Evidence-based farriery: pressure plate evaluation of shoeing with a wide toe in sound warmblood horses at the walk and trot

Oosterlinck, Maarten[1], Oomen, Annemiek M.[2], Sonneveld, Danse C.[2], Pille, Frederik[1], Gasthuys, Frank[1], and Back, Willem[1,2]

[1] Dept. Surgery and Anaesthesiology of Domestic Animals, Faculty of Veterinary Medicine, Ghent University, Belgium; [2] Dept. of Equine Sciences, Faculty of Veterinary Medicine, Utrecht University, The Netherlands

Introduction: By decreasing biomechanical stresses on injured anatomical structures, corrective shoeing may provide immediate pain relief and may even support the healing process in many equine orthopaedic disorders. Contrary to modern evidence based medicine, most farriery techniques have been developed empirically. Recently, researchers succeeded in performing detailed evaluation of the effect of shoeing with a rolled toe using a dynamically calibrated pressure plate.[1] Because a toe wedge has been shown to decrease the extension of the fetlock joint and the strain on the superficial digital flexor tendon (SDFT) and suspensory ligament (SL),[2] a shoe with a wide toe and narrow branches is increasingly being used in the treatment of SDFT and SL injuries. Presumably, this shoe results in more extension of the distal interphalangeal joint, hence a decreased strain in the SDFT and SL, at least in a soft bedding. It was hypothesized that a pressure plate could quantify the altered load distribution underneath this shoe even on a solid surface, providing a first step towards evidence based application of this shoeing procedure.

Methods: Six sound Dutch Warmblood mares (10.5 ± 3.7 years; height at the withers 1.62 ± 0.02 m; 585.5 ± 43.5 kg) were shod with 2 types of shoes (normal flat shoe and shoe with a wide toe and narrow branches) in a cross-over study. The horses were led at the walk and trot over a pressure plate (Footscan 3D 1 m-system, 250 Hz, RsScan International) with dedicated software (Footscan Scientific Gait 7, RsScan International), mounted on top of a force platform (Z4852C, Kistler), embedded in the middle of a 20 m long track, covered with a 5 mm rubber mat. A trial was considered valid if the horse moved at a constant pace, looking straight forward, while gait velocity was within a preset range and the hoof of at least one forelimb fully contacted the plate surface. Five valid measurements were collected for both forelimbs. Hoof prints were divided in a toe and heel region by a line through the maximal hoof width. For the toe and heel region the following variables were recorded: 1) stance duration (ST), 2) peak vertical force (PVF), 3) vertical impulse (VI), 4) peak vertical pressure (PVP), 5) time at which the maximal pressure occurs (tPVP), 6) total vertical pressure over the complete stance phase (TVP) and 7) contact area (CA). For all variables, hoof balance (toe versus heel) was calculated as: $[(X_{TOE} - X_{HEEL}) / 0.5 (X_{TOE} + X_{HEEL})] \times 100\%$. Statistical analysis (linear mixed model; Wilcoxon signed ranks test) was performed with SPSS 17.0 with $\alpha = 0.05$ and 0.025 respectively.

Results: There were no significant differences in toe-heel balance between both shoes for ST, PVF and VI. The toe-heel balance of both PVP and tPVP appeared lower (i.e. slightly lower and earlier exerted maximal pressure in the toe region), although these did not reach statistical significance ($P = 0.097$ and 0.079 respectively). However, the shoe with a wide toe showed a significantly larger CA and a lower TVP in the toe region ($P < 0.001$ and $P = 0.05$ respectively).

Conclusions: The present study demonstrates that the shoe with a wide toe results in a significant increase in toe contact area and a decrease in pressure underneath the toe, although the net force exerted in the toe region is not significantly affected. This altered pressure distribution can promote sinking of the heels in a deformable surface such as arena footing, providing a rationale for its application in SDFT or SL injuries.

References

1. Van Heel, M.C.V., Van Weeren, P.R. and Back, W. Shoeing sound Warmblood horses with a rolled toe optimises hoof-unrollment and lowers peak loading during breakover. *Equine vet. J.* 38 : 258-262, 2006.
2. Lawson, S.E.M., Château, H., Pourcelot, P., Denoix, J.-M. and Crevier-Denoix, N. Effect of toe and heel elevation on calculated tendon strains in the horse and the influence of the proximal interphalangeal joint. *J. Anat.* 210 : 583-591, 2007.