Comparison of muscle activities and joint movements in the lower limbs during gait in healthy subjects with and without simulating the scoliosis patient

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INTRODUCTION

Scoliosis is defined as a condition involving an abnormal sideways curvature of the spine, resulting in back pain and body immobility, and little research has explored the lower limb biomechanics in scoliosis. This study aimed to investigate whether there are any differences of gait parameters, electromyography and biomechanical data between simulated scoliosis gait and normal walking.

METHODS AND MATERIALS

A specially produced orthotic brace was made and used to simulate scoliosis by restricting trunks of candidates toward the right side in the frontal plane by approximately 20° as Figures 1 & 2. Sixteen normal participants (28.3±8.4 years old, 166.2±9.1 cm 67.2±11.3 kg and 9 males and 7 females), attended to walk as two groups; simulated scoliosis group and normal group. The simulated scoliosis group included Simulated walking and Brace simulated scoliosis walking whilst the normal group included Normal walking and Brace normal walking. Retro-reflective marker data, electromyography (EMG) were collected using Vicon motion capture system, force platforms and Delsys system, and then gait parameters (e.g. walking speed, stride length, cadence) and biomechanical variables (joint angles, forces, moments, powers) were calculated using Vicon Plug-in-Gait model. The comparisons among different groups were statistically analysed using General Linear Models Method in SPPS (23.0).

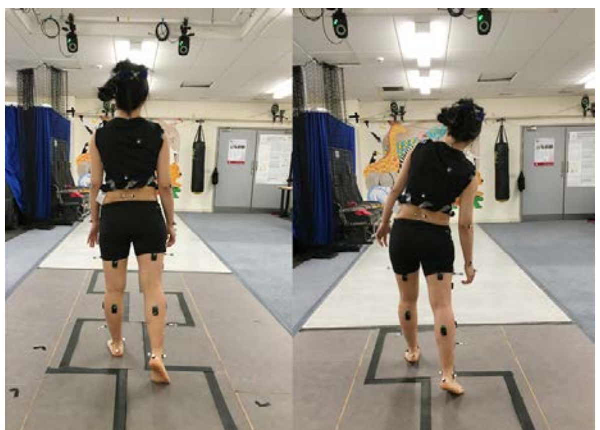

Figure 1. Normal walking (L) and normal walking with simulating scoliosis without brace (R)

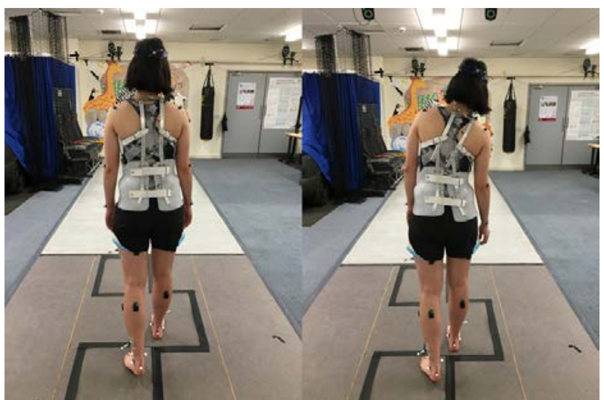

Figure 2. Braced normal walking (L) and braced walking with simulating scoliosis without brace (R)

RESULTS

In this study, the right side reduced walking speed by 7.07%, cadence by 2.6% and step length by 5% than the left side in the simulation group, but the stride time increased by 3.16% (Figure 3). The EMG data illustrated that there was a 24.6% increase of right bilateral vastus lateralis and 14.3% of bilateral tibialis anterior muscle activities in the simulation group during stance than the normal group, and left biceps femoris muscle decreased by 6.3% during swing phase and 20% of bilateral gastrocnemius during stance phase in comparison to the normal group (Figures 4-5). In a gait cycle, the biomechanical data of the simulation group showed that left pelvic movement decreased on the frontal and transverse planes were 26.5% and 39% compared with the normal group. Moreover, the left hip, knee and ankle suffered extra forces or moments by approximately 22% to 52% more than the normal group. The right hip angle increased by 23.8% whilst the left knee angle and left ankle angle decreased by 13.1% and 16.9% respectively (Figures 6-7).

