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# CONFORMATION AND SOUNDNESS

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## Introduction

The factors that predispose the racehorse to catastrophic injury and musculoskeletal disease continue to be an issue of debate. The cause of racing and training injuries in the horse is considered to be multifactorial, with genetics, racing surface, number of starts, age of the horse, pre-existing disease, biomechanics (conformation), and trauma being implicated as potential etiologic factors (McIlwraith, 1986; Kobluck et al., 1990; Mohammed et al., 1991; Dolvik and Klemetsdale, 1996). Each of these factors needs to be evaluated independently to determine its contribution to the complicated developmental scheme of race injury. Previous experimental studies on the cause of racing injuries in the horse have focused primarily on racing surface (Chaney et al., 1973; Hill et al., 1986), number of starts (Magnusson, 1985; Kobluck et al., 1990; Dolvik and Klemetsdale, 1996), and trauma (Jeffcott et al., 1982; Rossdale et al., 1985).

A controlled experimental study was needed to answer the question of whether conformation plays a role in racing injuries. Two studies were done. The purpose of the first study in racing Thoroughbreds was to make objective measures of conformation and determine if certain limb conformations predispose the racing Thoroughbred to musculoskeletal disease (from minor injury to catastrophic injury). The aim of the racing Quarter Horse study was to make the same determinations.

## Materials and Methods

*Thoroughbred Study.* Included in this study were 115 three-year-old horses bred and reared by the same stable. Photographs were taken of horses with markers placed at designated locations. The slides were scanned, and conformation was measured using a software program (NIH Image Program). Left lateral radiographs, as well as photographs from front and rear, were taken. All photographs had a ruler in place to measure size, and measures could be made of length and angle using points for identification. In addition to lengths and angles, an objective method of grading the degree of offset (bench) knee conformation was also used.

Clinical observations were recorded for each horse, and clinical conditions (including radiographic diagnoses), as well as subjective evaluation of limb rotation, were made. Clinical data were recorded as “event” or “no event.” Outcomes with frequencies greater than 5% remained in the data set for statistical analysis, and stepwise (forward) logistic regression analysis was performed to investigate the relationship between the binary response of the clinical outcomes, probability, and the conformation variables by the method of maximum likelihood (Version 6.12, SAS Institute, Inc., Cary, NC). Odds ratios (OR) of 95% confidence intervals were calculated to evaluate relative risk of musculoskeletal problems.

*Quarter Horse Study.* One hundred sixty-two two-year-old Quarter Horse racehorses in training at Los Alamitos Racecourse, California were included in this study. The horses had no previous racing history or known racing injury or lameness, and all were paid up in two-year-old races (futures). Data were collected in the same fashion as for the Thoroughbred study, and clinical data were analyzed and odds ratios calculated in the same fashion as previously described.

## Results

Clinical outcomes that were significantly ( $p < .05$ ) associated with conformational variables included effusion of the front fetlocks, effusion of the right carpus, effusion of the carpus, effusion of the hind fetlock, fracture of the right or left carpus, right front fetlock problems, and hind fetlock problems. The odds of having effusion in the front fetlock increased by a factor of 1.3 for every one-inch increase in the bottom line (length of underside) of the neck. The risk of effusion of the right front fetlock increased 1.18 times for every 10% increase in the right offset ratio (a measure of offset knees). For every 10% increase in right offset ratio, the odds of right front fetlock problems increased by a factor of 1.26. For every degree increase in right carpal angle (beyond 180 degrees in a carpal valgus direction), the odds of effusion in the right front carpus decreased by a factor of 0.68. The odds for effusion in the front carpus increased 1.45 for each 10% increase in dorsal:palmar hoof angle ratio. (This is dorsal wall angle:palmar wall angle. If ratio is one, the angles are the same. If greater than one, the heel slope is more, i.e., underslung heels). The risk of effusion in the hind fetlock increased 1.1 times for every degree increase in hind dorsal hoof angle. The odds of sustaining a fracture in the carpus decreased by a factor of 0.53 for every inch increment in scapula length, and, similarly, the odds of a fracture in the front limb were decreased by a factor of 0.5 for every inch increment in scapula length. The risk of right carpal fracture decreased 0.24 times for each one degree increase in carpal valgus angle viewed from the front (increasing carpal valgus). The odds of a fracture in the right forelimb also decreased (OR 0.71) for every degree increase in the carpal valgus angle measured from the front, assuming hoof ratio

