on the left posterior-superior femoral head, however, increased pressures acting on the superior-lateral femoral head by 0.91 MPa. ***Unaided gait while carrying load.*** Hand carrying a load on the left side reduced left femoral head superior pressures by 1.59 MPa, and posterior-superior pressures by 0.69 MPa, however, increased the pressure exerted on the left anterior-superior femoral head by 0.69 MPa. While carrying the load in the right hand, an increase of 1.27 MPa was observed on the left anterior-inferior femoral head. ***Cane aided gait while carrying load.*** When carrying a load in the right hand and using a left side cane, the left femoral head pressures increased by 2.38 MPa superiorly, 0.96 MPa posterior-superiorly and 1.35 MPa anterior-inferiorly. While carrying a load in the left hand and using a right side cane, posterior-superior and superior-lateral femoral head pressure decreased by 2.49 MPa and 0.73 MPa respectively. This is shown in Figure 1.

Discussion. Past *in-vivo* hip pressure studies [4] have identified the posterior-superior and superior portions of the femoral head to bear the highest stresses during many human activities. Our findings suggest that using a cane unilaterally may protect the posterior-superior cartilage of both hip joints, however, may expose the hip ipsilateral to the cane to higher than normal anterior and superior pressures. Neumann [5] hypothesized that carrying a load ipsilateral to the effected hip will reduce ipsilateral abductor loads. Our data suggest that posterior-superior and superior hip cartilage may be protected by carrying a load ipsilateral to the diseased joint, however may increase stress on anterior cartilage as well as increase stress on superior and anterior portions of the opposite hip. In the case of unilateral arthritis, combining cane use with small (10% B.W.) hand carried loads may work to protect the patient's acetabular or femoral cartilage, however, in the (acute or high risk) bilateral case, the act of protecting one hip may be detrimental to the opposite hip. Our data also suggest that clinicians should be aware of any radiologic evidence of regional cartilage degeneration since anterior femoral head stress may be increased for the above activities.

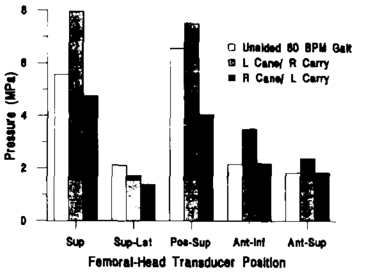

Figure 1. Hip pressures while carrying load in one hand and using a cane in the other.

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LOAD SHARING AT THE KNEE DURING VALGUS BRACING FOR MEDIAL COMPARTMENT OSTEOARTHRITIS

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INTRODUCTION

Osteoarthritis (OA) of the knee is frequently present in the medial compartment During gait, with the exception of initial stance which produces a valgus moment at the knee, the knee joint is subjected to a varus moment which will shift joint load to the medial compartment In patients with medial compartment pain the higher compressive load in the medial compartment will intensify pain and may be a contributing factor to the degenerative process To reduce medial compartment load, the concept of valgus bracing was developed in which a knee brace which applies valgus correction is utilized Valgus bracing has met with success in a majority of our patients, although to varying degrees To better understand the mechanics of valgus bracing it is necessary to determine the loads applied to the knee, the degree to which these are reduced, and the effect of such an alteration on medial compartment force The objectives of this study are to determine the load sharing capabilities of the brace, i e , to determine how much of the varus load applied about the knee is taken up by the brace, and to estimate the effect on medial compartment force using a model which considers the contributions of body weight and muscle force, in addition to the varus moment

METHODOLOGY

Six study subjects have been analyzed, to date A patient was included only if he/she presented with isolated medial compartment OA, a neutral or varus (0 - 10°) alignment, and no evidence of ligamentous instability Criteria for exclusion were, history of tibia or femur fracture, history of knee surgery other than arthroscopic debridement or meniscectomy, skin or peripheral vascular disease preventing brace application, or a fixed flexion contracture Informed consent was obtained from each patient prior to testing Each subject was fitted with an adjustable Generation II Unloader brace

Strain gages were applied to each brace and calibrated with known varus moments Knee kinematics and kinetics were collected using a six-camera video system (Motion Analysis Corporation, Santa Rosa, CA) and two force platforms (Bertec, Columbus, OH) Three trials were averaged for the following conditions unbraced, as fitted with a nominal 4° of valgus correction, with increased tension on the dynamic force strap, and with a 4° and an 8° correction from a zero load position determined in the laboratory A model which factored in the gravitational and muscular contributions to the joint reaction force and accounted for the load shift due to the varus moment was used to estimate the medial and lateral compartment forces A visual-analog scale assessing pain and function was administered

