THE EFFECTS OF A VARUS UNLOADER BRACE FOR LATERAL TIBIOFEMORAL OSTEOARTHRITIS AND VALGUS MALALIGNMENT AFTER ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION: A PROOF OF CONCEPT

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INTRODUCTION

Anterior cruciate ligament reconstruction (ACLR) is a well recognized risk factor for knee osteoarthritis (OA) [1]. Lateral tibiofemoral joint OA (TFJOA) is observed in more than 50% of those with knee OA 10-15 years after ACLR [2]. Valgus bracing is frequently prescribed for medial TFJOA to reduce varus malalignment and external adduction moments, and to improve pain and function. However, valgus bracing may not be appropriate for those with lateral TFJOA after ACLR. Lateral TFJOA is associated with significantly greater knee abduction angles and smaller external knee adduction moments compared to those associated with medial TFJOA [3]. The varus unloader brace is one potential targeted intervention for individuals with lateral TFJOA after ACLR. It is designed to control sagittal and transverse plane rotations associated with ACLR and correct frontal plane malalignment. The purpose of this proof of concept study was to investigate the immediate effects of the varus unloader brace on knee-related symptoms and biomechanics. The test conditions were: (i) no brace; (ii) brace with frontal-plane adjustment (varus re-alignment); and (iii) brace without frontal-plane adjustment (no varus realignment).

The immediate effects of the adjusted varus brace on symptoms were evaluated with the step down task [5], designed to replicate stair descent. On completion of the test performed with and without the varus brace, the patient rated his level of pain, difficulty of task, knee stability, and confidence on four separate 100mm visual analogue scales (VAS) where 100mm represents the worst possible symptoms (higher difficulty; greater instability; lower confidence; greater pain), and 0mm represents no symptoms.

Three-dimensional gait analysis was performed to assess the effects of the brace on knee biomechanics, according to a protocol described previously [6]. Reflective markers were attached at various locations on the trunk and the affected lower-limb of the subject. Markers on the thigh and leg of the affected lower-limb were positioned such that the brace could be easily fitted without altering any marker positions. Kinematic data were measured using a 9-camera video motion analysis system (Vicon, Oxford Metrics Ltd., Oxford), while ground reaction forces (GRF) were recorded simultaneously from three ground-embedded force platforms (Advanced Mechanical Technology Inc., Watertown, MA). Video and analog force-plate data were sampled at 120 Hz and 1,080 Hz, respectively. The patient walked at his self-selected speed under the three test conditions. Knee joint kinematics and
external knee joint moments were calculated for the affected limb [7].

RESULTS

The patient reported reduced task difficulty (no brace 74mm; brace 33mm), lower knee instability (no brace 74mm; brace 28mm), increased confidence (no brace 75mm; brace 26mm) and no pain (no brace 3mm; brace 0mm) with the adjusted brace compared to not wearing the brace. The vertical and fore-aft GRFs were similar between the three test conditions (Table 1). At contralateral toe-off (CTO), an increase in the external knee flexion moment was noted with the adjusted brace (33%) and unadjusted brace (25%) when compared to the no brace condition (Table 1). In the frontal plane at CTO, a 24% reduction in the knee abduction angle was observed with the adjusted brace. A small decrease in the external knee adduction moment in both unadjusted and adjusted brace conditions was also observed (Table 1). At CTO the adjusted brace reduced the knee internal rotation angle by 56%, with only a 17% decrease in the knee internal rotation angle noted with the unadjusted brace (Table 1).

DISCUSSION

The varus brace produced immediate symptomatic improvements and changes in frontal and transverse plane knee kinematics and kinetics that were more pronounced for the adjusted than the unadjusted brace conditions. While these data represent bracing effects for a single patient only, they provide preliminary evidence for the potential efficacy of a brace that is specifically targeted for lateral TFJOA after ACLR. The adjusted brace reduced the knee abduction angle, which is important since valgus alignment is associated with greater risk of lateral TFJOA progression [8]. An intervention that increases the external knee adduction moment may heighten the risk of medial TFJOA progression; however, we observed a reduction in knee abduction angle and a slight decrease in the knee adduction moment. Given no change in GRF magnitude, the knee brace may have shifted the centre of pressure laterally, thus reducing the magnitude of the GRF moment arm about the knee joint center. In the transverse plane, the adjusted brace substantially reduced the knee internal rotation angle. This change may be significant, since previous studies have reported an increase in internal rotation following ACLR, which is thought to play a role in initiation of knee OA following ACLR [9]. The ACL is essential in providing rotational knee stability. This study shows that an unloader knee brace may be able to mitigate abnormal knee joint behaviour in people with lateral TFJOA and valgus malalignment after ACLR.

REFERENCES


TABLE 1: Ground reaction forces, kinematics and kinetics data for three test conditions

<table>
<thead>
<tr>
<th></th>
<th>GRF (N/kg)</th>
<th>Kinematics (degrees)</th>
<th>Kinetics (Nm/kg)</th>
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<tbody>
<tr>
<td></td>
<td>Vertical</td>
<td>For-aft</td>
<td>Flexion</td>
</tr>
<tr>
<td>No brace</td>
<td>CTO</td>
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</tr>
<tr>
<td>Unadjusted</td>
<td>CTO</td>
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<tr>
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<td>CTO</td>
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<tr>
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</tr>
<tr>
<td>Unadjusted</td>
<td>PV</td>
<td>1.14</td>
<td>0.22</td>
</tr>
<tr>
<td>Adjusted</td>
<td>PV</td>
<td>1.14</td>
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GRF is ground reaction force; IR is internal rotation; CTO is contralateral toe-off; PV is peak value