CENTER FOR RESEARCH IN HUMAN MOVEMENT VARIABILITY

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

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INTRODUCTION

- Total Knee Arthroplasty (TKA) is the most common surgical procedure to treat end-stage knee steoarthritis (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 2030[2]. 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 progression[3].
- 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 OA[5]
- **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
  - % □□□□□□□□□ =_ □ 100
- **Pearson correlation** was calculated for stance time vs. vertical GRF asymmetry at self selected and fast speeds.

RESULTS

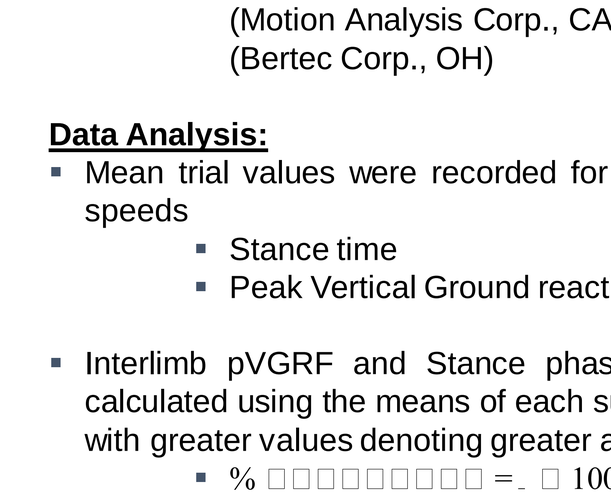

Figure 1. Fast walking Stance time symmetry values.

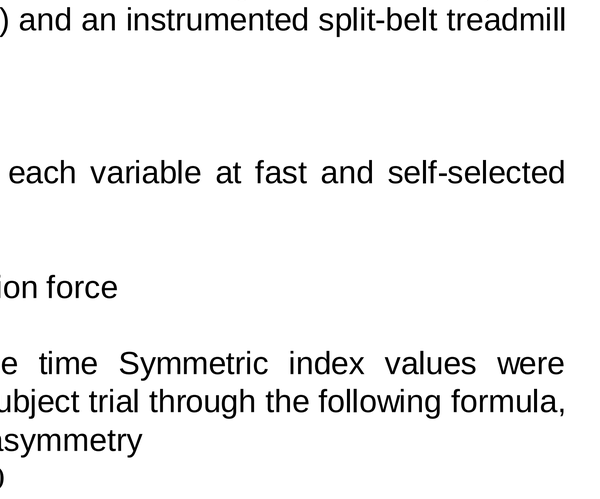

Figure 2. Fast walking pVGRF symmetry values.

*** Fast walking stance time & pVGRF symmetry coefficient correlation r= -0.01376**

RESULTS

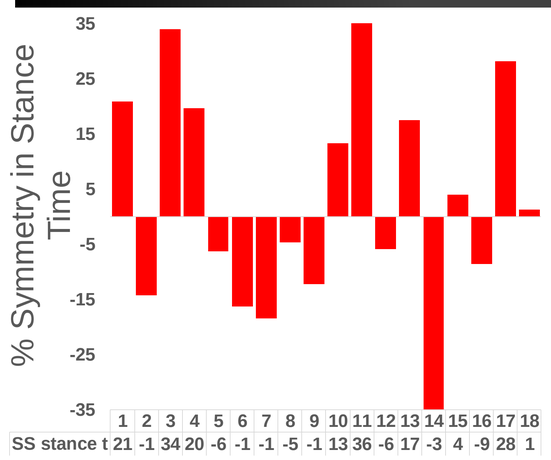

Figure 3. Self Selective walking Stance time symmetry

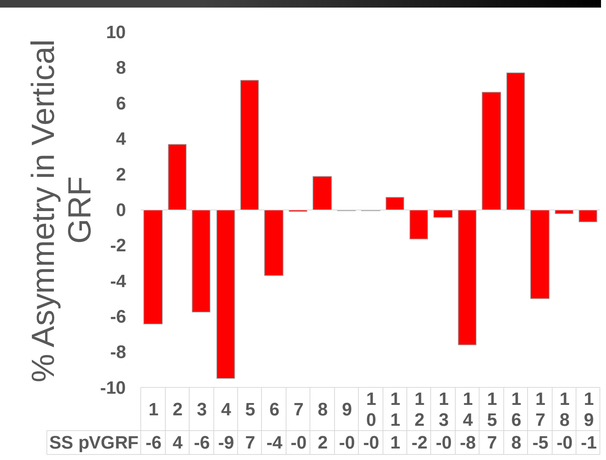

Figure 4. Fast walking pVGRF symmetry values.

***Self selective walking coefficient correlation between stance time & pVGRF r= -0.23708**

No.	Gender	Age	Mass (kg)	Height (m)	Self Selective speed (m/s)	Fast Speed (m/s)	Months since TKA	Unilateral or Staged?	QI Value	Worst Pain		Active ROM (deg)			
												Sx		noSx	
										Sx	noSx	Flex	Ext	Flex	Ext
1	M	72	85.93	1.778	1.15	1.8	7.15	Unilateral	0.815	1	0	125	2	140	-1
2	F	73	83.38	1.651	1.1	1.5	3.97	Unilateral	1.085	2	1	114	6	129	0
3	M	71	104.7	1.854	1.05	1.2	7.15	Unilateral	0.93	3	0	128	0	133	-2
4	M	67	79.41	1.702	1.5	1.75	6.3	Unilateral	0.714	3	2	105	-1	142	-5
5	M	67	86.75	1.778	1.25	1.8	12.3	Staged	1.132	0	3	125	-1	125	0
6	M	62	108.7	1.753	1.05	1.35	13.21	Staged	0.783	0	0	108	-3	125	-1
7	F	63	122.5	1.727	1.05	1.25	7.74	Staged	0.889	2	2	120	0	114	0
8	M	50	87.36	1.753	1.3	1.7	13.15	Unilateral	0.881	0	3	130	0	142	-2
9	M	66	99.19	1.803	1.2	1.8	13.44	Staged	0.8	4	4	128	0	140	0
10	F	63	82.06	1.676	1.1	1.45	15.28	Staged	0.786	3	0	130	-2	137	-2
11	M	68	84.55	1.727	0.9	1.35	12.39	Unilateral	0.694	3	3	106	-4	121	-3
12	F	69	57.61	1.499	1.15	1.4	25.34	Unilateral	0.922	0	0	106	-3	150	0
13	F	72	69.42	1.651	1.1	1.25	14.03	Staged	0.974	1	1	125	-1	127	-3
14	M	71	78.07	1.727	0.9	1.15	2.13	Unilateral	1.408	3	2	116	8	133	-6
15	M	63	108.6	1.88	1.3	1.5	12.85	Staged	*	*	*	*	*	*	*
16	F	68	103.2	1.676	1.2	1.4	24.92	Staged	*	*	*	*	*	*	*
17	M	68	81.29	1.803	1.02	1.3	3.84	Unilateral	0.76	5	7	105	3	127	0
18	F	57	70.65	1.727	1.25	1.65	6.33	Unilateral	1.23	2	0	135	0	142	-1

Table 1. Subject demographic and select clinical parameters. ***Note: Bold data correspond to subjects outside the acceptable range of symmetry and Quadriceps Index (QI) Value is a ratio of strength for the Sx and noSx limbs***

DISCUSSION

- **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 measuring interlimb asymmetry in post-TKA patients.**

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