PROSTHESIS ALIGNMENT AND UNEVEN TERRAIN

Meurer, L.M., Geil M.D.
Georgia State University, Atlanta

INTRODUCTION

Dynamic prosthetic alignment is an important element in overall prosthesis function. Prosthetic components, even if they are perfectly suited for an individual with limb loss, cannot function optimally if misaligned. The subjective element of dynamic alignment makes it possible that similar gait patterns can emerge within a range of alignments (Geil, 2002), indicating the challenge of achieving a truly optimized alignment.

Kendell et al. (2010) found contralateral adaptation in individuals with unilateral limb loss to changes in terrain and slope. It is possible that the gait of individuals with malaligned prostheses might appear suitable on even terrain but unsatisfactory when they are challenged by uneven terrain.

This case series tested the hypothesis that transverse plane alignment changes would produce changes in kinematic and kinetic parameters of gait on uneven terrain but that such gait changes would not be evident on uneven terrain. Results can inform the process of dynamic alignment.

METHOD

Three individuals with unilateral transtibial limb loss participated in the study using their own prostheses and footwear. An iPecs prosthesis force transducer (College Park, Fraser, MI) was inserted into each individual's prosthesis prior to testing, but their current alignment was presumed optimized and was not affected by the iPecs insertion.

Instrumented gait analysis (Vicon, OMG, Oxford) was conducted with each subject first on level ground with baseline alignment, and then for randomly ordered combinations of conditions for alignment and terrain. Alignment condition levels were medial and lateral pylon rotations of 4 and 8 degrees each, administered by a certified and licensed prosthetist. Terrain was a standard laboratory floor versus a walkway containing various sized gravel rocks similar to those found in a park pathway. Five trials were collected for each combination of conditions.

RESULTS

The hypothesis was supported for certain, but not all, outcome measures. An example of support for the hypothesis was found in Subject 3. On even terrain, contralateral limb step length varied little when alignment was changed. However, on uneven terrain, changes to pylon rotation, whether medial or lateral, produced decreased step lengths (Figure 1).

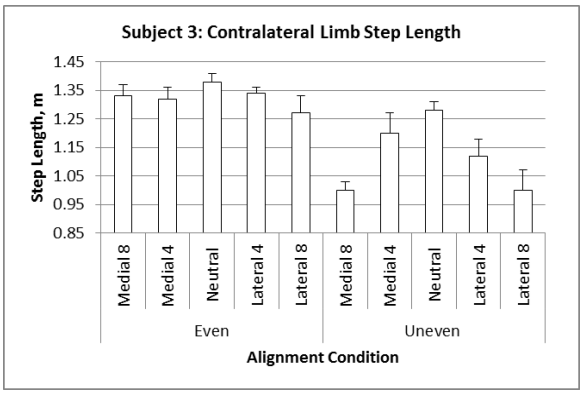

Figure 1: Average contralateral step length in meters across all trails for each condition for an individual subject. Conditions are shown as direction of transverse plane pylon rotation and degrees of rotation.

To the contrary, for Subject 1, step width tended to decrease for medial rotations and increase for lateral rotations, regardless of whether the terrain was even or uneven.

Peak axial force, measured with the iPecs, decreased and stayed more consistent on the uneven surface than on the even surface. The range for the even surface was 1020.82 N to 1149.26 N, and for the uneven surface was 761.75 N to 1068.91 N

DISCUSSION AND CONCLUSION

Qualitatively, the hypotheses was supported for the step length, step width, and walking speed for all the subjects with the exception of Subject 1's walking speed, where the speed remained the same for both the even and the uneven surfaces. The hypothesis was also supported for peak axial force. However, a larger number of subjects would be needed to determine if the changes were significant.

CLINICAL APPLICATIONS

There are elements of this study that would suggest that dynamic alignment should include "challenges" to gait, such as the sorts of uneven terrains encountered in daily life, in order to be further optimized beyond standard practice. However, the sample size is too small and the results too inconsistent to make this argument definitively.

REFERENCES

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