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ASSESSMENT OF AN AMPUTEE'S GAIT WITH MINIATURE SHOE-BORNE LOAD CELLS

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ABSTRACT--Miniature triaxial load cells are developed and these are used to access an amputee's gait. An amputee's gait is studied initially on a temporary prosthesis and later on a permanent prosthesis. The output from load cells are also used to correct the misaligment of the prosthisis, Thus allowing the amputee to walk near normallly. The center of pressure of an amputee is found to be a good predictor of his functional mobility.

The human gait has been studied for more than a century. Since then progress in gait analysis has closely followed with advances in technology.

Ranu et al[1980] has developed a miniature triaxial load cell (8x19x19 mm) which is capable of meeting the needs of an individual patient (Fig 1). The right prosthetic shoe of a below knee amputee was instrumented with five of these load cells. They were attached individually under the shoe, two under the heel region of the prosthetic foot, two approximately under the metatarsals and one approximately under the toe area of the prosthesis.

An amputee's gait was studied from first step in a temporary pylon to a final near 'normal' gait in a permanent prosthesis. The output from various load cells had been able to identify and then correct the misaligment of the prosthesis (Fig 2). An amputee's typical gait cycle for stance phase looks like a ramp for heel strike to toe off cycle (Fig 3). Initially the amputee requires a much longer time to support his body weight through the stump leg. For the initial run the peaks force is less, when compared with a run a month later. The reason could be a pain in the stump or simply a matter of getting used to the prosthesis.

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The center of foot pressure in forward direction for an amputee moved aburptly. This is a quantitative description of vaulting, which is not present in the normal subjects. The results also show excessive pronotion of the amputee's foot at the moment of heel strike (Fig 4).

It is concluded from this study:
(a). The force measuring shoe can assist in the rehabilitation of an amputee and other types of abnormal gait.
(b). It can detect subtle differences between normal and pathological gait.
(c). It can aid an amputee in the development of a more normal gait.
(d). The center of foot pressure can also guide in correcting prosthesis misalignments.

Therefore, this technique of analysing the human gait is simple, accurate, non-invasive and has enormous potential in the management of patients with lower extremity disabilities.

REFERENCE

Ranu, H. S. et al.[1980] A Study of Normal and Abnormal Human Gait with Miniature Triaxial Shoe-Borne Load Cells. Proceedings 26th Annual Meeting Orthopaedic Research Society (Orthapaedic Transactions of the Journal of Bone and Joint Surgery, 4, pp240-241).

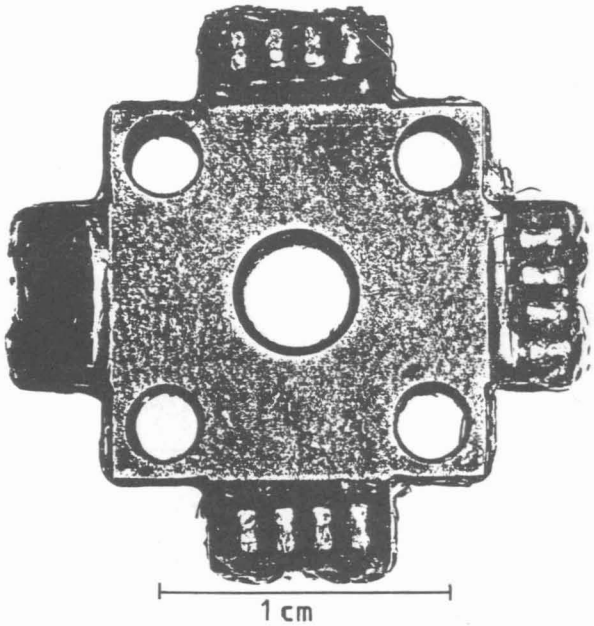

Figure 1. Miniature triaxial load cell.

