Introduction

Total knee arthroplasty (TKA) is a common procedure, with an average of 95,000 per year being carried out in the U.S. between 1985 and 1988, accounting for around 36% of all joint arthroplasties (AAOS, 1992). The vast majority of these (85.4%) were necessitated by severe osteoarthritis (OA) of the knee joint in patients who were 65 years of age or older (AAOS, 1992).

Stair negotiation in the general elderly population has been described as one of the most challenging activities of daily living (Startzell et al., 2000). Therefore, it is not surprising that the ability to negotiate stairs was the second highest concern behind unlimited walking ability in a group of 152 patients about to undergo total knee surgery (Trousdale et al., 1999). Similarly, descending and ascending stairs were identified as the most difficult and the second most difficult of 17 daily activities for a group of 69 hospital outpatients with OA (Creamer et al., 2000). Therefore, stair negotiation is a good determinant of the level of functioning of a total knee patient post-operatively, compared to either the pre-operative condition or to healthy elderly. Thus, post-operative studies of the stair climbing ability of knee arthroplasty patients provide a greater insight into functional ability than those studies that only consider level walking, which is a much less challenging and less constrained task (McFadyen and Winter, 1988).

The ability to easily determine the stair walking ability of TKA patients after surgery would provide an objective measurement of recovery status. The aim of the present study was to investigate the potential of ground reaction force (GRF) variables as objective indicators of recovery after TKA surgery.

Methods

Six patients (2 male, 4 female; mean age 70.2 years, standard deviation 7.2 years; 2 simultaneous bilateral, 4 unilateral) about to undergo TKA surgery at a single facility with a single type of implant volunteered to participate in the study. Data were collected immediately pre-operatively (PRE) and 1, 2, 3, 6, and 9 months post-operatively (POST1, POST2, POST3, POST6, and POST9). Only two patients were allowed by their surgeon to negotiate stairs at the POST1 visit. A purpose-built seven step staircase (rise 18cm, run 28cm) was used. Ground reaction force data were collected using a Kistler 9286 force platform (Kistler Instrument Corp, Amherst NY) embedded in the tread of a step in the mid-stair region. The subjects performed stair descent and ascent trials as tolerated, up to a maximum of five of each type, using their normal method. GRF variables were determined using custom Matlab software (MathWorks Inc, Natick MA). Passive range of knee motion (ROM) on the operative side was also measured at each visit.

Results and Discussion

GRF patterns during the first nine months POST were highly variable, although some general trends were apparent. During stair descent, maximum Fy loading rate (MAXLR) tended to increase from PRE to POST9. However, three subjects had an initial decrease in MAXLR at the first POST visit. The timing of MAXLR was consistent between visits within individual subjects. During stair ascent, MAXLR did not vary widely between visits and no trend was apparent. Four of the 6 subjects showed increasing peak
forces on each POST visit during descent while there was no clear trend for stair ascent. Passive knee flexion ROM increased by ~5 degrees per month in 5 of the 6 subjects.

![Figure 1](image1.png)  
**Figure 1:** Peak vertical forces during stair ascent and descent over visits. Note that POST1 values were not available for Ascent because subjects lead with the contralateral leg.

![Figure 2](image2.png)  
**Figure 2:** Peak vertical force loading rates during stair ascent and descent over visits

![Figure 3](image3.png)  
**Figure 3:** Passive knee flexion range of motion

The trends observed indicate that stair descent may be a better indicator of recovery status after TKA than stair ascent, in terms of a consistent relationship between MAXLR and peak force with the number of months post-surgery. The present study will continue up to 12 months POST to determine whether the observed trends continue through the recovery period and at what stage, if any, they plateau.
References


Acknowledgements

This study was partially supported by Kistler Instrument Corp (Amherst, NY). The assistance of Mary Becker in data collection is greatly appreciated.