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FOOT TAPING AFFECT POSTURAL ADJUSTMENTS IN WOMEN WITH LOW PLANTAR ARCH DURING SENSORY PERTURBATION

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SUMMARY
Foot taping is a commonly used technique in the treatment and prevention of injuries caused by lower limb misalignments; however, its efficacy on postural control is still uncertain. Our hypotheses is that foot taping, applied on the midfoot with the intention to improve the cutaneous sensorial acuity, would bring benefits to the postural control of flat foot subjects, especially under conditions of sensory perturbation. The mean velocity and root mean square of center of pressure trajectory were assessed in 13 low arched young woman during the maintenance of quasi-static stance in four conditions of sensory perturbations: (1) fixed support, eyes open; (2) fixed support, eyes closed; (3) moving support, eyes open, and (4) moving support, eyes closed. Results indicate that when foot taping was applied, a higher and faster center of pressure sway was observed in most of the sensory perturbation conditions, especially in the medio-lateral direction. This could be explained either by a difficulty for the subjects to adapt to a new imposed postural condition, or by a gain in confidence while using the taping, reflected by the increase in postural adjustments.

INTRODUCTION
Foot taping is a commonly recommended technique for the treatment and prevention of knee and ankle sprains and muscle strains; assisting in the alignment of the ankle-foot complex based on different rationales, including the restriction of inappropriate movement and somatosensory stimulation of this region.

Some authors have argued that the benefits of taping are mostly due to neuromuscular facilitation by increasing input from cutaneous mechanoreceptors [1]. In this case, the use of elastic tape is indicated, as it causes less skin irritation and can be applied to improve misalignment without reducing mobility. However, conflicting data is reported when taping is applied exclusively for increasing cutaneous information, without the intention of joint realignment [2] or focused on populations with no misalignment or proprioception and balance alteration [3]. Therefore, it is difficult to conclude whether balance benefits would be observed in populations with greater demands for alignment or sensory feedback. Considering that cutaneous stimulation favors postural control, especially in cases of sensory restriction [4], the hypothesis of the present study is that tape applied to realign the longitudinal arch may improve the proprioceptive acuity of subjects with low plantar arches, resulting in better balance, specially during conditions of sensory disturbance.

METHODS
The data acquisition was performed during the maintenance of the quasi-static posture by the NeuroCom® modified Sensory Organization Test on a PRO Balance Master® (NeuroCom® International Inc., Clackamas, OR). A single examiner assessed all of the subjects, 13 young woman that met the eligibility criteria and were included in this research (26.7±5.1 years old, 1.6±0.1 m, 64.7±10.5 kg, 8.4±0.39-cm maximum foot width). Each subject made three 20-second attempts for each balance condition, which were recorded at a sampling rate of 100Hz. The Chippaux-Smirak [5] index was used for the classification of the medial longitudinal arch, calculated from footprints as the ratio between the smallest width of the midfoot and the largest width of the forefoot.

Figure 1: Foot tape application. (A) Realignment of the transverse arch, (B) realignment of the longitudinal arch, (C) sagittal and (D) frontal view of the foot with tape.

A single trained physical therapist applied the tape (Kinesio® Tex, Tokyo, Japan) to all individuals. The technique for applying the tape involved the following steps: (1) cleansing the skin with alcohol and drying with paper towels; (2) applying the tape in the direction of the realignment of the transverse arch with traction of the forefoot fat pad; and (3) applying the tape in the proper direction to fix the realignment of the longitudinal arch. One strip of tape was applied in a spiral, from the body of the fifth metatarsal, passing across the sole and up to the

navicular tuberosity, and ending at the lateral portion of the lower third of the leg (Figure 1).

After the tape was applied, the subjects were instructed to walk freely around the laboratory to ensure that they were free of any discomfort or movement limitation. The center of pressure trajectory was assessed without and with the plantar tape, during the quiet stance in the following sensory disturbance conditions: (1) fixed platform and eyes open, (2) fixed platform and eyes closed, (3) moving platform and eyes open, and (4) moving platform and eyes closed. Platform movement occurred in the antero-posterior direction, and it was adjusted to follow the same direction and magnitude as the center of gravity oscillation. The conditions were always performed in the described sequence and with a progressive demand of control to avoid postural response adaptation, which is frequent when a task with a higher demand follows another with a lower demand [6].

