The Importance of Alignment

Successful acceptance and rehabilitation of an amputee depends on factors that relate directly to the alignment of a prosthesis. Discomfort commonly observed at the fitting of a new prosthesis can be due to slight differences in the alignment of the device and can lead to distrust or even rejection of the device by the patient.[1]

It has been shown that small shifts in alignment can affect both the magnitude and timing of pressures experienced on the residual limb. The exact nature of these changes in pressure vary according to the alignment deviation. While the amputee is often able to compensate for subtle mal-alignment, the imposed forces can have long-term effects on the underlying tissues. [2] Additionally the compensatory ambulation can further limit stability and confidence on the prosthetic device.

These findings support the concept that sub-optimal alignment can cause a decrease in both function and comfort of the prosthetic device.

Difficulty in Achieving Good Alignment

While subjective observation is the most commonly used form of analysis it is limited by multiple factors, the first of which is unreliable user feedback, both perceived and expressed. For example the pressure differences caused by mal-alignment are often not reflected in immediate discomfort of a patient, and therefore reliance upon user feedback is suspect. This complexity can be compound by physical constraints of the amputee including level of amputation, multiple amputations, and residual limb shape.[2,3]

Secondly, inconsistencies in clinical repeatability make precise alignment difficult. In a study by Ford et al., it is concluded that there is not a specific and systematic observational method utilized by clinical practitioners for gait analysis. Differences in technique can make exchange of information between practitioners and to patients subject to inconsistency.[4]

In trials conducted to show the repeatability of prosthetic alignment, researchers Zahedi et al. found that individual prosthetists produce multiple and unique final dynamic alignments on separate fittings of the same patient, demonstrating inconsistencies in clinical practice. Additionally, when multiple prosthetists found final dynamic alignment for the same patient, the results showed considerable inconsistencies in the specific alignments.[1] Acceptable alignments for a given patient can therefore be described as a range dependent upon the individual fittings conducted by various prosthetists or a single prosthetist on separate occasions.

Lacking precision, these alignment ranges obtained through solely subjective methods are not sufficient to successfully optimize amputees' performance and limit common occurrences of prosthetic induced collateral injuries.[3]

How Compas™ Improves Alignment

In his study on prosthetic alignment, Zahedi et al. theorized that supplementing visual dynamic alignment with the use of an objective device would enhance a prosthetist's proximity to optimal alignment. The device should be lightweight and easily manipulated by the prosthetist with few tools, and must be designed for long term use as a component of the prosthesis.[1] Today, Compas™ is the product that Zahedi et al. described over 20 years ago.

The Compas™ system allows the practitioner to "see" the forces of gait in real time, as has only been possible before by the use of a full gait lab. This impractical and expensive method has now been replaced with a portable in-line component that can read and display forces at the distal end of the socket. The Compas™ is capable of displaying in real-time the individual steps of a gait trial so that a prosthetist is able to make specific alignment adjustments based on objective evidence rather than on what they think they saw as the patient walked. The Compas™ will make alignment correction suggestions that are derived from years of scientific research, supplying the prosthetist with the first of its kind evidence based data. Now instead of guessing how a softer heel or alignment alteration may help the feel to the patient, the practitioner can actually see and record how these changes benefit the patient. By better aligning a prosthesis, a better distribution of forces on the limb can be obtained, minimizing damage to the residual limb tissue and improving comfort and function for the patient.

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[1] Zahedi, M. S., et. al. (1986). Alignment of Lower-Limb Prostheses. *Journal of Rehabilitation Research and Development*. 23(2). 2-19.

[2] Pearson, J. R., et. al. (1973). *Pressure in Critical Regions of the Below-Knee Patellar-Tendon-Bearing Prosthesis.* Bulletin of Prosthetics Research: Prosthetic and Sensory Aids Service. Department of Medicine and Surgery. (pp. 52-76).

[3] Saleh, M. (1988). Alignment and Gait Optimization in Lower Limb Amputees. In G. Murdoch (Ed.), *Amputation Surgery and Lower Limb Prosthetics* (pp. 357-365). Oxford, GB: Blackwell.

[4] Ford, N. et. al. (1995). Improving Reliability in Observational Gait Analysis for Alignment of Transtibial Prostheses.