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A knee brace alters patella position in patellofemoral osteoarthritis: a study using weight bearing magnetic resonance imaging

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SUMMARY

Objective: To assess using weight bearing magnetic resonance imaging (MRIs), whether a patellar brace altered patellar position and alignment in patellofemoral joint (PFJ) osteoarthritis (OA).
Design: Subjects age 40–70 years old with symptomatic and a radiographic Kellgren–Lawrence (K–L) evidence of PFJOA. Weight bearing knee MRIs with and without a patellar brace were obtained using an upright open 0.25 T scanner (G-Scan, Easote Biomedica, Italy).
Five aspects of patellar position were measured: mediolateral alignment by the bisect offset index, angulation by patellar tilt, patellar height by patellar height ratio (patellar length/patellar tendon length), lateral patellofemoral (PF) contact area and finally a measurement of PF bony separation of the lateral patellar facet and the adjacent surface on the femoral trochlea (Fig. 1).
Results: Thirty participants were recruited (mean age 57 SD 27.8; body mass index (BMI) 27.8 SD 4.2); 17 were females. Four patients had non-usable data. Main analysis used paired *t* tests comparing within subject patellar position with and without brace.
For bisect offset index, patellar tilt and patellar height ratio there were no significant differences between the brace and no brace conditions. However, the brace increased lateral facet contact area ($P = .04$) and decreased lateral PF separation ($P = .03$).
Conclusion: A patellar brace alters patellar position and increases contact area between the patella and femoral trochlea. These changes would lower contact stress at the PFJ. Such changes in patella position in weight bearing provide a possible biomechanical explanation for the success of the PFJ brace in clinical trials on PFJOA.

Introduction

Patellofemoral osteoarthritis (PFOA), a common subtype of knee OA, is a major cause of pain with stair climbing, arising from a chair and activities involving kneeling or squatting. It is associated with pain, stiffness and functional limitation[1,2]. Guidelines for the non-surgical management of generalised knee OA found 'fair' quality of evidence for the use of knee braces and knee sleeves[3,4]. Treatment of PFOA is similarly limited but one potential treatment is a patellar sleeve device. Evidence for its clinical efficacy is provided by two clinical trials in PFOA[6,15]. These trials had positive effects on pain and structure from wearing a patellar sleeve brace compared to no brace[15] and on pain with or without the patellar retaining strap.[6]

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One of the proposed reasons for this clinical success is that the patellar brace may, during weight bearing activities, change patellar alignment and alter patellar tracking relative to the trochlear groove both of which are considered major contributions to the pathomechanics of PF pain. Whilst a brace's effects on the biomechanics of the PF joint are still not well understood, there is evidence from studies in non-arthritic PF pain that it may correct malalignment[7] and increase contact area of the PF joint[8]. This distribution of forces over a greater area could decrease the contact stresses.

Several authors agree that magnetic resonance imaging (MRI), with its capability of viewing the patellar position in various planes, is more useful and informative than plain radiography[9–11]. MRIs also have the advantage of using non-ionising radiation enabling repeated imaging, as in the present study, with and without a brace. Weight bearing MRIs may give a more valid view of PF congruence and position under natural loads exerted by body mass. PF position is usually assessed clinically through palpation of the patella through a range of motion or by observing the motion of the skin over the patella. This assessment is commonly performed in a seated, unloaded posture that does not reflect joint movement during functional, weight bearing tasks.

To date, one study has used weight bearing MRIs to assess braces on non-arthritic, symptomatic PF pain[12]. To our knowledge there have been none assessing PFOA, although McWalter *et al.*[13] assessed a knee sleeve in PFOA with simulated weight bearing MRIs by applying 15% of body weight of axial load through the patient's foot.

Since PFOA is likely to affect either medial or lateral patellar compartments[14], the effects of braces on patellar position might have a bearing on treatment choices and brace design. Consequently, the weight bearing MRI may give a more realistic view of PF congruence and be a more appropriate technique when assessing patella position.

Purpose

The purpose of this study on PFOA was to use weight bearing MRIs to assess whether a sleeve brace altered patellar position. The hypothesis was that there would be differences in measures of PF position after the application of a patellar brace compared to no brace.