Root mean square (RMS) and mean velocity (MV) were calculated for the antero-posterior (ap) and medial-lateral (ml) directions in a custom-written function in MATLAB v.8 (MathWorks Inc., Natick, MA) [7]. All of the data underwent a low-pass filtering (4th order Butterworth), with a cutoff frequency selected by residual analysis specific to each examined trajectory and a removal of trends in the signal. The antero-posterior and medio-lateral root mean square and mean velocity data followed a normal distribution (Kolmogorov–Smirnov test) and exhibited homogeneity of variance (Levene's test). We undertook a two-factor (Condition, Tape) ANOVA for each variable, followed by Newman–Keuls post-hoc tests ($p<0.05$). The effect sizes and the 95% confidence interval (IC 95%) from the evaluation with and without the plantar tape were also calculated.

RESULTS AND DISCUSSION

With the foot taping the subjects showed significant increases (Figure 2), in the MV and RMS for some of the evaluated sensory disturbance conditions, especially for the medial-lateral direction, showing that the tape was capable of affecting the postural control of young women with low plantar arches.

It was expected that, in conditions of sensory restriction or disturbance, the increase in afferent signals provided by the tape would reduce postural oscillation, as observed in previous studies [2,3]. However, in the present study, tape was used not only to stimulate the cutaneous receptors, but also to improve a misalignment, which might result in mechanical and/or sensory input changes that would require an increased afferent flow obtained through augmented oscillation for the maintenance of balance. Nevertheless, the increased COP trajectory does not necessarily mean poorer postural control. Conversely, it could mean that the somatosensory stimulation provided by the tape increased the perception of changes at the midfoot, giving more confidence to the subjects on medial-lateral adjustments, and providing wider stability limits.

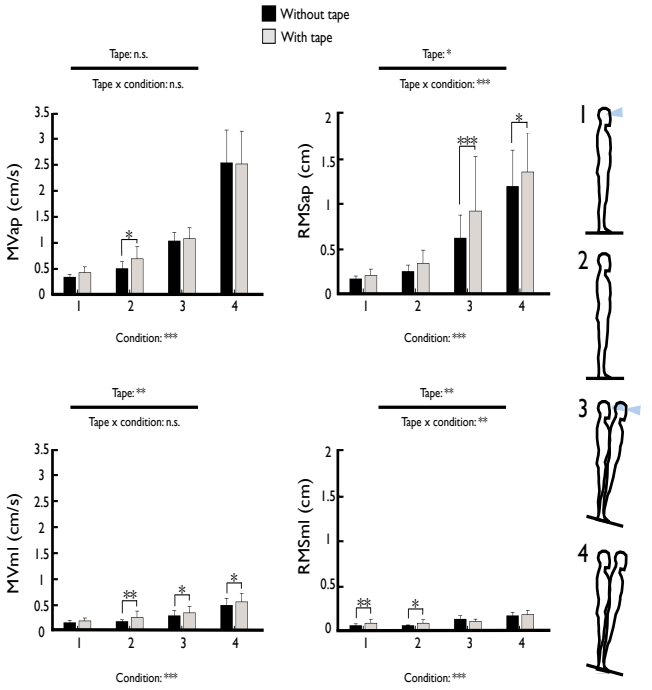

Figure 2: Mean velocity (MV) and root mean square (RMS) of the COP trajectory in the antero-posterior and medial-lateral directions, without and with plantar tape. Values are means ± standard deviations based on ANOVAs with tape, condition, and tape x condition as the fixed effects followed by Newman–Keuls post-hoc tests, under the sensory disturbance conditions: (1) fixed platform and eyes open, (2) fixed platform and eyes closed, (3) moving platform and eyes open, and (4) moving platform and eyes closed. *p<0.05; **p<0.01; ***p<0.001; n.s., not significant.

CONCLUSIONS

Foot taping applied to realign the longitudinal arch of the foot in young women with low arches increased the postural adjustments, mainly for the medial-lateral direction, regardless of the sensory disturbance conditions. This result may be explained by the lack of adjustment of the subjects to the novel postural condition imposed by the application of tape, or it might indicate that, with the tape, the subjects felt more confidence testing wider stability limits or relying on medial-lateral adjustments.

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