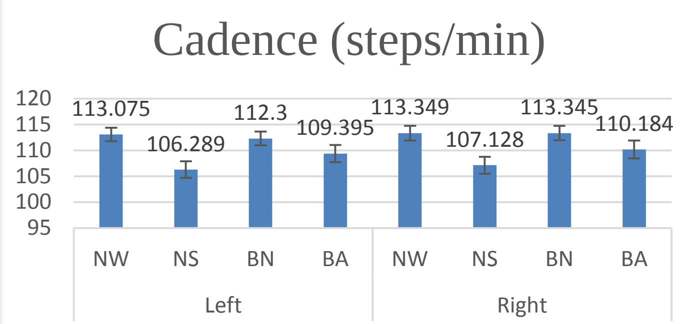

Figure 3. Cadence comparsion among four types

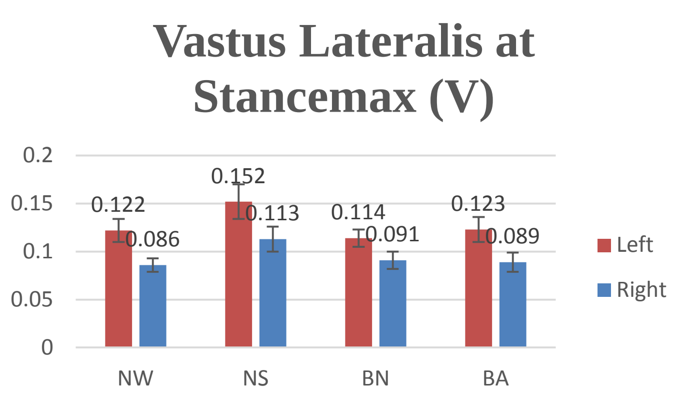

Figure 4. EMG comparsion between two sides

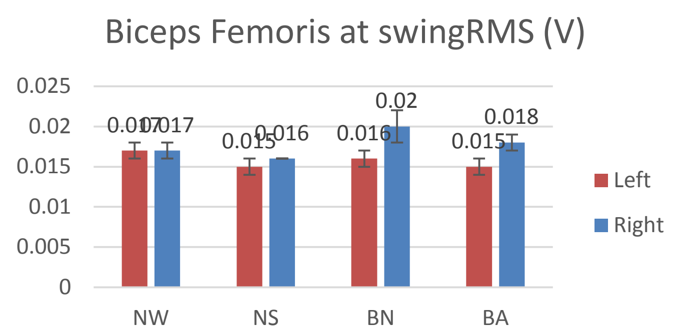

Figure 5. EMG comparsion between two sides

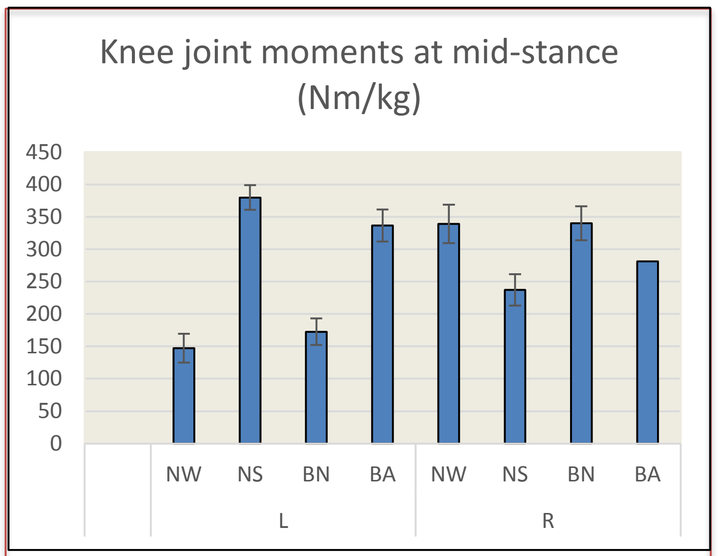

Figure 6. Joint moments comparsion

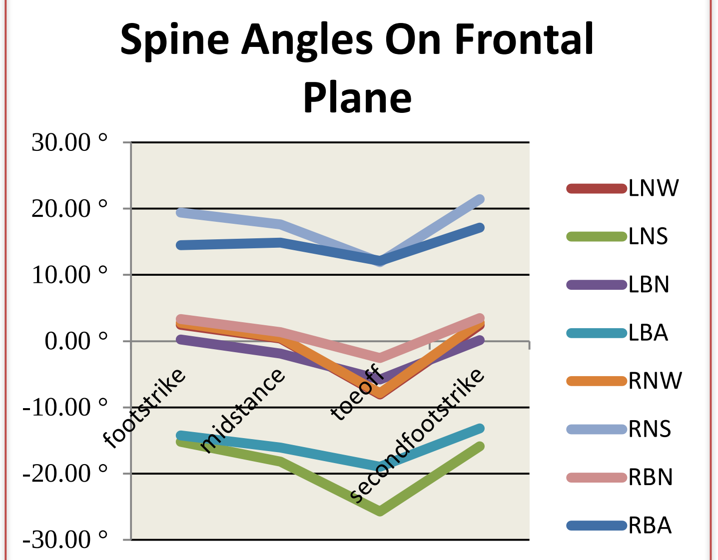

Figure 7. Spine angles comparsion

DISCUSSION

Due to the simulated scoliosis brace being set for the subjects, almost all of the biomechanical parameters were significantly affected. These scoliosis variations are likely to contribute more severe pathological symptoms to scoliosis. Further studies should be carried out in patients with scoliosis, who attend to various clinical treatments. A new study could be done to investigate the effect of pre- and post-treatment on biomechanical parameters in the lower limb joints.

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