

Effects of an unloader knee brace on knee-related symptoms and function in people with post-traumatic knee osteoarthritis after anterior cruciate ligament reconstruction



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ABSTRACT

Background and purpose: This pilot study evaluated the immediate and four-week effects of an unloader knee brace on knee-related symptoms and performance-based function in people with knee osteoarthritis (OA) after anterior cruciate ligament reconstruction (ACLR).

Methods: Individuals with knee OA, five to 20 years post-ACLR, were recruited for two within-subject randomized studies: immediate effects ($n = 18$) and four-week effects ($n = 11$). Patient-reported knee-related symptoms (knee pain, perceived task difficulty, confidence, stability) were assessed during hop for distance and step-down tests, while performance-based function was assessed with hopping distance under three conditions: i) no brace; ii) unadjusted brace (sagittal plane support); and iii) adjusted brace (sagittal plane support with varus/valgus readjustment). Participants in the four-week brace effect study were randomized to wear the unadjusted or adjusted brace for four weeks after baseline (no brace) testing, and repeated tests in their allocated brace at four-week follow-up. Friedman tests evaluated differences between the three brace conditions for each variable for the immediate brace effect study ($p < 0.05$), and Wilcoxon signed-rank tests evaluated differences between no brace and allocated brace for the four-week study ($p < 0.05$).

Results: The adjusted and unadjusted unloader braces produced immediate improvements in knee confidence during hop for distance, and knee pain during step-down. Following the four-week brace intervention, the allocated brace improved knee confidence, perceived task difficulty and stability during hop for distance; and knee pain, perceived task difficulty, confidence, and stability during step-down.

Conclusions: The unloader knee brace, adjusted or unadjusted, has the potential to improve knee-related symptoms associated with knee OA after ACLR.

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1. Introduction

Post-traumatic knee osteoarthritis (OA) is common after anterior cruciate ligament (ACL) injury, occurring in over 30% of individuals within five years [1] and over 50% within 10–20 years of injury [2], regardless of surgical reconstruction (ACL) [3]. Medial tibiofemoral joint (TFJ) OA is evident in 41 to 93% of individuals 10 to 15 years post ACLR, lateral TFJ OA in 23 to 57%, and patellofemoral (PFJ) OA in 12 to 60% [4,5]. Knee OA after ACLR frequently affects young adults aged 30 to 40 years [6], much earlier in the lifespan than non-traumatic OA. Knee-related symptoms such as knee pain, impaired knee confidence, functional limitations, and reduced quality of life [2,7,8] can impact

participation in domestic, occupational, and physical activities. Thus, interventions with the potential to improve knee-related symptoms and function are urgently needed for this patient population.

Knee bracing is an effective non-surgical intervention to reduce knee-related symptoms in older adults with non-traumatic knee OA [9–11]. Considering differences in compartmental distribution of radiographic OA in those with post-traumatic OA, similar beneficial effects cannot necessarily be assumed for this population. While knee bracing has potential to relieve knee-related symptoms, no studies have evaluated the effects of knee bracing for post-traumatic knee OA, such as that seen after ACLR. Our recent case study evaluated the immediate effects of a knee brace, which can be adjusted to provide varus or valgus frontal plane knee alignment as required, in a single patient with predominant lateral TFJ OA after ACLR [12]. This study provided important preliminary evidence that a varus knee brace can immediately reduce knee valgus malalignment and moment, as well as improve self-reported

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knee confidence, stability, and task difficulty [12], indicating its potential benefits for people with lateral knee OA and valgus malalignment. To our knowledge, no other studies have evaluated the effects of valgus bracing in a lateral OA cohort.

Building on these findings, the aims of this pilot study were to evaluate the immediate effects and four-week effects of an unloader knee brace on patient-reported knee pain, perceived task difficulty, knee confidence, knee stability, and performance-based function in individuals with knee OA after ACLR. It was hypothesized that the unloader brace would improve knee-related symptoms and performance-based function in people with early knee OA after ACLR following immediate application and after four weeks of wear.

2. Methods

2.1. Participants

Two cohorts of volunteers who had undergone a primary ACLR (hamstring tendon or patellar tendon graft) five to 20 years beforehand were recruited from the community via advertisements and referrals from orthopedic surgeons, health, and medical practitioners. All participants in the immediate brace effects study were invited to participate in the four-week effects study.

