Sit-to-Stand Symmetry in Individuals with Hip Pathology

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Introduction

Why study hip fracture?

- Hip fractures occur in approximately 300,000 individuals over 65 years of age and is on the rise
- 53.3% of those who fall, fall again
- 50% loss of function in involved lower extremity post fracture
- 25% increased mortality rate 1 year post hip fracture

An asymmetry in force production has been found to exist between fractured/non-fractured sides during a sit-to-stand task post hip fracture, despite having adequate capacity to perform the task symmetrically.

Houck 2011 found the asymmetry is a result of weakness in the fractured lower extremity.

Briere 2013 found the asymmetry is a result of motor control dysfunction in the nervous system rather than a pure strength deficit.

An explanation for these errors could be that patients rated their perceived effort distribution rather than their force/weight distribution through their lower extremities during a functional sit to stand task.

Hypothesis

- While rising from sit-to-stand, individuals who are fully rehabilitated post-hip fracture will shift weight off of their involved lower extremity resulting in an asymmetrical vGRF.
- Individuals, post-hip fracture, will not accurately perceive the presence of their own sit-to-stand asymmetry.
- During sit-to-stand, at seat off, individuals post hip fracture will determine loading through the feet (vGRF) based upon perceived level-of-effort rather than actual level-of-force.

Methods

One community-dwelling older adult, post left THA secondary to a fall related hip fracture, was included who fulfilled the following inclusion criteria:

Age 65 ± 30 years	Post-surgical rehabilitation (i.e. PT)
Post unilateral hip fracture with surgical correction (i.e. ORIF, THA)	Living independently within the community
Adequate tolerance to functional testing based on physical examination	Ability to complete a sit-to-stand from a standard height chair without the use of upper extremities

- The subject was recruited from the community, screened over the telephone, and given informed consent upon arrival on test day
- Data was collected using a 10 camera Qualisys IR system, two ATMI force platforms, and Visual 3D (C-Motion) software
- Sit-To-Stand: Self-selected (VAS L/R symmetry), 50/50, self-selected maximum load excursion (VAS for shift)
- Load Matching through feet: Self-selected L/R matching (seated then standing)
- Isometric Knee Extension: Matching, MVIC, VAS MVIC

Results

	vGRF(N)		VAS (%)		Actual vGRF (%)		Error (VAS – Actual)	
	Right	Left	Right	Left	Right	Left	Right	Left
1)Sit to stand Self- selected	446.710	326.684	50	50	61.11	44.69	11.11	5.31
2) Sit to stand, 50/50			50	50				
3) Sit to stand Max Load R	443.571	295.981	73	27	60.68	40.49	12.32	13.49
Sit to stand Max Load L	404.096	330.266	12	87	55.28	45.18	43.28	41.82
4)Load Matching	**vGRF (N)**		**VAS (%)**		**Actual vGRF (%BW)**		**Error % (VAS–Actual)**	
Standing Match R	580	**520**	91		**79.34**	**71.13**	**11.66**	**19.87**
Standing Match L	590.598	541.832	92		80.71	71.13	11.29	17.85
Sitting Match R	72	61	90		63.15*	53.51*	26.85	36.49
Sitting Match L	56	76	90		49.12*	66.66*	40.88	23.34
5) Fixed Asymmetry	425.368	320.397	50/50		58.19	43.83	8.19	6.17
6) Isometric Knee Ext Matching , MVIC	**Target voltage(v)**	**Actual voltage(v)**	**VAS(%)**		**Actual % of MVIC**		**Error (%)**	
R MVIC		2.035 (avg)			100			
L MVIC		1.389 (avg)			100			
KE match R (start with R Match with L)	1.12 (R side)	0.62 (L side)					44.64	
KE match L (Start with L match with R)	0.75 (L side)	0.70 (R side)					7.66	
20% MVIC R	0.407		8		20		12	
20% MVIC L	0.278		10		20		10	
	* Using the 114N measurement of weight of Feet when subject is sitting for this % calculation*							

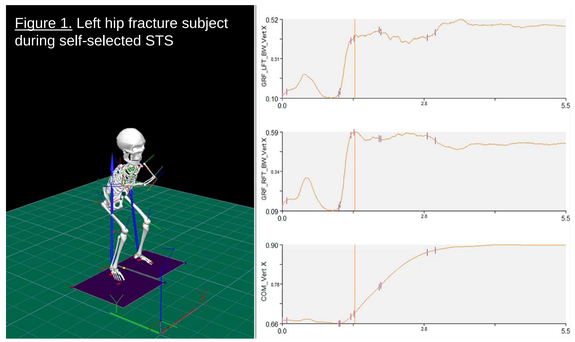

Figure 1. Left hip fracture subject during self-selected STS

Sit-to-stand trials:

- During sit-to-stand, the fracture side (L) had lower vGRF compared to non-fracture (R) (approximately 60/40 %BW). Subject was unaware of asymmetry.
- The only time that the subject was able to approach symmetry during sit-to-stand was when asked to maximally load the fracture side. This resulted in only 5% vGRF improvement (55/44 %BW), but a 40% increase in perceptual effort.

Load Matching Trials

- Subject unable to match target load between right and left limbs, with larger error when tasked with matching force with the fracture limb side in both standing and sitting.
- VAS scores did not correlate with actual force distribution, largest errors both occurring from the fracture limb.

Isometric Knee extension: MVIC, matching and VAS MVIC trials:

- MVIC KE torque production showed a 30% deficit on the fracture side compared to the non-fracture side.
- Both sides showed a 10% perceptual underestimate of target KE forces.

Discussion

This subject's sit-to-stand and load matching data suggests:

- A discrepancy between perceived loading forces between limbs and actual force distribution between limbs during sit-to-stand and load matching tasks.
- Greater force placed on the non-fractured limb throughout sit-to-stand tasks as well as static standing.
- Subject unable to correct asymmetry despite perceiving a correction, suggests long lasting impact of orthopedic injury on nervous system.
- Long term nervous system changes have decreased the subjects variability in the sit-to-stand task, resulting in synergistic movements of COM trajectory and limb loading to complete the task.

This subject's isometric knee extension data suggests:

- The sit-to-stand and standing vGRF perceptual deficits are not explained by KE muscle perceptual deficits.

Follow up studies should consider:

- Following COM trajectory throughout sit-to-stand tasks.
- Possible role of biofeedback and other Physical Therapy interventions impact on retraining perception of force production in patients with hip fractures.

Limitations:

- Low sample size and availability.
- We would have liked to utilize data collection at 0.5s prior to and after seat off, as seen in the Briere study, however, seat off switch technology was not functioning at the time of the study.
- Seated load matching may have been skewed by perception of load through ischial tuberosities by the subject, rather than through the feet, and rating on VAS under that assumption.

Declarative Statement

- Individuals with a previous hip fracture are not able to accurately perceive symmetrical weight distribution through limbs during sit-to-stand, resulting in greater weight bearing through the non-fractured limb.
- Data from subject VAS ratings of left/right symmetry and load (as a percentage of maximum effort) suggests that the nervous system is tuned to level of effort rather than level of force after hip fracture.
- Following a hip fracture, individuals develop a deepened attractor state, reducing the variability of movement options to complete the sit-to-stand task.

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