Do Air-Vented Boots Effectively Cool Down Tendon Temperature in the Equine Distal Limb During Exercise and Recovery?

Harriet Raymond (Aberystwyth University)

Introduction

Horses (*Equus caballus)* are susceptible to injuries because the distal limb only uses tendons and ligaments to create movement, rather than muscles (Wickler *et al.*, 2004), which means the tendons and ligaments must meet the demands of exercise that muscles meet in other animals. In the United Kingdom, 2002, 21% of horses did not start their CCI competition due to injury of the Superficial Digital Flexor Tendon (SDFT) or suspensory ligament (Singer *et al.*, 2008). Boots are often put on the equid to support and protect the distal tissues (Hoyt., 1984; Kicker *et al.*, 2004).

During exercise heat is produced to allow elasticity of the tendon and ligaments, however boots can trap this heat (Snively *et al.*, 2015) and increase the core temperature of the tendon leading to cell death, resulting in rupture of the tendon (Sander *et al.*, 2013). Repeated exposure to hyperthermia or high stresses has been suggested to cause changes in the tendon matrix composition (Bateson *et al.*, 2003) resulting in SDFT injuries and provoking research into air-vented boots to help cool the limb during exercise (Sander *et al.*, 2013). Previous research has found core tendon and skin surface tendon temperatures significantly increased ($p<0.001$) when a boot was worn compared to unbooted limbs, however there was limited effect on temperature between boot types, particularly air-vented boots (Sear *et al.*, n.d; Sander *et al.*, 2013; Westermann *et al.*, 2014; Snively *et al.*, 2015)

Abstract

Injuries of the equine distal limb are common in performance horses and boots are used to protect and support the distal limb to decrease the chance of developing SDFT injuries. However, previous studies have found boots increase core and skin surface tendon temperatures so this study aimed to determine if air-vented boots effectively cool the equine distal limb after exercise versus an un-booted limb, and compared two brands of air-vented boots. Five horses of similar age carried out an intense exercise regime with one forelimb wearing either a Premier Equine air-cooling boot or a Veredus E-Vento boot. The opposite boot was unbooted, acting as the control. The boot was removed immediately after exercise and the temperature was recorded every minute, using an infra-red camera. A significant difference was found between booted and unbooted distal limb skin surface temperature of the tendon areas of both Premier Equine and E-Vento boots. Furthermore, a significant difference was found between Premier Equine and E-Vento booted limbs. Therefore, air-vented boots are more beneficial than unbooted forelimbs during and after exercise, however the Veredus E-Vento boot proved to be more effective than Premier Equine Air-cooling boots.

Aims and objectives

This project aimed to investigate if air vents lower skin surface tendon temperatures during exercise, resulting in quicker recovery of the forelimb.

The objective of this project was to determine the skin surface temperature recovery of the tendon using an infra-red camera of horses wearing two types of air cooling boots, Premier Equine Air-Cooled Original boots and Veredus E-Vento boots, individually by comparing to the unbooted forelimb.

Materials and methods

Five healthy horses of similar age ($6.5\pm0.5^{o}C$), height and work load with no previous tendon injuries were used in this study and the same competent rider was used throughout the study. The left distal limb was booted with either a Premier Equine air-cooling boot or Veredus E-Vento boot and the right

distal limb was unbooted. Horses exercised for 30 minutes (5min trot, 5min canter, 10min trot, 10min canter) in the same order at the same time each day. Boot was removed after exercise and the skin surface tendon temperature recorded immediately using a FLIR T420 infrared camera (Figure 1). Temperature measurements were taken every minute, whilst the horse was walking on the horse walker, until the surface temperature of the booted limb was similar to the unbooted limb or the temperature plateaued for more than three minutes.

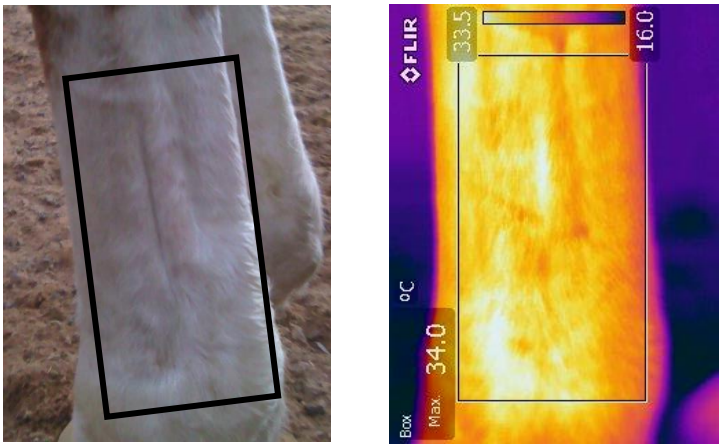

Figure 1- The area taken by the infra-red camera to calculate the maximum surface temperature of the tendon area.

Results

A significant difference ($p<0.001$) in skin surface tendon temperature was found between the unbooted and booted limbs of both Premier Equine Air-cooling Original and Veredus E-Vento Cross Country boots and there was a significant difference ($p<0.001$) in surface tendon temperature between the type of air-vented boot used. However, the Premier Equine booted and unbooted limbs took 26 minutes for surface temperature of the tendon to plateau, whereas E-Vento booted and unbooted limbs took 18 minutes.

Discussion

Skin surface tendon temperatures were significantly different between unbooted and booted limbs, which is supported by a previous study comparing Tri-Zone Allsport air-cooling boots and unbooted distal limbs (Green., 2014) suggesting air-vents are effective to decrease tendon skin surface temperature. However, the exercise protocol used by Green (2014) was different to the one used in this study; the horses were tested on the same day with both forelimbs unbooted and then booted, so the distal limb may not have cooled completely before the boots were applied, whereas each horse was tested on a separate day in the present study.

Additionally, E-Vento boots have double ventilation whereas Premier Equine boots only have single ventilation. The air enters the front vent in Premier Equine boots and exits almost immediately out the side vent (Premier Equine., 2017), whereas air entering the vent in E-Vento boots circulates the tendon which directs heated air outwards through the microperforated neoprene layer and 3D mesh ducted fabric (Veredus., 2017). Double ventilation may increase cool air flow over the tendons resulting in lower surface temperatures of the tendons and a shortened time for the tendons to reach resting surface temperature during recovery after intense exercise.

Furthermore, distal limbs injuries are more common at competitions than training in an arena and air-vented boots are commonly used during competitions are rarely during training (Horse and Hound., 2013). Further investigation of the effects of boots during a field test is required or in a humidity and temperature controlled chamber (Kohn *et al.,* 1999). Similarly, age, height and weight affects tendon composition would may affect distal limb temperature so needs further investigation (Birch *et al.,* 1999; O'Sullivan., 2007; Murray *et al.,* 2010).

Conclusion

In conclusion, the findings of this study suggest air-cooling boots significantly affect tendon skin surface temperature compared to unbooted distal limbs. Furthermore, there are significant differences between different types of air-cooling boots on tendon surface temperature. Further study into the effects of different air-cooling boots is required, particularly whether the materials used affect the transfer of air over distal limb tendons. Moreover, there may have been a cumulative effect of the tendon surface temperature, because the boots were used in the same sequence. Therefore, a randomised design of the boots and legs would be beneficial to reduce the likelihood of the cumulative effect.

Take home message

Air cooling boots significantly decreased tendon temperature compared to unbooted distal limbs and Veredus E-Vento boots significantly cool the temperature compared to Premier Equine Air-cooling Original boots.