Hip Muscle Activity and Mechanics in Osteoarthritis Gait

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TAP TO GO BACK TO KIOSK MENU

Introduction

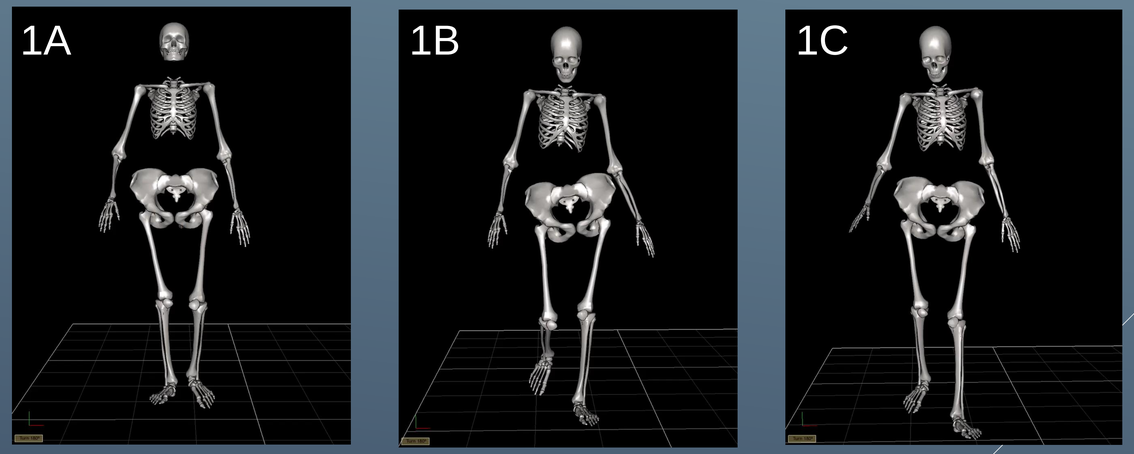
- Hip OA is one of the most common degenerative joint diseases in the U.S. leading to joint pain, reduced mobility, and physical impairment
- Patients with hip OA alter their gait in order to compensate for hip pain while still maintaining frontal plane balance during walking
- Different compensatory characteristics exist among hip OA patients, particularly in pelvic motion, step width, and muscle activity
- Some hip OA patients adopt a 'Trendelenburg Gait' with decreased step width and decreased gluteus muscle activity (Figure 1) while others walk with an elevated pelvis, increased step width, and increased gluteus activity (Figure 2)
- It is expected that these walking conditions are chosen to either maximize step width or minimize hip joint force and moment

Study Aims

- Our study aims to use healthy subjects, uncomplicated by pathological factors, to investigate the relationship between several gait parameters in order to determine which factors cause hip OA patients to adopt specific compensatory walking strategies
- Specifically, we sought to investigate whether the patterns of pelvic motion were related to increases in gluteus medius muscle activity and hip joint moment and hip joint force

Methods

- The inclusion criteria were subjects without any musculoskeletal disorders and without pain during walking
- Kinematics were recorded via a 12-camera Vicon motion capture system using the standard full-body Plug-In Gait marker set (Figure 3)
- Subjects performed walking trials on an AMTI force-instrumented treadmill at 1.0 m/s under varying pelvic motions which mimic those seen in hip OA patients (normal, exaggerated swing-side pelvic drop, and swing-side elevation)
- Bilateral muscle activity of gluteus medius was recorded using a Noraxon surface electromyography (EMG) system
- Following data collection, EMG data were filtered with a 20-250 Hz band-pass filter, rectified, and a windowed (60 millisecond) root-mean-square average was applied using custom-written code in Matlab
- Differences between conditions were tested for significance using Linear Mixed Models with subjects as a random factor with individual intercepts and slopes, as well as post-hoc pair-wise comparisons.



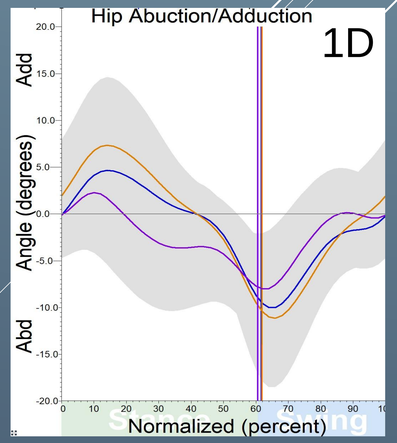


Fig 1. Normal pelvis (a), pelvic drop (b), and pelvic elevation (c) gaits were performed by each subject. The resulting hip motion indicated that the prescribed conditions generated the expected patterns of motion (d).

