Role of Conformation in Musculoskeletal Problems in the Racing Thoroughbred and Racing Quarter Horse

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Abstract
Using a computer-based digitized photographic method of objective analysis of conformation, certain conformation variables that affect the incidence of musculoskeletal problems in the racing Thoroughbred and Quarter horse have been identified.

1. 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 multi-factorial, with genetics, racing surface, number of starts, age of the horse, pre-existing disease, biomechanics (conformation), and trauma being implicated as potential etiologic factors [1-4]. 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, [5,6] number of starts, [2,4,7] and trauma [8-11].
A controlled experimental study was needed to answer the question of whether or not conformation plays a role in racing injuries. Two studies were done. The objective 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.

2. Materials and Methods
Thoroughbred Study - Included in this study were 115 3-yr-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 [a]. 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 off-set (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. Additionally, stepwise (forward) logistic regression analysis was performed to investigate the relationship between the binary response of the clinical outcomes, probability, and conformation variables by the method of maximum likelihood [b]. Odds ratios (OR) of 95% confidence intervals were calculated to evaluate relative risk of musculoskeletal problems.
Quarter Horse Study - One hundred sixty-two 2-yr-old Quarter horse racehorses in training at Los Alamitos Racecourse, CA, were included in this study. The horses had no previous racing history or known racing injury or lameness, and all were paid-up in 2-yr-old races (futurities). Data were collected in the same fashion as for the Thoroughbred study. Clinical data were analyzed and odds ratios were calculated in the same fashion as previously described.

3. Results
Thoroughbred Study - Clinical outcomes that were significantly (p < 0.05) 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, problems with the right front fetlock, and problems with the hind fetlock. The odds of having effusion in the front fetlock increased by a factor of 1.3 for every 1-in increase in the bottom line (length of underside of neck) of the neck. The risk of effusion in the right front fetlock increased 1.18 times for every 10% increase in the right off-set ratio (a measure of off-set knees; Fig 1). For every 10% increase in right off-set 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° 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 the ratio is 1.0, the angles are the same. If the ratio is >1.0, the heel slope is greater than dorsal hoof angle (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 every 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 ratio or dorsal:plantar ratio is the angle of the toe in relationship to the angle of the palmar or plantar surface. It can be assumed that the increase in 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 (assuming that all other factors in the model were 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 1 in increase in the length from elbow to ground (assuming that all other factors in the model were held constant). The length of the toe was also significant, because when the length of the toe increased by 1 in, 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. With the knee off-set ratio increased by 10%, the odds of synovitis and capsulitis in both left and right front fetlocks increased by a factor of 2.26.
4. Discussion

The method used for measuring conformation provided an objective means to investigate the relationship between conformation and clinical conditions, because most reported relationships are based on logical hypotheses and practical experience [12-14]. When fetlock problems were grouped together, the right off-set 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 off-set 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 [15].

The recognition that carpal effusion and incidence of fracture decreased as the carpal angle, viewed from the front, increased is an important finding in the Thoroughbred, because the common desire of a buyer is to have a straight leg and the common practice of surgically manipulating carpal valgus is used to achieve a straighter forelimb. Other significant findings were off-set knees being associated with fetlock problems, long toe being associated with carpal problems, and longer scapula length decreasing the likelihood for forelimb fractures.

In Quarter horses, many of the ORs presented were 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 off-set knees was supported by an increase in synovitis and capsulitis as well as carpal chip fragmentation seen in the data.

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Footnotes
[a] National Institute of Health, Bethesda, MD, 20817.

References


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