RESULTS

Results for these six subjects demonstrated that, with 4° valgus correction applied, the brace took up 9% of the external varus moment applied about the knee Increasing correction to 8° increased the load share of the brace to 13% A similar behavior was seen with increased strap tension Valgus bracing for patients diagnosed with medial compartment OA has demonstrated success with respect to functional improvements and symptomatic pain reduction Based on visual-analog scales all six subjects were improved with respect to pain and function

The estimates of medial compartment loads were variable in their outcomes For two subjects the medial compartment force was increased This is attributed to a marked increase in their flexion moments during gait, requiring a greater quadriceps force which was primarily responsible for the increased joint reaction force at the knee In this study, the six subjects analyzed with the instrumented brace demonstrated moment-sharing capabilities which support the concept that valgus bracing (at least with the type of brace used in this study) does take up a portion of the varus load

DISCUSSION

Clearly, there are multiple factors which can influence the outcome of bracing, e g , increased proprioception and alterations in knee kinematics or loading other than those designed into the brace We are studying those effects which the brace is primarily designed to elicit and to determine to what degree they prevail The results clearly demonstrate that adjusting the degree of correction and/or the tightness of the strap impacts the degree to which load-sharing occurs during gait Requests for third-party payment for orthotics is being subjected to even greater scrutiny Demonstration of the biomechanical performance of valgus bracing will result in more informed decisions being made with respect to these patients

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Gait Adaptations of Anterior Cruciate Ligament Deficient Knees

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Introduction

ACL rupture is among the most frequent traumatic knee injuries Patients with ACL deficiencies have been observed to exhibit unique walking adaptations to compensate for knee laxity The only consensus among studies is that there is great variation in the adaptations Most studies show similar kinematic results when compared with normals (Berchuck, et al.; Kadaba, et al., Tibone, et al.) and Kadaba, et al. showed similar kinetic results when compared with normals in 78% of his subjects However, Berchuck, et al. described drastic changes in the knee joint kinetics of 75% of their subjects in the absence of serious kinematic differences. The purpose of this study was to observe the gait adaptations made by the ACL deficient patient (muscle EMG patterns, joint kinematics & joint kinetics) and compare these changes to normal gait.

Methodology

The study consisted of ten patients who had unilateral deficiency of the ACL ligament (10 sides) and twelve healthy control subjects (24 sides) The ACL deficient group involved individuals with a complete ACL tear confirmed by magnetic resonance imaging and assessment by an orthopaedic surgeon Individuals from both groups lacked pain or other injuries which might impede the gait pattern Both groups were analyzed during three trials of computerized gait analysis with surface EMG Electrodes were placed on the following muscles Vastus lateralis, vastus intermedius, vastus medialis, semimembranosus, biceps femoris, gastrocnemius, and anterior tibialis Reflective markers were placed bilaterally over the fifth metatarsal, lateral malleolus, mid-shank, lateral femoral epicondyle, mid-thigh, anterior superior iliac spine, and acromioclavicular joints Additionally, a marker was placed over the sacrum Data were gathered via a five camera MacReflex video based motion analysis system (60 Hz) Three-dimensional coordinate data were obtained using the DLT algorithm Joint kinematic and kinetic data were obtained via the AutoGait 3D program which accompanies the MacReflex motion analysis system Methods similar to Kadaba, et al. (1990) were used for calculating kinematic & kinetic data All data were gathered as each subject walked at a self selected pace barefoot across a Kistler force plate mounted flush in the floor and centered in a twenty-five foot runway EMG, joint kinetic, and joint kinematic data were synchronized and standardized to percent of gait cycle for analysis Statistical significances were determined by independent t-tests using the 0.05 alpha level.

Results

The ACL deficient study group (n=10, 7 males, 3 females) had a mean age of 31.8 +/- 11.4 years, mean height of 171.6 +/- 9.8 cm, mean weight of 76.6 +/- 13.4 kg, and a duration since injury of 11.0 +/- 7.6 months The control group (n=12, 6 males, 6 females) had a mean age of 26.0 +/- 6.2 years, mean height of 168.0 +/- 9.3 cm, and a mean weight of 72.3 +/- 12.2 kg Table 1 shows the joint angles and table 2 shows the joint kinetics of interest with significantly different items indicated.

Discussion

In the current study, none of the subjects with ACL deficiency demonstrated the quadriceps advoidance adaptation as indicated by Berchuck et al All demonstrated a flexed knee gait pattern with an internal extension moment at the knee There were no significant differences between the maximum knee extension moments during mid-stance of the ACL deficient subjects versus normal subjects (2.9 +/- 1.8 vs 3.2 +/- 1.0 %BW*Ht respectively) This is similar to the results found by Kadaba, et al (78% with flexed knee gait & knee extension