Methods

The study was approved by the XXX Local Research Ethics Committee (Ethics number 09/H1012/35). It was performed at the XXXX and at the University XXXX.

Subjects

We recruited a subset of subjects age 40–70 years who had been enrolled in a previous randomised trial of patellar brace treatment for people with PFOA[15]. They had a Kellgren–Lawrence (K–L) score grade 2 or 3 in the PF compartment which was greater than K–L score for the tibiofemoral compartments (this score required at least probable narrowing of the PF joint on X-ray and definite osteophytes in the PF compartment). Those who did not have plain radiographs were assessed for PFOA by either MRIs or arthroscopy, for which we required typical changes of OA with at least cartilage loss present in the PF joint. Subjects were also assessed by an experience clinician for PF joint symptoms such as pain reproduced with stair climbing, kneeling, prolonged sitting or squatting or if they had lateral or medial patellar facet tenderness on palpation or a positive patellar compression test. Pain must have been present daily for the previous 3 months and the pain had to be sufficiently severe for a nominated aggravating activity to score of 40 or above on a 0–100 mm visual analogue scale (VAS_{NA}). The VAS_{NA} has been found to be at least as sensitive, and in some cases more sensitive to change than the Knee injury and Osteoarthritis Outcome Score (KOOS) or Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) questionnaires[16,17]. Typically, subjects' nominated aggravating activities were stair climbing, kneeling, prolonged sitting or squatting.

Exclusion criteria

Participants were excluded if they had a previous patellar fracture or patellar realignment surgery, if the predominant symptoms emanated clinically from the tibiofemoral joint, from meniscal or ligament injury, if they had rheumatoid arthritis or other forms of inflammatory arthritis or if they had an intra-articular steroid injection into the painful knee in the previous month. For the purposes of the MRI, patients were excluded if they had a cochlear implant, metal objects in the body including a joint prosthesis, a cardiac or neural pacemaker, a hydrocephalus shunt, an intrauterine contraceptive device or coil, if they had kidney dysfunction or were undergoing renal dialysis.

MRI procedures

Participants had MRIs of their knee joint using an upright open 0.25 T scanner (G-Scan, Easote Biomedica, Italy). Participants first remained supine for approximately 5 min to enable the recovery of viscoelastic structures in the knee, as the participant had been weight-bearing prior to entering the scanner. Following this rest period, an initial positioning scan (scout) was performed followed by axial and sagittal plane scans. Scans had a time to relaxation (TR) range of 690–830 ms and time to echo (TE) range of 14–28 ms with a slice thickness of around 4 mm and a gap between slices of 0.4 mm. The bed of the MRI scanner was then be tilted into the upright position 4° inclined from the vertical to allow weight-bearing. Foot position was controlled by aligning the great toe with a piece of tape on the platform. The scan time for each sequence was 2:43 min, with one acquisition. Subjects were randomised to the order of brace or no brace by sealed opaque envelopes under the supervision of the study statistician. Images were viewed off line.

Study intervention

The brace intervention consisted of a Bioskin Patellar Tracking Q Brace (Ossur UK, Stockport, England) (Fig. 1).

Patellar alignment measurements

Medical imaging software Clear Canvas Workstation (Version 7.0.0.) was used. All images were anonymised so that examiners were blinded to the patient identification and group conditions (brace or no brace).

Five measurements of PF alignment and congruence were taken.

Bisect offset index assessed medio-lateral patellar displacement relative to the femur. The technique was initially described by Stanford *et al.*[18] and used by Powers *et al.*[19]. A line was drawn connecting the posterior femoral condyles on the slice in which the posterior condyles were most obvious and a perpendicular line was projected up through the deepest point (apex) of the trochlea. Then another slice was found on which the patellar width was clearest and on which a line could be drawn to measure the width. Finally, these two slices were superimposed allowing us to project the line anteriorly from the bisection of the posterior condylar line through the second line on the patella[19]. To determine the patellar displacement by the bisect offset, the extent of the patella lateral or medial to the perpendicular midline was expressed as a percentage of the total patellar width (Fig. 2).