Peak Vertical Ground Reaction force & Stance Phase time to assess post-TKA interlimb asymmetry

Abderrahman Ouattas¹, Nicole Ray², Brian A. Knarr¹
¹Department of Biomechanics, University of Nebraska at Omaha, Omaha, NE 68182
²Mechanical Engineering, University of Delaware, Newark, DE 19713

INTRODUCTION

- Total Knee Arthroplasty (TKA) is the most common surgical procedure to treat end-stage knee osteoarthritis (OA), which more than 500,000 TKA surgeries performed annually in the U.S.¹
- The annual rate of TKA surgeries is expected to increase to 3.5 million by 2030². Within a minimum of 10 years after the primary TKA, almost 50% of patients undergo a secondary TKA on the contralateral limb due to OA progression³.
- A study showed that 35% of patients who undergo primary TKA have secondary joint replacement to replace the contralateral knee (TKA=92%) and hip (THA=8%)⁴.
- Aberrant loading, such as shifting more load on the contralateral limb, may increase the chances of OA³.
- The purpose of this study was to investigate and determine if clinically observed measurements can estimate quantitative assessments and indicate gait impairments (specifically loading) in total knee arthroplasty patients.

METHODS

Data Collection:
- 18 adults (66:6 years, 11M,7F) at least 1 mo. post-unilateral TKA (11.19:6.47 months)
- Session 1: Clinical evaluation
  - Self-reported surveys on functional ability
  - Tests of clinical impairments and functional performance
- Session 2: 1 minute walking trials at self-selected and fastest comfortable speeds
  - Motion and force data were collected using an 8 camera system (Motion Analysis Corp., CA) and an instrumented split-belt treadmill (Bertec Corp., OH)

Data Analysis:
- Mean trial values were recorded for each variable at fast and self-selected speeds
  - Stance time
  - Peak Vertical Ground reaction force
- Interlimb pVGRF and Stance phase time Symmetric index values were calculated using the means of each subject trial through the following formula, with greater values denoting greater asymmetry
  - Pearson correlation was calculated for stance time vs. vertical GRF asymmetry at self selected and fast speeds.

RESULTS

- Patients with TKA demonstrate asymmetric loading during gait even > 1 year after surgery.
- Although patients exhibited both stance time interlimb asymmetry and loading asymmetry, there was poor correlation between peak Vertical ground reaction force and stance time asymmetry index at either self selected or fast walking speeds.
- Given the lack of correlation between measures, stance time asymmetry does not necessarily indicate loading asymmetry for post-TKA patients.
- Clinically accessible methods to assess joint loading are needed to assess interlimb asymmetrical loading in post-TKA patients, as traditional spatiotemporal may not provide proper insight.
- Accelerometers may be used as a low cost assessment tool to record quantitative asymmetrical analyses of interlimb loading patterns post-TKA. Further research should be done to assess accelerometers validity in assessing interlimb asymmetrical loading in TKA patients.

REFERENCES

3) Shao Y, Zhang C, Charron KD, MacDonald SJ, McCalden RW, Bourne RB. The fate of the remaining knee(s) or hip(s) in osteoarthritic patients undergoing a primary TKA or THA. J. Arthroplasty 2013:28(10):1842-1845. doi:10.1016/j.arth.2012.10.008

Acknowledgements

Thank you to NIH P30-GM103333 for support of this project as well as Kevin McGinnis, Adam Marmon, Dana Mathews, and Christiana Care Dept. of Orthopedics for their assistance in data collection.