was held constant. For every 10% increase in the right hoof angle ratio, the odds of a right front limb fracture decreased by a factor of 0.52 with right carpal angle held constant. The dorsal:palmar or dorsal:plantar ratio is the angle of toe in relationship to the angle of the palmar or plantar surface. It can be assumed that the increased odds for carpal effusion reported here are associated with improper hoof balance.

*Quarter Horse Study.* The length of the humerus was significant for several clinical entities. For every inch increase in the length of the humerus, the odds for a proximal first phalanx chip fragment in the left foreleg increased by a factor of 2.3, and the odds of sustaining synovitis/capsulitis increased by a factor of 1.85 in the left carpus and by 1.7 in the right carpus, all other factors in the model held constant. The length from elbow to ground was found to be significant in both carpi. The odds of sustaining a carpal chip fragment in the left foreleg rose by a factor of 2.06 in the right foreleg and a factor of 2.58 in the left foreleg for every one inch increase in the length from elbow to ground, assuming all other factors in the model held constant. The length of the toe was also significant, as when the length of the toe increased by one inch, the odds of sustaining a carpal chip fracture increased by a factor of 40.33.

For every degree increase in the angle of the shoulder (i.e., more upright), the odds of sustaining a proximal first phalanx chip fragment increased by a factor of 1.48. The odds of sustaining synovitis and capsulitis in the carpus decreased by 0.89 with every degree increase in the angle of the shoulder. For every degree increase in the angle of the left fore pastern (more upright), the odds of sustaining synovitis and capsulitis in the carpus were increased by a factor of 1.09. As the knee offset ratio increased by 10%, the odds of synovitis and capsulitis in both left and right front fetlocks increased by a factor of 2.26.

## Discussion

The method used for measuring conformation provided an objective means to investigate the relationship between conformation and clinical conditions, as most reported relationships are based on logical hypotheses and practical experience (Green, 1969; Beeman, 1973; Stashak, 1985). When fetlock problems were grouped together, the right offset knee ratio increased the odds of fetlock problems in the right front fetlock by a factor of 1.26 for every 10% increase, insinuating change of stress in the fetlock joint with an offset knee. It is not surprising that the highest frequency of all clinical outcomes was that of effusion in the front fetlock joints (28% and 31% for right and left, respectively) because many horses in training develop inflammation and synovial effusion, along with varying degrees of lameness (Goodman and Baker, 1990).

The recognition that carpal effusion and incidence of fracture decreased as the carpal angle increased, as viewed from the front, is an important finding in the

Thoroughbred in light of the common desire of a buyer to have a straight leg and the common practice of surgically manipulating carpal valgus to achieve a straighter forelimb. Other significant findings were offset knees being associated with fetlock problems, long toe being associated with carpal problems, and longer scapula length decreasing the likelihood of forelimb fractures.

In the Quarter Horses, many of the odds ratios presented close to 1.0, indicating little importance. However, proximal first phalanx chip fractures, synovitis and capsulitis of the carpus and coffin joint, and carpal chip fractures were associated with conformation variables. It is expected that, with greater numbers, other conformation variables could become significant. The significance of offset knees was supported by the data with an increase in synovitis and capsulitis, as well as carpal chip fragmentation.

Information in this article is provided from "The Role of Conformation in Musculoskeletal Problems in the Racing Thoroughbred and Racing Quarter Horse," by C.W. McIlwraith, T.A. Anderson, P. Douay, N.L. Goodman, and L.R. Overly.

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