THE EFFECT OF BRACING ACL DEFICIENT KNEES ON SKELETAL 3-D KINEMATICS

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INTRODUCTION

Bone pins have been implanted into the tibia and femur to directly measure three-dimensional knee articulations *in-vivo* [1,2,3]. This method may also provide a more sensitive measure of how functional knee braces affect skeletal joint motion. For this study, tibiofemoral kinematics was measured with pins in patients with ACL deficiency to examine whether functional knee braces altered skeletal motion during strenuous activity.

MATERIAL AND METHODS

Steinmann pins were implanted into the knees of six male subjects with ACL deficiency. Knees were flexed 45° to minimise impingement problems with the iliotibial band. The femoral pin was inserted anterior and superior to the lateral femoral condyle and directed oblique postero-medially. The tibial pin was inserted postero-laterally into the antero-medial aspect of the tibial shaft. Stereo-photogrammetric x-rays were taken with markers affixed to the pins to identify the femoral and tibial anatomical reference points. They were located at the deepest point of the intercondylar groove and the superior aspect of the medial intercondylar eminence respectively. Kinematics was recorded with the MacReflex motion analysis system at 120Hz. A Kistler force platform was synchronized to collect ground reaction forces at 960 Hz. Subjects were randomly assigned to start with either the braced or non-braced condition. Neutral standing trials were recorded to define anatomical co-ordinate systems for each condition. Patients then jumped for maximal horizontal distance, pushing off from their sound limb and landing with their contralateral deficient limb. Average non-braced and braced curves were derived for each subject. Analysis focused on differences in magnitudes and changes in the shape of the curves between conditions and across subjects.

RESULTS

Two subjects were excluded. One bent the femoral pin during knee flexion, the other was due to noise in the kinematic data. Mean peak vertical and peak posterior shear force was generally consistent between bracing conditions (Table 1). Peak forces varied across subjects since subjects jumped within their own comfort limits. Overall, the shape and amplitudes of the skeletal curves were fairly similar. Differences in movement patterns and ranges of motion (ROM) between brace conditions were small, i.e. kinematics were very repeatable. Table 2 depicts the differences in angular and linear ROM between non-braced and braced conditions. Negative values indicate reductions in amplitudes during bracing. Across subjects, larger variations in the shape of the movement patterns and amplitudes were evident.

Table 1: Ground reaction force data

	Peak vertical		Peak posterior	
	Non	Br	Non	Br
Subject A n = 5	2.9 (0.4)	2.6 (0.1)	-1.3 (0.2)	-1.1 (0.1)
Subject B n = 3	2.2 (0.3)	2.4 (0.1)	-0.6 (0.2)	-0.9 (0.1)
Subject C n = 5	3.4 (0.4)	2.6 (0.6)	-0.7 (0.1)	-0.6 (0.1)
Subject D n = 5	n/a	2.9 (0.3)	n/a	-1.1 (0.0)

Table 2: Differences in angular ROM (degrees)

	Flexion	Abduction	Internal
Nonbrace-brace	NB-B	NB-B	NB-B
Subject A n = 5	10.0	3.2	-1.2
Subject B n = 3	2.6	0.7	-0.9
Subject C n = 5	-2.9	-1.1	0.8
Subject D n = 5	-6.9	-3.0	-5.0

Differences in linear ROM (mm)

	Medial	Anterior	Distraction
Nonbrace-brace	NB-B	NB-B	NB-B
Subject A n = 5	1.6	-0.7	-5.1
Subject B n = 3	-0.4	-1.1	-2.3
Subject C n = 5	0.3	1.3	-1.9
Subject D n = 5	-3	-3.1	-2.4

DISCUSSION AND CONCLUSION

Bracing resulted in small kinematic changes in skeletal joint motion. These changes cannot be attributed to differences in the subject's landings, but rather to the brace itself. The offset in the kinematic patterns between bracing may be due to the brace. But it is more likely the result of the different standing reference trials used for each condition. This created small deviations in alignment of the tibial and femoral anatomical coordinate systems. In conclusion, our findings suggest a new avenue of research in examining the relationship between functional knee bracing and their effect on three-dimensional skeletal tibiofemoral articulation.

REFERENCES

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