point indentation (RPI). This provided a measurement of indentation distance increase (IDI), which is inversely associated with ease of fracture (Williamson *et al.,* 2017). The association between indentation distance increase (IDI), micro-CT variables and training variables was analysed (Williamson *et al.,* 2017). Bone mineral density was not significantly associated with IDI and was consequently excluded from the model (Williamson *et al.,* 2017). Untrained horses and those that died as a result of musculoskeletal fatigue injuries had higher IDI values, which in-turn was positively correlated with connectivity density (Williamson *et al.,* 2017). This suggests that horses with reduced articular surface material properties have a reduced ability to resist forces and are consequently more susceptible to fracture (Williamson *et al.,* 2017). However, as RPI is a novel technique, articular surface unevenness may have introduced some measurement variability (Williamson *et al.,* 2017). This study concluded that measures of bone connectivity and trabecular surface shape are more reliable determinants for assessing fracture risk. The changes that occur when horses commence training represent a period when fracture risk at this site is highest (Williamson *et al.,* 2017).

These articles have made remarkable advancements in research for the development of a suitable screening method for assessing fracture risk. Ultimately, this would allow us to detect horses at risk of fracture and implement suitable interventions, thereby reducing the number of horses globally that are subjected to euthanasia as a result of catastrophic fracture (Williamson *et al.,* 2017).

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