MODERATION OF LOWER LIMB MUSCULAR ACTIVITY DURING JUMP LANDING BY THE APPLICATION OF ANKLE TAPING

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Ground reaction forces were measured using a Kistler force platform when 8 female subjects, wearing their own shoes, landed as they received a netball chest pass. Simultaneously electromyography recordings were made of three ankle muscles. The peak impact (total 2.3 BW; vertical 2.2 BW) and landing (total 1.8 BW; vertical 1.8 BW) forces were similar whether the ankle was taped or not ($p>0.05$). Statistical analysis of the electromyography data indicated that, for the subject group as a whole, the peak muscular activity of the gastrocnemius medius ($p=0.031$), tibialis anterior ($p=0.018$) and peroneus longus ($p=0.019$) muscles was significantly reduced during landing when the ankle was taped using zinc oxide tape.

KEY WORDS: ankle, electromyography, force, netball, taping.

INTRODUCTION: Ankle taping is commonly used within sport to provide ankle support and to prevent injury (MacDonald, 1994). The aim of this study was to determine the effect of ankle taping upon the muscle activity of three ankle muscles during jump landing from a netball chest pass.

METHODS: Eight female netball players from the 1st or 2nd University teams volunteered for the study and wore their own netball shoes. All participants had been free of injury for 12 weeks, had no current musculoskeletal lower limb problems, and provided written informed consent. The University gave ethics approval. Participants were required to catch a netball chest pass from a feeder by forward jumping and landing on the dominant leg on a 9851B Kistler force platform which was sampled at 500 Hz for 4 seconds using Provec 5.0 software. The jump distance was 1.25 times the participants' leg length (Hopper *et al.,* 1999). Three jumps were performed with landing on the dominant limb without any taping and then another three jumps after ankle support had been applied using Transpore zinc oxide tape. The applied taping was a combination of a Gibney basketweave and figure of 8 continuous heel locks as described by Rarick *et al.* (1962) consisiting of 2 anchor strips above the achilles, and 2 at the tarsal arch of the foot. Three vertical, and 3 horizontal horsehoe-shaped strips were used as stirrups. The vertical stirrups were pulled from the medial to the lateral side of the foot, slightly everting the foot (Davies,1977) which was found to aid with prevention from the inversion sprain mechanism. Figure-of-eight heel locks were wrapped under the foot, behind the heel, and the lower leg, which were repeated once more, and adding 2 figure of 6 tapes (Hopper *et al.,*1999). Prior to testing in each condition the participants completed a 3 minute warm up on a Monark cycle ergometer. Subjects were allowed up to 3 practice jumps before recording began. Peak total impact and landing forces and peak vertical impact and landing forces were normalised for each subject's body weight (BW). Taped ankle range of motion was measured after application and after the completion of testing (Physio Med International standard goniometer). Electromyography (EMG) activity of the dominant leg was recorded from the ankle plantar flexor gastrocnemius medius, dorsiflexor and invertor tibialis anterior, evertor and assisting plantar flexor peroneus longus using a patella reference electrode. Medicotest blue sensor electrodes were applied following skin cleaning and mild abrasion using disposable products. An MIE radiotelemetry system was used to record EMG data at 500 Hz for 4 seconds with Myodat 3.0 software and later to perform linear envelope analysis. Results from the two most representive jumps for each participant in each condition were averaged. Statistical analysis was performed using paired two-tailed t tests.

RESULTS: Upon landing the ground total force trace usually displayed an initial greater impact peak with a following second peak as the foot came into full contact with the floor as shown in Figure 1.

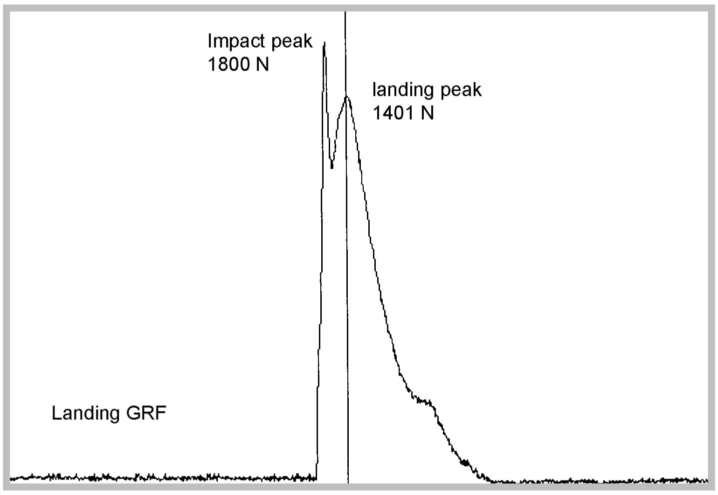

Figure 1: **A representative example of total ground reaction force (reflecting the vertical, sagital and mediolateral planes) after receiving a netball pass when ankle taping had been applied.**

