INTRODUCTION

Whether on a temporary basis or permanently, individuals are prescribed walkers to assist with balance and/or to reduce lower extremity weight bearing. Over 77% of those reporting the use of a walker in 1997 were over 65 years of age (Russell, 1994). In order to understand the possible mechanisms of secondary conditions that may develop due to the increased loading demands imposed by using walkers it is first necessary to obtain some baseline information on the actual joint forces and moments through biomechanical analysis of actual patients as they ambulate with their required walker. The purpose of this study was to describe the joint forces and moments of the wrist, elbow and shoulder in a sample of patients that are using a walker as a result of total joint surgery of the hips and knees.

METHODS

Twenty individuals (age = 66.6±8.2 years, M =11,F=9, height = 1.7±1.2m, weight = 89.6 ±14.0kg) post-surgical hip (n=8)or knee (n=12) joint replacement participated in the study. Three-dimensional kinematics of both upper extremities were collected at 100 Hz using infra-red light emitting diodes (Optotrack?, Northern Digital Inc., Waterloo, Ontario). Local coordinate reference frames defined by digitization of anatomical landmarks using specialized software (Innovative Sports Training, Chicago, IL). Kinematics were synchronized with forces transmitted through walkers obtained with transducers integrated into the handles of a walker (AMTI, Watertown, MA, USA). Inverse dynamics approach was used to calculate joint forces and moments at the wrist, elbow and shoulder.

Following subject set up, subjects ambulated approximately ten feet, two to three trials resulting in approximately 10-16 complete walker steps Walker steps were normalized from initial walker loading , to initial walker loading representing one walker cycle. Cycles were ensemble averaged and peak values calculated. Descriptive statistics were calculated and paired t-tests (p<0.05) determined if differences existed in the surgical compared with non-surgical side upper extremity.

RESULTS AND DISCUSSION

Subjects were found to ambulate with 46.1% ± 13.9% weight on their upper extremities (r=0.24), 25.7±7.0% and 20.4±8.5%, non-surgical and surgical side, respectively. No difference was found between the surgical and non-surgical side upper extremity joint kinematics. The wrist was found to be near neutral at contact and due to the progression of the forearm over the hand, the radial deviation angle increased until near peak hand force, then
ulnar deviation was seen throughout the remainder of the cycle. The elbows were in flexion at initial contact, extended until peak hand loading, following which the elbows moved into flexion until the end of the cycle. Shoulder angles began in slight flexion and as the body progressed over the walker the shoulders moved into extension until after the swing phase started.

Peak forces at the hand transducer were greater in the non-surgical side, however, no difference was found in the total area during contact for the non-surgical limb (surgical = 241.2±143.0 N/kg BW, non-surgical = 273.2±108.8N/kg BW).

Anterior shear forces were larger (p=0.02) for the non-surgical wrist as compared with the surgical side. The compressive (vertical) forces in the wrist (p≤0.01) and elbow (p≤0.01) were found to be greater in the uninvolved upper extremity (Figure 1). Larger sagittal plane moments were found in wrist (p=0.01) and elbow (p≤0.01) for the uninvolved limb as compared with the surgical side upper extremity (Figure 2).

Vertical, or compressive forces were found to be greater than body weight at each of the upper extremity joints, both surgical and non-surgical sides, greatest at the wrist and decreasing proximally. Because the upper extremity joints are functionally and structurally designed as non-weight bearing joints, the use of these types of mobility devices places increased demands on the user's upper extremities often resulting in and pain and pathology. Although the current subjects were post-surgical patients, they were in good health with normal upper extremity strength and function and utilized the walker for a reduction of lower extremity weight-bearing of less than 50% BW. However, many walker users are frail, elderly individuals following a sudden trauma such as a hip fracture and may have difficulty meeting the high demands of this task, especially if lower extremity weight bearing status is further limited.

![Figure 1: Vertical/compressive Joint Forces (*= significant difference between sides)](image)

![Figure 2: Sagittal Plane Moments (*= significant difference between sides)](image)

**SUMMARY**

Results of this study indicate that demands on upper extremity joints associated with the use of a walker for assisted ambulation can reach as much as 2.5X body weight. The torque on the elbow joint tends to be the greatest suggesting high muscular demands of the elbow extensors and shoulder extensors. Further studies are needed to address the cause-effect relationship between the actual joint loading and the development of secondary musculoskeletal upper extremity complaints in more frail assistive device users.

**REFERENCES**