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Comparison of Clinic-Based Biomechanical Measures during Walking to Laboratory Measures after Total Knee Arthroplasty

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Abstract Text:
Purpose/Hypothesis: Abnormal movement patterns during walking, such as asymmetries in between-limb vertical ground reaction force (vGRF), are common after total knee arthroplasty (TKA) and are related to poorer long-term outcomes; however, clinically feasible methods to assess movement biomechanics are needed. Insole pressure measurement systems are capable of measuring kinetics in clinic settings and prior research has validated vGRF, impulse, and loading rate assessments using insole sensors with concurrently collected motion capture data. However, the relationship between measurements collected clinically to those collected in a laboratory setting has not been examined. Therefore, the purpose of this study was to compare clinic-based measures of gait biomechanics using insole sensors collected during a physical therapy session to laboratory-based motion capture measurements 10-weeks after TKA.

Number of Subjects: 61 (aged 65±8 years)

Materials and Methods: Subjects underwent biomechanical assessments while walking at a self-selected pace 10-weeks after TKA under two different conditions on different days: 1) using single sensor insoles (Loadsol, Novel Electronics) during a physical therapy intervention session (clinic-based assessment) and 2) using an 8-camera motion capture system and embedded force plates (laboratory-based assessment). Average vGRF, impulse, and loading rate for the surgical limb, uninvolved limb, and between-limb symmetry ratio (surgical/uninvolved) were collected during both sessions. Clinic and laboratory-based measurements were compared using paired t-tests and intraclass correlation coefficients (ICC 3,k). ICCs were interpreted as follows: <0.50 poor, 0.50-0.75 moderate, 0.75-0.90 good, >0.90 excellent.

Results: Symmetry ratios and uninvolved-limb vGRF were not different between clinic and laboratory-based assessments ($p>0.05$) but were different for surgical limb vGRF, impulse and loading rate ($p<0.05$) and uninvolved limb impulse and loading rate ($p<0.05$). ICCs for all measurements were less than 0.5, indicating poor consistency between clinic and laboratory-based measurements.

Conclusions: Clinic-based symmetry ratios demonstrated greater accuracy than individual limb measurements of vGRF, impulse, and loading rate with laboratory-based measurements of walking 10-weeks after TKA. This may be due to ratios having the advantage of correcting for systematic differences in magnitude (e.g. insoles forces being lower on both surgical and uninvolved limbs). The poor consistency between clinic-based measurements and laboratory-based measurements could be due to several factors: 1) differences in data collection methods (e.g. environment); 2) subject variability; or 3) measurement-error.

Clinical Relevance: Insole pressure measurement systems may have clinical utility as a less-costly alternative to motion capture systems for investigating between-limb kinetic symmetry. However, future research is needed to determine optimal methods for increasing accuracy and consistency between clinic-based and laboratory-based measurements of gait biomechanics after TKA.

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Comparison of Clinic-Based Biomechanical Measures during Walking to Laboratory Measures after Total Knee Arthroplasty

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References:

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Speaker Bio: Associate Professor Physical Therapy Program Department of Physical Medicine and Rehabilitation University of Colorado Anschutz Medical Campus, Aurora, CO Dr. Bade is an associate professor in the physical therapy program at the University of Colorado Anschutz Medical Campus and is actively involved in the mentorship of both professional and post-professional students. He completed his orthopaedic manual physical therapy at Duke University and is the past director of Regis University's Orthopaedic Manual Physical Therapy Fellowship Program. He is a recognized researcher and lecturer in the area of orthopaedics and has received funding from numerous sources including the National Institutes of Health.

Speaking Experience Level: National conference (US)

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Speaker Bio: Dr. Victor Cheuy is an Assistant Professor in the Department of Physical Therapy and Rehabilitation Science and the Department of Radiology and Biomedical Imaging. An engineer by training, Dr. Cheuy received his BS and MS in Biomedical Engineering with a minor in Psychology from Washington University in St. Louis. He completed his doctoral work, entitled “Contributing Factors to Forefoot Deformity in the Diabetic, Neuropathic Foot,” under the mentorship of Dr. Michael Mueller, PT, PhD, FAPTA, in the Movement Science Program at Washington University. Dr. Cheuy then completed his postdoctoral fellowship in Rehabilitation Science at the University of Colorado Anschutz Medical Campus under the mentorship of Dr. Jennifer Stevens-Lapsley, PT, PhD. His work focused on the development and implementation of clinical trials centered on the effectiveness of rehabilitation interventions after hip and knee joint arthroplasty. Dr. Cheuy joined the UCSF faculty in 2019, with the continued interest of integrating rehabilitation, advanced imaging, and technological innovation in lower extremity conditions.

Speaking Experience Level: International conference (outside the US)

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Cory Lynn Christiansen, PT, PhD

Speaker Bio: Dr. Christiansen is a professor in the Department of Physical Medicine & Rehabilitation at the University of Colorado and a rehabilitation researcher within the VA Eastern Colorado Healthcare System. He completed physical therapist training at Duke University (MS) and earned a PhD in Sport and Exercise Science at the University of Northern Colorado. He directs the Interdisciplinary Movement Science Lab on the Anschutz Medical Campus at the University of Colorado, and his research focuses on optimizing rehabilitation for older adults with movement dysfunction from a biopsychosocial perspective with particular emphasis on biomechanical interventions. He leads a primary line of research related to optimizing rehabilitation after lower-limb amputation. In addition to research, Dr. Christiansen has taught in the University of Colorado DPT Program for the past 16 years and has presented multiple educational sessions, primarily on the topics of amputation rehabilitation, gait analysis, and movement science.

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Jennifer Elaine Stevens-Lapsley, PT, MPT, PhD, FAPTA (UCD Physical Therapy Program)

Speaker Bio: Dr. Stevens-Lapsley is a Professor and Director of the Rehabilitation Science PhD program in the Physical Therapy Program at the University of Colorado at the Anschutz Medical Center. She is also the Associate Director of Research, Geriatric Research, Education and Clinical Center at the Eastern Colorado VA Healthcare System. She identifies, integrates, and advances innovative, evidence-based medicine solutions for older adult rehabilitation through highly effective research methods and partnerships. She has 20 years of clinical research experience in patients with osteoarthritis planning joint replacement, and more recently, medically complex populations. Her research ranges from understanding the mechanisms of skeletal muscle dysfunction to studies of implementation of best rehabilitation practices in post-acute care settings. Her clinical research has resulted in over 150 publications, national and international speaking invitations, awards such as the APTA Marian Williams Award for Research, and over $20 million dollars to support her clinical research in the past 15 years. She has served as a research mentor for many physical therapists pursuing post-graduate education. As well as has lectured both at the state and national level on the topic of post-professional educational decision making.

Speaking Experience Level: International conference (outside the US)

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