Impact total forces were higher than landing total forces for both the control condition and when ankle taping was applied as shown in Figure 2. When compared to the control condition there were similar impact and landing total forces recorded with ankle taping (Figure 2). These peak total forces ($\sqrt{}(Fx^2 + Fy^2 + Fz^2)$) represent the integrated response of the foot in the horizontal plane (sagittal and mediolateral) and were adopted as the foot was not always in line with the force platform horizontal axes on landing, and consequently separate measures would be misleading. When taped, the ankle range of movement was similar before and after jump testing ($p=0.655$). The peak vertical forces at impact were similar in the control (2.25 ± 0.31 BW) and taped condition (2.21 ± 0.16 BW; $p>0.05$). Similar peak vertical landing forces were recorded with and without taping (control 1.84 ± 0.09 BW; taped 1.78 ± 0.07 BW). Mean peak total forces were slightly greater than the vertical forces reflecting the contribution of the integrated horizontal ground reaction force components

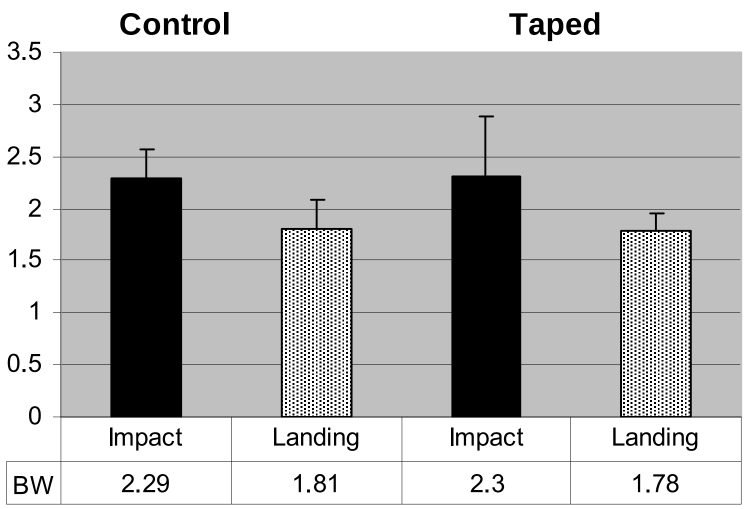

Figure 2: Total forces, reported for jump landing (±SD) after catching a netball chest pass when the ankle was not taped (control) and when taping was applied (n =8).

Figure 3 shows a recruitment sequence of the three muscles during the take off and landing. At take off, the gastrocnemius and peroneus muscles simultaneously reached peak activity as they acted to plantarflex the ankle. After air time, the gastrocnemius acted to plantarflex the ankle for the toe contact landing and tibialis anterior to gradually dorsiflex the ankle. The peroneus activity increased to aid in counteracting the secondary inversion action of the tibialis anterior by eversion.

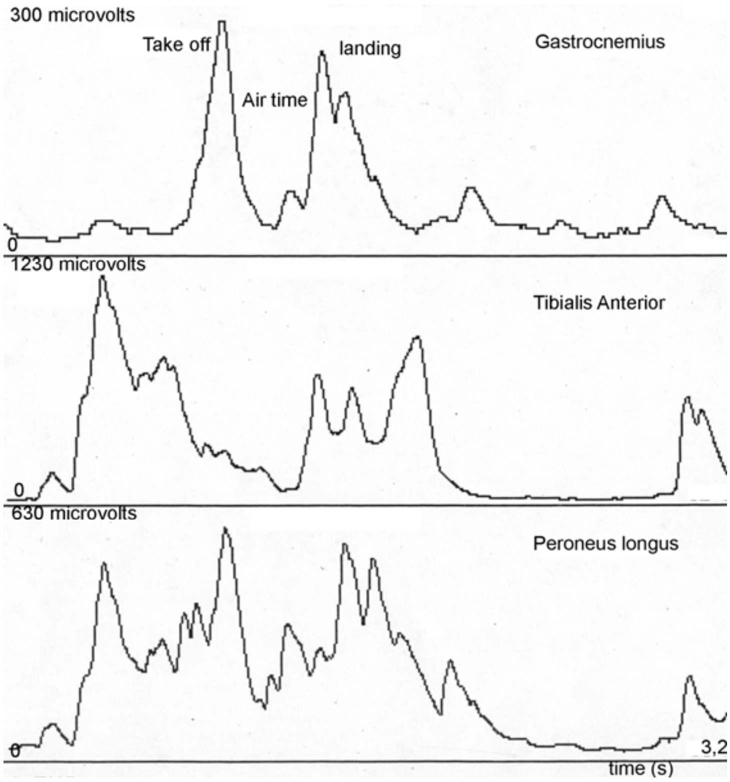

Figure 3: Linear enveloped EMG activity of ankle muscles during take off and landing to receive a netball chest pass.

