THREE DIMENSIONAL KNEE JOINT KINEMATICS AND LOWER LIMB MUSCLE ACTIVITY OF ANTERIOR CRUCIATE LIGAMENT DEFICIENT KNEE JOINT PARTICIPANTS WEARING A FUNCTIONAL KNEE BRACE DURING RUNNING

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INTRODUCTION

Knee braces have been found to provide limited stability to the ACL deficient (ACLD) knee in situations where the knee is loaded during sporting movements [1,3]. The increased laxity in the joint requires the patient's body to compensate for the ACLD by also altering muscle recruitment patterns, such as the hamstrings and quadriceps to adequately stabilize the knee during such activities [4,5]. Different adaptation strategies have been found between patients that can cope with the injury and patients that cannot. One of the expected changes can be muscle activation characteristics of the injured knee during strenuous activity with and without a functional knee brace.

METHODS

A group of 11 ACLD male participants (mean: 33.5, ± 7.7 yrs, 89.1, ± 12.5 kg, 185.7, ± 7.8 cm) took part in the experimentation. At the time of the testing session, all participants exhibited full knee range of motion and no pain during walking. Three dimensional (3D) kinematic and electromyography (EMG) data were collected for ten consecutive gait cycles during running on a treadmill under both braced (B) and unbraced (UB) conditions. Video was collected using the SIMI* Motion system (SIMI* Reality Motion Systems GmbH) from four digital video cameras (JVC GR-DVL9800) set at 60 Hz. EMG data was collected at 1000 Hz (Bortec Biomedical Ltd.) for vastus lateralis and medialis, biceps femoris, semitendinosis, lateral and medial gastrocnemius muscles. Statistical analysis of both the EMG and 3D kinematic data using one-way Anova ($p=0.05$) focused on comparisons between the braced and unbraced conditions.

RESULTS AND DISCUSSION

Fairly similar flexion/extension knee joint patterns were observed between the braced and non-braced conditions. Bracing significantly reduced ($p<0.05$) the peak abduction angle, and the total range of motion during running (Table 1). The internal/external rotation curve for the braced condition showed a significantly ($p<0.05$) lower range of motion than in the unbraced condition (Table 1). Bracing also prevented the ACLD knee from going into internal rotation during the running cycle. Overall analysis demonstrated that bracing reduced the overall range of motion of the knee joint in the frontal and transverse planes but did not affect the motion in the sagittal plane for ACLD participants during running.

Comparisons of muscle activity between the braced and unbraced conditions revealed some changes in timing and amplitude characteristics of the EMG signal. Muscle activity (measured as the area under the LE EMG curve) increased for all the muscles in the braced condition. This increase ILE EMG was not significant most likely because of high variability within participants. Our results showed a tendency that at heel-strike, the EMG amplitude of the quadriceps (vastus medialis and lateralis) decreased while hamstrings (biceps femoris and semitendinosis) increased in the braced condition.

CONCLUSIONS

The findings of this study suggested that bracing significantly affected the kinematic profile of ACLD patients during running. Although no significant differences were observed for the EMG variables, tendencies were noted both in terms of muscle activity and timing, especially for the semitendinosis muscle. The tendencies in EMG activity changes caused by the brace to the semitendinosis muscle were not however in accordance with the added mechanical restrictions expected while wearing a functional knee brace. This led us to believe that the brace had a proprioceptive effect on the injured limb, resulting in added active muscular stability. These findings are therefore in accordance with the phenomenon of a proprioceptive contribution of the functional knee bracing [2]. We must point out that the sample size might have a large influence in the statistical difference in the EMG findings.

REFERENCES

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Table 1. Kinematics data in the sagittal, frontal, and transverse planes over the duration of the running cycle, n=11.

	Peak angle (deg.)						Total ROM (deg.)		
	Flex.	Abd.	Ext. rot.	Ext.	Add.	Int. rot.	Flex./Ext.	Abd./Add.	Int./Ext. rot.
UB	82.4±8.0	15.3±4.2*	-10.8±5.9	13.2±5.5	1.2±2.7	5.1±8.0	69.2±8.9	14.7±4.7*	15.9±5.6*
B	83.4±7.1	10.2±2.9*	-9.7±5.4	14.2±4.6	1.0±2.4	1.2±3.0	68.7±6.4	9.2±2.8*	10.9±4.8*

*Significant difference in the angular value between bracing conditions ($p<0.05$)