LETTER TO THE EDITOR

Re: **Below-Knee Amputee Gait with Dynamic Elastic Response Prosthetic Feet: A Pilot Study**[1]

To the Editor:

The authors of the pilot study on dynamic elastic response feet are to be commended for the comprehensive and objective measurements reported. The Pathokinesiology Laboratory at Rancho Los Amigos is an ideal setting to investigate this area of conflicting subjective claims.

As the authors have anticipated in their discussion, however, readers with significant clinical experience fitting a variety of such feet will question the validity of deliberately choosing NOT to optimize the dynamic alignment for each successive foot type. Although the subjective nature of optimum alignment is widely acknowledged, it also can have a profound effect on the function of prosthetic feet.

Amputees will acclimate to a broad variety of misalignments over time and compensate by altering their gait mechanics. The recent amputee who arrives at clinic wearing higher heeled shoes is a classic illustration. The decision NOT to optimize alignment for each foot/subject combination—over a range of cadences—contradicts contemporary standards for prosthetic care and inadvertently confounds the result by potentially masking differences between foot mechanisms.

A good analogy might be exchanging automobile engines to determine their propulsive capabilities. Simply bolting in a replacement is not sufficient; each must be individually tuned with careful (but somewhat subjective) carburetor and ignition adjustments prior to dynamometer testing. I believe the pilot study protocol demonstrates that simply bolting a fancy foot on a pre-existing prosthesis is ineffective but this does not accurately reflect clinical practice.

The subjects' uniform lack of enthusiasm for the Flex-Foot is puzzling. At Duke, we always offer our Flex-Foot candidates an extended trial with at least one other dynamic response foot, providing the Flex-Foot only if the amputee prefers it to the less expensive alternative. In our experience, over 90 per cent of those patients who have been given the option choose the Flex-Foot.

However, as previously reported, we provide serial realignment of the prosthesis over several weeks or months until the amputee is fully acclimated to the greater range of motion and other response characteristics of the device.[2] We agree with Hittenberger and others that optimal alignment for dynamic response feet must always be individualized but typically results in somewhat greater plantar flexion or anterior placement than for less responsive alternatives.[3] Such alignment changes enhance the deflection of the more flexible anterior lever arm of the sophisticated feet and presumably affect performance. We also agree with Supan's group that if such changes are exaggerated, gait parameters can be adversely affected.[4]

Data reported in the pilot study tend to support the hypothesis that the Flex-Foot configuration may not have been optimally aligned. The finding that ". . . knee torque approached zero by the end of midstance (Flex-Foot)" suggests insufficient anterior resistance. The speculation that "because none of our subjects chose the Flex-Foot at the end of the study, perhaps this rapid progression of body weight during single-limb support was perceived as instability by the amputee and not as an optimal characteristic," lends further support to this contention.

The fact that every amputee rejected the SACH foot, given an alternative, agrees with our clinical experience at Duke. We have speculated that the SACH design (and its single axis alternative) may require more effort from the amputee (at least at the BK level) than the more responsive alternatives, particularly at higher cadences or on inclines.[5] The amputee preference for either Seattle or CCII designs coincides with our clinical experience as well.

The fact that both the Seattle Litefoot and CCII are significantly lighter than the SACH or STEN may also be a factor. Since we believe the optimal alignment for both Seattle and CCII is closer to traditional SACH alignment than will be the case with the Flex-Foot, their universal popularity in this study may also be related to the lack of dynamic alignment optimization previously discussed.

The authors' comment that their subjects tended to select the prosthesis offering the greatest velocity is an intriguing one. If documented in subsequent studies, this may offer a rational and low cost means to determine the optimal foot/alignment configuration. It is certainly well established that one of the chronic liabilities of lower limb amputation is the inability to sustain the same pace as the two-legged population despite prosthetic restoration.

The authors have provided an excellent model for the scientific investigation of prosthetic gait parameters. The clinical field remains eager for the assistance of research scientists in determining the optimal prosthetic configuration for each individual amputee. It is hoped that these constructive criticisms will help further our joint mission, and that subsequent studies will not omit the critical factor of individualized cadence-appropriate dynamic alignment for each amputee/component combination.

Sincerely,

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[1]Leslie Torburn, Jacquelin Perry, Edmond Ayyappa, Stewart L. Shanfield: Below-Knee Amputee Gait with Dynamic Elastic Response Prosthetic Feet: A Pilot Study. *Journal of Rehabilitation Research and Development,* 27(4): 369-384, 1990.

[2]J.W. Michael: Energy Storing Feet: A Clinical Comparison. *Clinical Prosthetics and Orthotics,* 11(3):154-168, 1987.

[3]D. Hittenberger: The Seattle Foot. *Orthotics and Prosthetics,* 40(3):17-23, 1986.

[4]J. Wagner, S. Sienko, T. Supan, D. Barth: Motion Analysis of SACH versus Flex-Foot in Moderately Active Below-Knee Amputees. *Clinical Prosthetics and Orthotics,* 11:55-62, 1987.

[5]J.W. Michael: Overview of Prosthetic Feet. *Instructional Course Lectures,* Volume 39. Walter B. Greene, MD (Ed.), American Academy of Orthopedic Surgeons, 367-372, 1990.