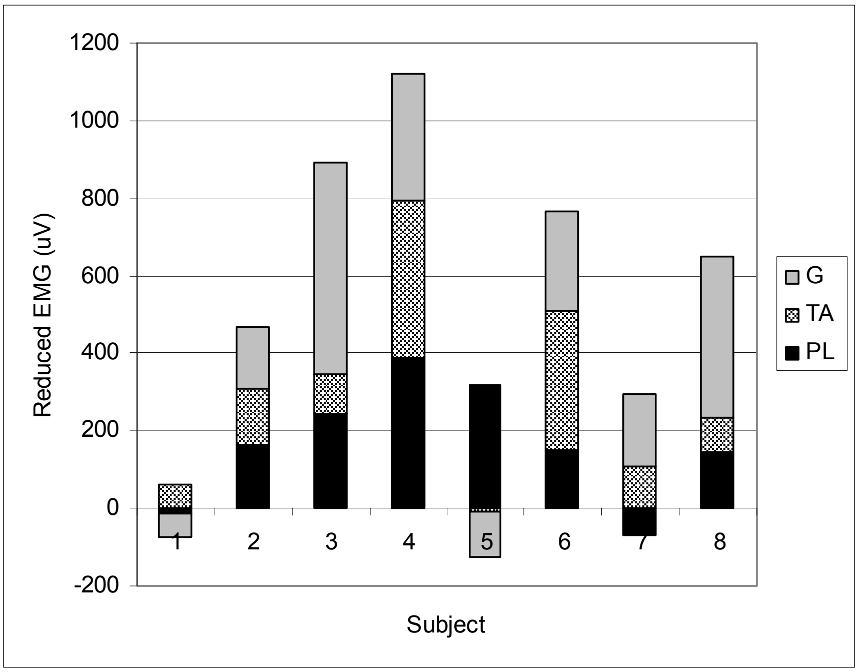

Figure 4: Reduction in muscular activity recorded from the gastrocnemius medius (G), tibialis anterior (TA) and peroneus longus (PL) muscles when the ankle was taped before taking and landing from a netball pass, relative to the control ankle condition without any tape application.

For the whole group, the muscle activity of the gastrocnemius medius ($p=0.031$), tibialis anterior ($p=0.018$) and peroneus longus ($p=0.019$) muscles was significantly reduced when landing from receiving the netball pass when ankle taping had been applied. Figure 4 summarizes the reduction in muscular activity, determined by subtraction of the peak values with taping from those without taping (Mitchell *et al.,* 2008). The reduction in peroneus longus peak activity when the ankle was taped in slight eversion was evident. Peroneus longus has an important counteracting eversion protection action in the avoidance of ankle inversion injuries. However within subject reductions in activity of the ankle dorsiflexor and invertor tibialis anterior is also evident together with reduced gastrocnemius activity.

DISCUSSION: In review, the role of ankle taping is not just of avoiding injury by increased mechanical stability, but also of improving proprioception in foot orientation and athletic confidence (Robbins & Waked, 1998). Most ankle sprains are inversion injuries, and in netball most injuries occur when landing from a jump (Hopper *et al.,* 1999). Within netball, taping has relevance as each episode of play lasts 15 minutes, less than the 20 minutes research has indicated that taping efficacy is maintained (Robbins & Waked, 1998) albeit more than the 10-15 mins reported during research review (Kadakia & Haddad, 2003). Hopper *et al.* (1999) reported similar EMG peak activity when tape was applied in contrast to this research. Maximal voluntary contraction normalisation has not been used in this research area due to the dynamic nature of the jumping and landing task, and the predictable effect of weakening the taping applied. Robbins & Waked (1998) considered that reduced EMG peak activity induced by taping might increase the injury risk. Study of induced EMG activity with graded ankle range of movement restriction could be worth investigation to identify the contributions of the slight eversion and restriction. Total forces (reflecting the forces in the frontal, saggital and vertical planes of the foot), and vertical forces of peak impact and landing were similar whether the ankle was taped or not. This is in accord with general reports in the reviews of Robbins & Waked (1998) and Bot *et al.* (2003), and for netball by Hopper *et al.* (1999). In this research peak vertical forces were less than the 3.3 BW reported by Hopper *et al.* (1999). Larger studies would clarify if this is due to dvances in sport shoe design over 20 years.

CONCLUSION: Maximal vertical and total ground forces were 2.3 BW when landing from a netball chest pass, and were similar if ankle taping was applied. However, the maximal EMG activity of the evertor peroneus longus, and also the gastrocnemius medius and tibialis anterior muscles was significantly reduced when the ankle was taped in slight eversion with zinc oxide tape.

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