BRACING ALTERS PATELLOFEMORAL CONTACT MECHANICS DURING THE GAIT CYCLE: A DYNAMIC BIOMECHANICAL STUDY

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INTRODUCTION

Patellofemoral (PF) pain is one of the most common knee disorders seen in orthopaedic practice [1]. However, the etiology of PF pain remains unclear and functional outcomes after treatment are unpredictable and often unsatisfactory [2]. Clinical decreases in PF pain symptoms with the application of bracing have been demonstrated [1]; yet, the mechanism by which an individual brace reduces pain is not well understood. The purpose of this study was to evaluate the effects of three PF braces in altering contact mechanics during gait.

METHODS

Three fresh-frozen human cadaveric knees were tested during simulated free-speed walking under the following five test conditions: (1) no brace; (2) three DonJoy™ PF braces including, the Tru-Pull™, Lateral "J", and an elastic sleeve; and (3) after a lateral release had been performed. The major individual muscles crossing the knee joint were moderately loaded according to their physiological cross-sectional areas [3]. A Tekscan™ sensor was inserted into the PF joint, through a medial parapatellar arthrotomy.

Fifteen strides were collected with each knee under each test condition. Differences in contact area, total contact pressure, peak pressure and center of pressure due to application of the three braces and the lateral release were analyzed using ANOVA with multiple comparisons (i.e. Tukey's HSD) with the non-braced condition set as the control group.

RESULTS AND DISCUSSION

Biomechanical variables, including peak pressure, contact area, and center of pressure, varied systematically with the gait stride (Figure 1a, 1b). Peak PF pressures during mid-stance were significantly reduced when compared with the unbraced condition by the Lateral "J", the Tru-Pull, the elastic sleeve, and the lateral release (Figure 1a, $p<0.03$). The Lateral "J" reduced peak pressure during mid-stance by 21%; Tru-Pull by 19%; elastic sleeve by 19%; the lateral release by 22%. The Tru-Pull, elastic sleeve, and the lateral release also reduced peak pressure throughout swing phase (Figure 1a, $p<0.04$). The Lateral "J" did not significantly reduce peak pressure during the swing phase of the gait cycle. The elastic sleeve increased PF contact area by 79% during the double-support phase of the gait cycle ($p<0.05$). However, the Tru-Pull decreased contact area by 32% during mid-stance ($p<0.03$). Contact area did not significantly change with the Lateral "J". Application of the Lateral "J" shifted the center of pressure medially during single-leg support (Figure 1b, $p<0.02$).

CONCLUSIONS

This study presents a quantitative approach to the evaluation of PF contact mechanics with a range of clinical interventions during simulated locomotion and can aid understanding of the factors that contribute to PF pain and the mechanisms underlying symptom reduction associated with bracing.

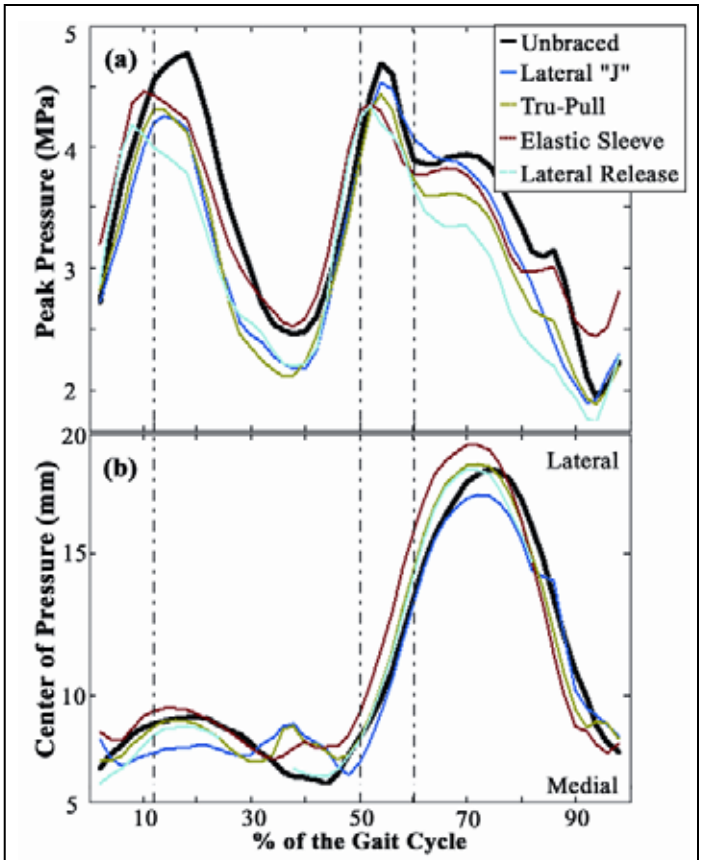

Figure 1. (a) Peak pressure and (b) Center of pressure, (x-coordinate) vs. % of the gait cycle. The three vertical lines (located at 11.8, 50.7, and 60.5% respectively) correspond to the onset of single-leg support, the onset of the second double-leg support, and the end of the stance phase, respectively. In (b) lateral and medial directions are as indicated.

The demonstrated reduction in peak PF pressure, for example, is a potential mechanism for pain relief associated with bracing. Limitations of this study include the small sample size, specimens not necessarily having a PF disorder, open-chain movement, and moderate muscle loads. A follow-up study is planned.

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