Eligibility criteria for both studies were as follows: i) aged ≥ 16 years at the time of ACLR; ii) the presence of symptomatic (Knee Injury and Osteoarthritis Outcome Score (KOOS) criteria [13] and radiographic (≥ 1 grade Kellgren and Lawrence) knee OA [14]; iii) no previous lower limb arthroplasty, hip or knee fractures; iv) no concomitant pain from the hips, ankles, feet or lumbar spine; v) no neurological or medical conditions, or contraindications for X-ray; and vi) able to understand written and spoken English. Ethics approval was obtained from The University of Melbourne's Human Research Ethics Committee. To fulfill inclusion criteria for symptomatic OA, participant's responses to at least half of the items within the subscale had to be at least one step down from the best possible response (i.e. indicating no pain/symptoms or best possible function/quality of life) on the KOOS quality of life (QOL) subscale, and two of the four additional subscales (pain, symptoms, function in activities of daily living [ADL], function in sports and recreation [sport/rec]). Individual radiographic OA features were graded for each compartment using the OARSI atlas [15], and compartmental distribution of OA (to assist with brace fitting) was based on previously described criteria for the TFJ [16] and PFJ [17].

Demographic data were collected prior to testing, including age, sex, body mass, height, graft type, and time since ACLR surgery. The KOOS was administered to characterize the cohorts, and consists of five subscales: pain, symptoms, ADL, sport/rec, and QOL. A normalized score out of 100 was calculated for each subscale, where scale of 0 represents maximum knee-related symptoms, and 100 represented no knee-related symptoms [18].

2.2. Intervention

The effects of the unloader knee brace on patient-reported knee-related symptoms and performance-based function was evaluated in all participants. The unloader knee brace (DJO Global, Vista, USA) is designed to control joint translations, abnormal sagittal and transverse plane motions associated with ACLR, in addition to correcting frontal plane malalignment (Fig. 1). The adjusted brace condition was used to evaluate the bracing effects with frontal plane adjustment, and the unadjusted brace condition was used to assess bracing effects without frontal plane adjustment. The direction of frontal plane adjustment (varus/valgus) was based on participant-specific OA compartmental distribution [15] and frontal plane malalignment measured on antero-posterior radiographs [19]. Angles $< 180^\circ$ were defined as varus malalignment, and angles $> 180^\circ$ were defined as valgus malalignment [19]. Participants with medial knee OA with/without varus malalignment were prescribed a varus unloader brace, and those with lateral knee OA with/without valgus malalignment were prescribed a valgus unloader brace.

The unloader brace was adjusted to approximately 50% of the maximum (varus/valgus) adjustment for all participants. This adjustment was selected based on patient-reported comfort during walking (i.e., comfortable pressure distribution across contacting surfaces). The amount of brace adjustment required to produce mechanical change in frontal plane alignment is unclear. Therefore, to ensure that the other knee compartment was not adversely loaded, 50% of the maximum available adjustment was selected. An independent investigator (NJC), who was not involved in outcome measurement, applied the brace conditions to facilitate assessor blinding (HFH). Participants were also blinded to the applied brace condition (Part A—immediate) and the allocated brace condition (Part B—four-week). A study on brace compliance has reported that despite pain relief, poor brace compliance is observed in patients with knee OA beyond one-month period [20]. Therefore, four weeks intervention period was selected for the current study to investigate longer-effects of knee bracing.

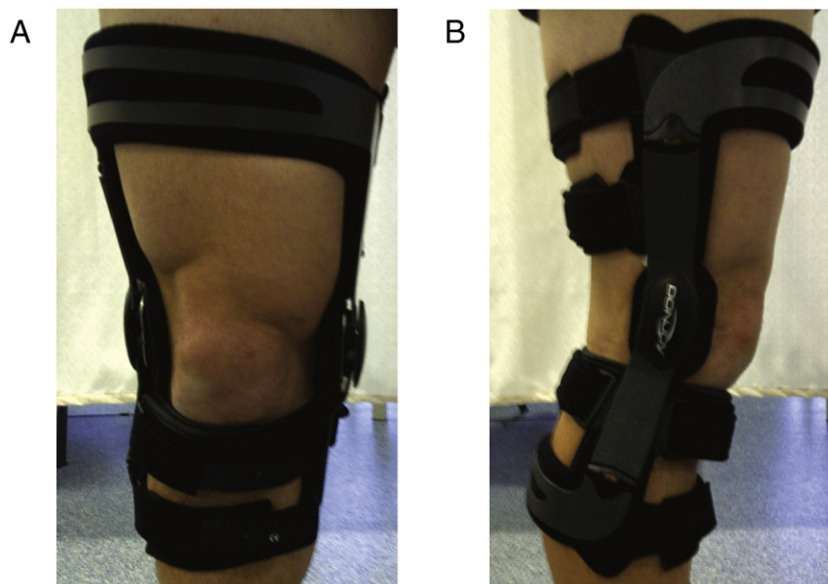


Fig. 1. Donjoy unloader brace, where (A.) represents the frontal view, and (B.) represents the lateral view.

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