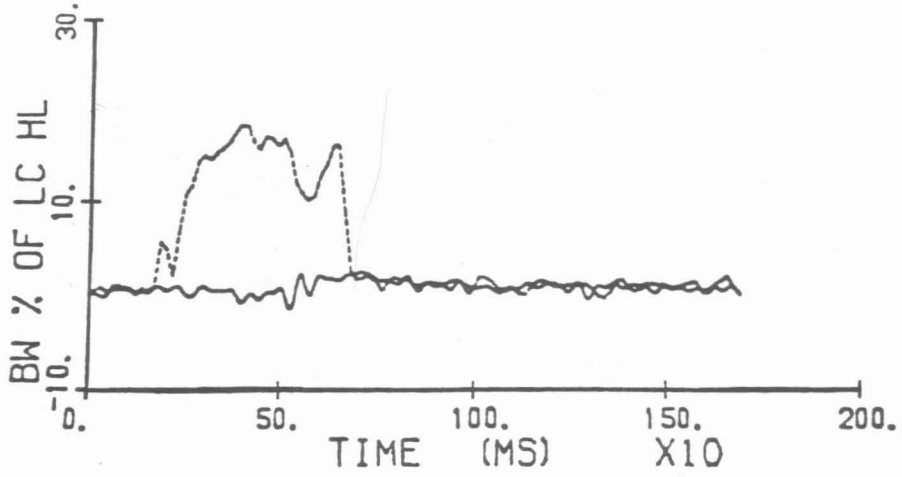

Figure 2. Lateral Heel ground reaction of an amputee, before and after adjustment by a prosthetist.
(—— 3% adj.), (--- 18% adj.)

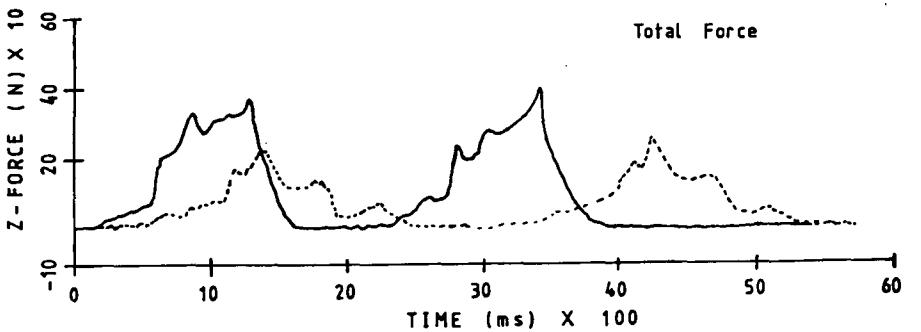

Figure 3. Total ground reaction force histories of an amputee for successive steps(z-axis).
(--- first run), (—— second run, one month later)

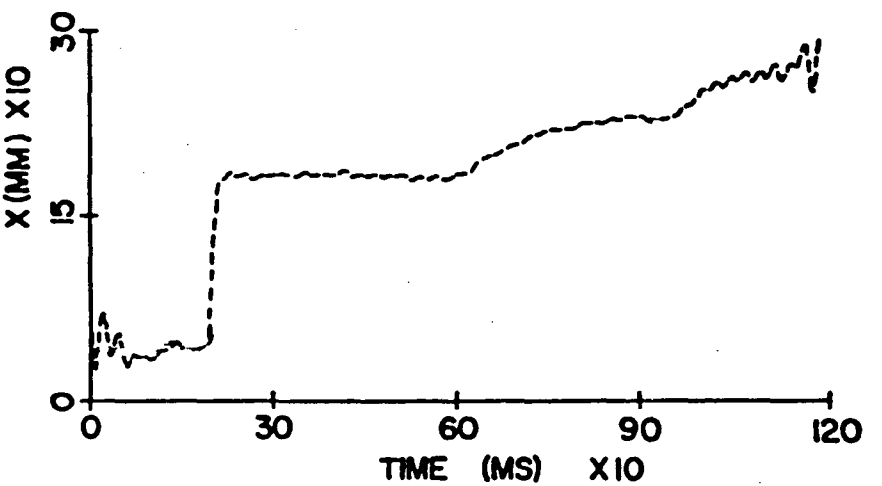

Figure 4. The center of pressure of an amputee.