The Protective Effect of Kevlar® Socks Against Hockey Skate Blade Injuries: A Biomechanical Study

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Introduction: Several recent high profile injuries to elite players in the National Hockey League (NHL) secondary to skate blade lacerations to the lower calf have generated significant interest in these injuries and possible methods to protect against them. These injuries are typically due to direct contact of the skate blade of another player with posterior aspect of the calf resulting in a range of potential injuries to tendons or neurovascular structures. The Achilles tendon is most commonly involved, as this is the region least protected by the current protective equipment the players wear. Kevlar® reinforced socks have recently become available for hockey players to wear and are cited as providing possible protection against such injuries. While several studies have demonstrated that Kevlar® reinforced garments offer significant protection against knife injuries,1,2 there has been no investigation of the possible protective effects of Kevlar® reinforced socks against skate blade injuries. As such, it is currently unknown what protective effects, if any, that Kevlar® reinforced socks provide against these injuries. In addition, an informal survey of team physicians and trainers in the NHL suggests that less than 10% of NHL players currently wear these socks.3 The proposed study sought to address this by conducting a biomechanical investigation of the protective effects of Kevlar® reinforced socks against Achilles tendon injuries in a simulated model of skate blade injury using human cadaver limbs. This novel investigation is the first to address the possible benefits to hockey players of wearing Kevlar® reinforced socks.

Methods: Seven matched pairs of human cadaver lower limbs (including the knee, ankle and foot) were fitted with a Kevlar® reinforced sock comprised of 60% Kevlar®/20% Coolmax® polyester/18% Nylon/12% Spandex (Bauer Elite Performance Skate Sock, Bauer Hockey Corporation, Missisauga, Ontario, Canada) on one limb and a standard synthetic sock comprised of 51% polyester/47% nylon/2% spandex (Bauer Premium Performance Skate Sock, Bauer Hockey Corporation, Missisauga, Ontario, Canada) on the contralateral limb as a control. Each limb was then mounted on a Materials Testing System (MTS) with the ankle dorsiflexed to 90° and the knee held in full extension (to fully tension the Achilles) using a custom designed jig. Specimens were then impacted with a hockey skate blade directed at the posterior calf, 12 cm above the heel, at an angle of 45° and a speed of 325 mm/s, to a penetration depth of 4.3 cm, to simulate a typical ice hockey injury. Peak force, energy and power were calculated from the force-displacement data collected from the 7 matched pair trials. The cadavers were then dissected to identify the extent of the injury the skin and Achilles tendon from blade impact. Analysis of variance was used to test for a significant difference between the groups.

Results: None (0/7) of the Achilles tendons were lacerated when protected with Kevlar® reinforced socks; whereas all (7/7) Achilles tendons tested using the standard synthetic sock were completely severed (Figure 1). Peak force (4030 +/- 1191 N vs. 2037 +/- 729 N), energy (38.9 J vs. 26.3 +/- 13.2 J) and power (166.7 W vs. 258.3 +/- 93.5 W) were all significantly (p<0.05) increased in the Kevlar® reinforced sock group compared to the standard synthetic sock group in our testing model (Figures 2 and 3).

Discussion: The Kevlar® reinforced socks provided significantly more cut resistance and were able to withstand a significantly larger peak force, energy, and power from skate blade impact when compared to standard synthetic hockey socks in a biomechanical testing model using human cadaver limbs. Furthermore, at the forces tested here, Kevlar® reinforced socks were able to prevent significant injury to the Achilles tendon in contrast to standard hockey socks which were not protective.

Significance: This is the first investigation to address the benefits of wearing Kevlar® reinforced hockey socks in a simulated model of hockey skate injuries. Our results suggest a significant protective effect from the use of Kevlar® reinforced socks against hockey skate injuries to the posterior calf and Achilles tendon, providing compelling evidence to recommend their use to hockey players.

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3. Personal communication with Dr. J. Theodoropoulos, March 2013.
Figure 1: Load-displacement curves from a representative specimen
Figure 2: Bar Graph representation of mean values for Peak force, Power and Energy all of which were significantly increased in the Kevlar® reinforced sock group compared to the standard synthetic sock (regular) group.
Figure 3: Representative photos after dissection of the sock and skin to expose the Achilles tendon showing complete laceration (red arrow) after testing with the standard sock versus intact tendon (white arrow) with the Kevlar ® sock.