- Normal
- Hip Hike
- Pelvic Drop

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Results

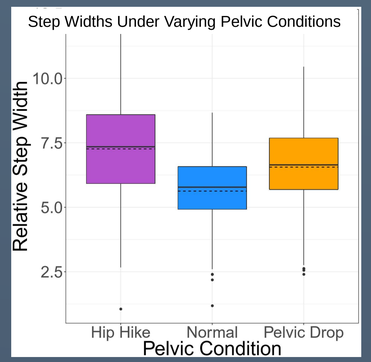


Figure 2. It was expected that the two different walking conditions would result in wider (pelvic elevation) and narrower (pelvic drop) step widths. As expected, swing-side pelvic elevation resulted in an increased step width (12.06 ± 1.93) while contrary to expectations, exaggerated swing-side pelvic drop also resulted in an increased step width (10.95 ± 1.93).

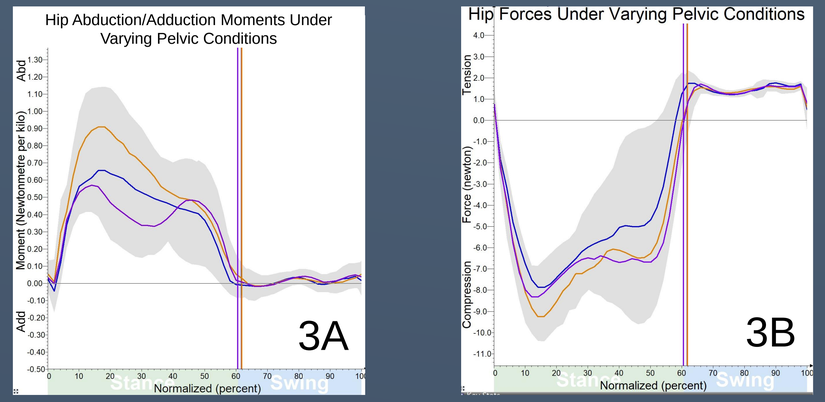


Figure 3. It was expected that the pelvic drop condition would entail decreased hip forces and abduction moments, and there were no explicit predictions for pelvic elevation. Contrary to predictions, pelvic drop increased both hip abduction moment (a) and hip joint force (b). Pelvic elevation also entailed increased hip force (b) but decreased hip abduction moment (a) compared to normal walking.

Figure 4. It was expected that gluteus medius activity would increase and decrease during the hip hike and pelvic drop conditions (respectively) compared to normal walking. While some subjects showed this expected pattern (a), on average, both prescribed conditions resulted in increased gluteus medius muscle activity, with the pelvic elevation condition showing the highest EMG activity (b).

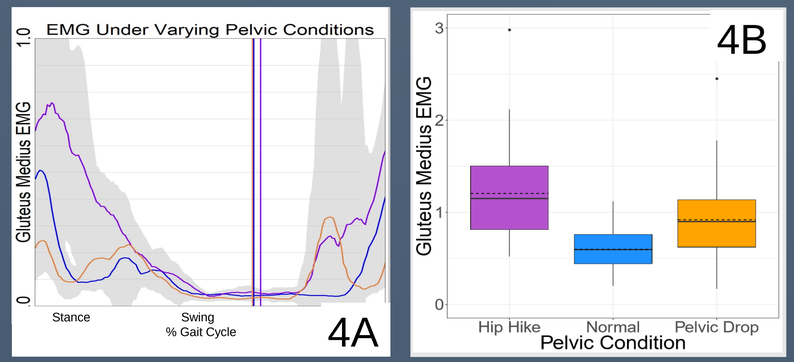
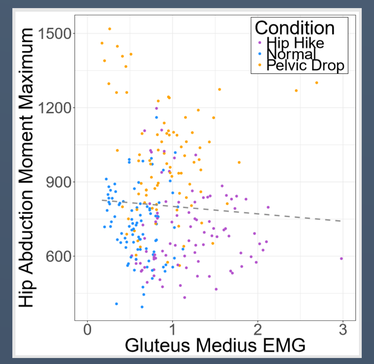


Figure 5. Though differences in gluteus medius activity exist between conditions, there is no direct link between hip moment and muscle activity.

- Normal
- Hip Hike
- Pelvic Drop



Conclusion

- Contrary to expectations, both compensatory OA gaits increase step width, muscle activity, and hip joint force.
- The only variable which decreased was hip abduction moment during the hip hike condition.
- These results suggest that OA patients may be prioritizing increasing step width and thereby stability, at the expense of hip joint force.
- However, the models utilized herein do not account for internal muscle forces, which may have a large effect on overall joint mechanics.

Future Directions

- Inclusion of models which account for muscle forces in calculation of hip joint force will lead to better estimation of hip mechanics.

References

1. Hurwitz, DE, et al. "Gait Compensations in Patients with Osteoarthritis of the Hip and Their Relationship to Pain and Passive Hip Motion." Journal of Orthopaedic Research, vol. 15, no. 4, 1997, pp. 629–635.
2. Dwyer, MK, et al. "Comparison of gluteus medius muscle activity during functional tasks in individuals with and without osteoarthritis of the hip joint." Clinical Biomechanics, vol. 28, no. 7, 2013, pp. 757-61.
3. Thurston, AJ. "Spinal and pelvic kinematics in osteoarthrosis of the hip joint." Spine, vol. 10, no. 5, 1985, pp. 467-471.

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