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Dynamic sensor-guided assessment for fine-tuning of orthotic design in unloading of medial compartment knee osteoarthritis

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Introduction

In Hong Kong, osteoarthritis (OA) knee cuases pain in 7%-13% of men and women with age ≥50years, respectively. Unloading the symptomatic knee compartment using orthoses help to relieve pain in medial knee OA. However, unloading force required were arbitrary and not commonly recognized by the patient during trial fitting. Objective method in fine-tuning of orthotic design would provide an optimal unloading force that ensure outcome and avoid discomfort due to excessive force.

Objectives

To develop an innovative method in biomechanical-guidance of orthotic design for unloading of medial compartment knee osteoarthritis

Methodology

Subjects with painful & moderately degenerated medial knee OA (i.e. Kellgren and Lawrence stage 2 or 3) were recruited. Subjects were randomized into intervention (Hardgp) and sham group (Softgp) by a sealed envelope. An innovative orthosis using ankle brace with lateral-wedged insole (hard insole for Hardgp and soft insole for Softgp) were fitted into subjects' shoes. At baseline, shank motion data upon different orthotic conditions were collected using accelerometer, during 8m level ground walking trials with 4mm, 6mm, 8mm and 10mm lateral wedged insole. Subjects were provided with 6mm lateral-wedged insole. Change of knee pain (VAS) severity were observed at baseline, 1-month, 3-month and 6-month follow-up. Multivariate regression analysis was performed to establish the correlation between shank motion data and rate of change of pain.

Result

Thirteen subjects with mean age of 64 years were recruited. In 6-months, averaged pain reduction is 45%. Rate of pain reduction was not related to age, BMI, deformity severity, laterality or insole materials. Multivariate regression model, based on the shank motion data, pain (VAS-baseline) and knee stiffness (WOMAC-baseline) achieved a good correlation, i.e. R-square value of 0.95, with rate of knee pain reduction. Based on the correlation between multivariate regression model and rate of change of knee pain, orthotic design can be fine-tuned by an objective biomechanical dynamic motion assessment to ensure clinical outcome in pain improvement. Ineffective or over-corrected orthotic treatment can be avoided. Clinical effectiveness can be enhanced, by as much as one-fold, using the sensor-guided fine-tuning orthosis for medial compartment knee osteoarthritis.