Effects of a non-rigid AFO on ML foot placement during post-stroke locomotion

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Introduction

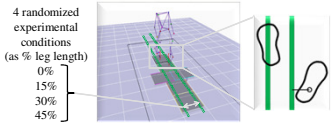
Mediolateral (ML) foot placement redirects ML body center of mass motion (red arrow) during ambulation and has been identified as one strategy for maintaining dynamic balance [1]. Post-stroke, abnormal swing phase locomotor patterns, including hip hiking and circumduction, may negatively affect ML foot placement ability.

The purpose of this study was to:

1) investigate ML foot placement accuracy during post-stroke locomotion and
2) determine whether an ankle-foot orthosis (AFO), commonly prescribed to address abnormal lower limb posturing post-stroke, improves ML foot placement accuracy.

Methods

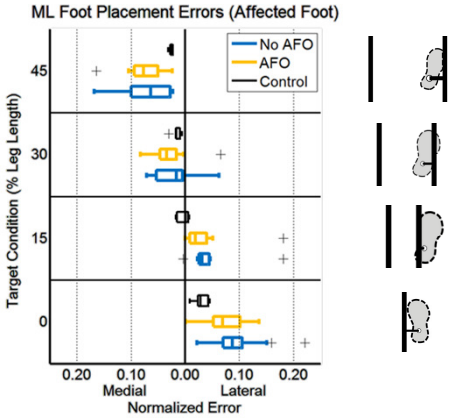
Gait analysis and ML foot placement error calculation

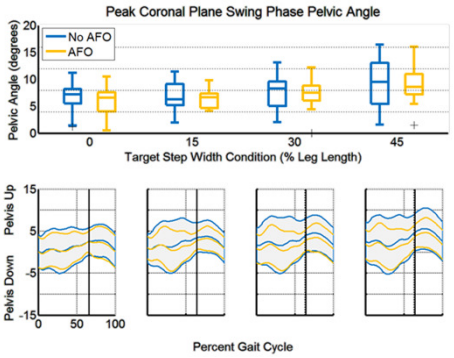


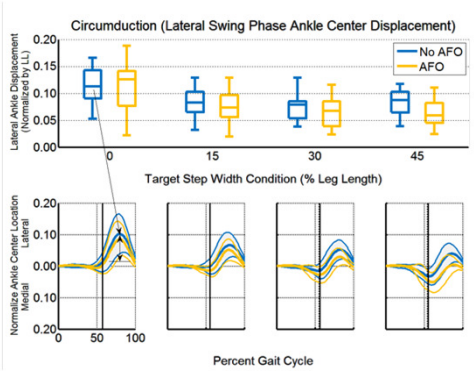
Statistical analysis:

A two-way repeated measures ANOVA (within subject factors, *step width* (4 levels) and *orthosis* (2 levels)) was performed on the affected foot placement error data.

Results







Summary

- n = 13 (post-stroke) and n = 6 (controls)
- Preferred walking speed:
  No AFO = 0.69 ±0.17
  AFO = 0.78 ±0.19
  Controls = 1.23 ±0.20
- Post-stroke subjects demonstrated larger ML foot placement errors than control subjects:
  No AFO: $F_{(1,17)} = 17.077$, $p = 0.001$
  AFO: $F_{(1,17)} = 6.041$, $p = 0.025$
- AFO use did not significantly improve ML foot placement accuracy
  $F_{(1,12)} = 1.994$, $p = 0.183$
- Magnitudes of hip hiking and circumduction were not significantly different with AFO use
  $F_{(1,12)} = 0.387$, $p = 0.545$
  $F_{(1,12)} = 2.037$, $p = 0.179$

Conclusions

Results from this study indicate that use of a non-rigid AFO does not improve ambulatory ML foot placement accuracy of the affected foot for individuals with chronic post-stroke hemiplegia.

The importance of swing phase, as it relates to ML foot placement adjustments during ambulation, has been highlighted previously [2]. Abnormal foot and ankle posturing during the swing phase of post-stroke gait contributes to inadequate mid-swing toe clearance. Hip hiking and circumduction are believed to be compensatory actions utilized to create adequate mid-swing toe clearance. We expected that correction of the equinovarus posturing of the foot and ankle complex would reduce the use of swing phase compensations and promote improved ML foot placement accuracy. Our results do not support this hypothesis; while the median magnitude of hip hiking and circumduction decreased, neither magnitude was significantly affected by AFO use.

In light of the present results, we cannot rule out the possibility that ML foot placement accuracy was precluded by abnormal motor coordination. It also should be noted that results might not generalize to a more severely affected post-stroke population. Additionally, the relatively small sample size of the current study may limit generalizability.

Finally, it is interesting to note that subjective reports commonly indicate positive benefits from AFO use, while evidence of the biomechanical effects of AFO use on balance during walking remain inconclusive. Given the multidimensional nature of balance, it is possible that an AFO improves other dimensions of balance such as confidence [3,4].

References

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Acknowledgments

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Further information

The goal of our research is to improve the quality of life for persons who use prostheses (limb replacements) and orthoses (assistive systems) through creative applications of science and engineering to the Prosthetics & Orthotics (P&O) field.

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