Hoof Balance Characteristics Associated with Catastrophic Injury of Thoroughbred Racehorses

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Perfect mediolateral symmetry may not be the optimal mediolateral hoof balance, and decreasing the difference between toe and heel angles should be considered to help prevent catastrophic injury.

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1. Introduction

Hoof balance affects the distribution of forces and patterns of movement of the lower limb, and alterations in these components of locomotion are hypothesized to contribute to racehorse injury. Lower toe angles were reported for racehorses with musculoskeletal problems, and toe grabs (which may decrease the functional toe angle) have been associated with an increased risk of catastrophic injury; however, to our knowledge a comprehensive, analytic evaluation of hoof conformation and the risk of catastrophic injury has not been reported.

The objective of this case-control study was to identify hoof size, shape, and balance measurements associated with the risk of forelimb catastrophic musculoskeletal injury (CMI), specifically including fatal suspensory apparatus failure (SAF) and cannon bone lateral condylar fracture (CDY) of Thoroughbred racehorses in California.

2. Materials and Methods

Front hooves were collected from 95 Thoroughbred racehorses examined through the California Horse Racing Board Postmortem Program between February 23, 1994 and July 29, 1996. Cases of CMI (70 horses) included 43 horses that sustained SAF and ten horses with CDY. As controls, 25 horses that died for reasons unrelated to the musculoskeletal system (non-CMI) were compared with each group of cases.

Signalment and injury data were obtained from the Postmortem Program, and horses were categorized (yes or no) as having a CMI, SAF, or CDY. Length, angle, and area measurements were obtained from digital photographic images of each hoof.

One-way analysis of variance models were used to individually compare mean (± SEM) values between non-CMI horses and CMI, SAF, and CDY horses, with significance set at p < 0.1. Multivariable logis-
tic regression was used to estimate odds ratios with a 90% confidence interval (CI) for each variable in the final CMI, SAF, and CDY models. CMI and SAF models were adjusted for the potential confounding effects of age, sex, toe grab height, and the presence of a rim on the shoe.

3. Results

No measurements related to overall hoof size were significantly different between cases and controls. Toe and heel angles were higher among controls (50.7° ± 0.5° and 41.6° ± 0.8°, respectively) compared with SAF horses (49.2° ± 0.4° and 39.3° ± 0.6°) and CDY horses (48.8° ± 0.8° and 38.8° ± 1.5°). The toe-heel angle difference was only slightly higher (p = 0.2) among SAF horses (10.1° ± 0.6°) than it was among control horses (8.8° ± 0.8°).

Several measures of mediolateral balance were significantly different between cases and controls. For control horses, the lateral aspect of the hoof was larger than the medial aspect, with the lateral-medial ground surface width difference (3.9 ± 1.0 mm) and lateral-medial sole area difference (248.9 ± 52.2 mm²) larger compared with those of CMI horses (1.4 ± 0.6 mm and 74.8 ± 30.7 mm², respectively) and SAF horses (0.8 ± 0.9 mm and 86.8 ± 40.4 mm², respectively), and compared with the CDY horse lateral-medial sole area difference (−103.0 ± 57.6 mm²).

The adjusted odds of CMI were 0.75 times lower (90% CI, 0.43–1.32) for a 3° increase in toe angle, 0.62 times lower (90% CI, 0.48–0.80) for a 5-mm increase in the lateral-medial ground surface width difference, and 0.49 times lower (90% CI, 0.27–0.87) for a 100-mm² increase in the lateral-medial sole area difference.

The adjusted odds of SAF were 0.56 times lower (90% CI, 0.29–1.10) with a 3° increase in toe angle, 6.75 times greater (90% CI, 1.16–39.26) with a 10° increase in the toe-heel angle difference, and 0.58 times lower (90% CI, 0.42–0.80) with a 100-mm² increase in the sole area difference.

The odds of CDY were 0.26 times lower (90% CI, 0.08–0.97) with a 3° increase in toe angle, 0.15 times lower (90% CI, 0.03–0.76) with a 5-mm increase in the lateral ground surface width, and 0.35 times lower (90% CI, 0.16–0.75) with a 100-mm² increase in the lateral-medial sole area difference. The CDY model failed to converge when age, gender, toe grab, and rim were added to the model.

4. Discussion

CMI, SAF, and CDY horses were characterized by more acute toe and heel angles compared with controls; however, these differences were only significant for the SAF and CDY groups. A more substantial and significant influence on the risk of SAF was the difference between toe and heel angles. The evidence suggests that an increased toe-heel angle difference is a risk factor for SAF and may be more important than toe or heel angle alone.

It is often recommended that the hoof should be trimmed to axial symmetry for the optimal mediolateral balance. In the study presented here, however, mediolateral symmetry was more characteristic of injured horses than of controls. This suggests that trimming the hoof to perfect mediolateral symmetry may not be the best approach to preventing catastrophic injury.

The moderate sample size and small number of controls relative to the number of cases in this study likely resulted in low power for many of the statistical analyses conducted. To help offset this limitation, the level of statistical significance was set at p < 0.1, prior to data analysis. Because of the limited number of CDY cases available for study, the CDY model could not be adjusted for the possible confounding effects of age, sex, toe grab height, or the presence of a rim shoe. As a result, true odds ratio estimates for CDY could be substantially higher or lower than those reported here.

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References and Footnotes


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