Prosthetics and Orthotics International, 1986, 10, 139–141

Body sway in below-knee amputees

D. VITTAS, T. K. LARSEN* and E. C. JANSEN**

Department of Orthopaedic Surgery T., Gentofte Hospital, University of Copenhagen,

**Department of Orthopaedic Surgery, Hvidovre Hospital, University of Copenhagen,*

***Biomechanical Laboratory, Gentofte Hospital, University of Copenhagen.*

Abstract

The purpose of the present study was to test the hypothesis that below-knee amputees have less standing stability than normal persons. Twenty below-knee amputees were tested with the quantified Romberg test.

All amputees below 59 years and all women above 59 years had a decreased sway compared with matched control groups of normal persons.

Amputated men above 59 years did not show any difference in sway compared with the matched control group.

Presuming that small sway excursions can be interpreted as a stable standing position, the study shows that a well fitted PTB-amputee stands at least as safely as a normal person.

Introduction

A safe standing position is essential both for normal persons and for amputees. Below-knee amputees may have an altered ability to stand safely on their prosthesis. Since Romberg in 1851 introduced his visual test for assessment of postural sway, few authors have described advanced methods of measuring the sway of normal individuals as well as of lower limb amputees.

It is known that sway increases significantly with age (Sheldon, 1963; Overstal et al, 1977; Brynskov et al, 1979) and that old men sway significantly more than old women (Brynskov et al, 1979).

In a previous study, Fernie and Holliday (1978) found that leg amputees had an increased speed of sway when compared to normal persons.

The present study aimed at the basic question: Do below-knee amputees have figures of standing stability different from those of normal persons?

All correspondence to be addressed to Dr. D. Vittas, Department of Orthopaedic Surgery T, Herlev Hospital, Herlev Ringvej, DK-2730, Herlev, Denmark.

Patients and methods

Twenty patients, eighteen men and two women, fitted with patellar-tendon-bearing (PTB) prostheses after below-knee amputations, were included in the trial.

The median age was 61 years (range 16–76 years). Seven patients had a right-leg amputation and 13 were amputated on the left side.

The reasons for amputation were in eight cases traumatic, in seven arteriosclerotic and in five diabetic.

The patients were examined clinically and their history was taken. The patients admitted to the study had to meet the following criteria:

1. A well-functioning PTB prosthesis. All patients could walk without a stick.
2. No disease of the central nervous system.
3. No disease of the spine.
4. No other abnormalities of the lower extremities, except the amputation.
5. No signs of cardiopulmonary insufficiency.
6. No intake of alcohol during the last 12 hours before the test.
7. Well regulated diabetes (for the five diabetic patients).

All amputations were performed by the same technique: sagittal flaps as described by Persson (1974). All patients had well healed scars, without neuroma formation or any other complications.

The measurements of body sway were performed with the patient standing on a force plate (Jansen et al, 1982). The patient was asked to stand relaxed with closed eyes, arms hanging at the sides and the medial sides of the feet separated by an interspace of 1cm. The test lasted for three minutes and the time from the 15th to the 75th second was the period of measurement.

The force plate is placed horizontally, level with the surrounding floor of the room. The size of the plate is 45×30cm. The force plate is

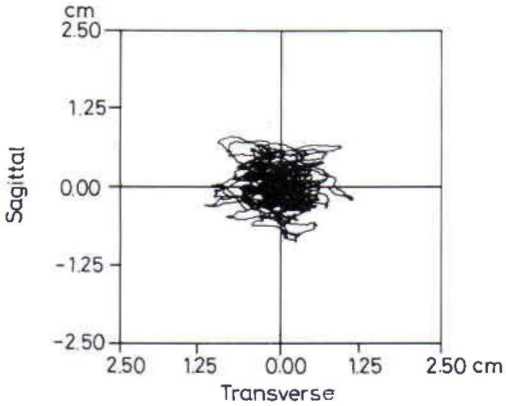

Fig. 1. The movements of the centre of pressure of the feet during 60 seconds of standing position. The patient had a PTB prosthesis on the left side.

mounted on resistive strain gauge transducers one in each corner of the plate. Thus the vertical force applied to each corner of the plate is measured (Fig. 1).

The measurements are transferred to a computer (PDP 11/10) and the values of the sway in the sagittal and transverse directions are determined during the 60 seconds of measured sway; the mean values of the sway excursions are also determined in the two directions (Fig. 2). The area between the mean value and the sway curves is found and is divided by the time of measurement. Thereby the average distance between the sway curve and the mean value is found. This calculation is made in the sagittal and transverse directions. By vectorial summation a common sway figure can be calculated. The unit of measurement is length (cm).

Due to previous findings in studies of normal persons (Thyssen et al, 1982) the material was divided into two groups:

Group I: All women and men below 59 years of age (10 patients), and

Group II: All men above 59 years of age (10 patients).

As body sway was uniform in men aged 20 to 59 years and women aged 20 to 69 years, the values of Group I of the present study were compared to the sway values of the whole age corresponding normal material. In Group II the men older than 59 years were compared with normal men of matching age.

The comparison was made by use of the Mann-Whitney (rangsum) test. Level of significance $p<0.05$.

Results

In Group I there was significantly less sway in the two directions, transverse and sagittal, as well as in total sway than in the corresponding control group. (median: transverse 38%, sagittal 34%, sum 46%).

In Group II there was no significant difference in sway in the transverse direction, but there was significantly less sway (median 24%) in the sagittal direction.

The smaller sway in the sagittal direction did not cause significant differences in the total sway ($p>0.05$).

The results of the two groups are shown in Figures 1. and 2.

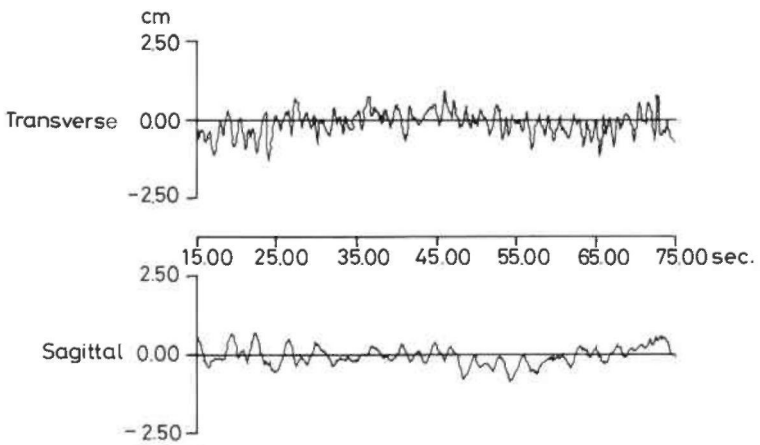

Fig. 2. Sway curves in the sagittal and transverse directions. The curves are calculations for the plot in Figure 1.

Discussion

The findings differed from those of Fernie and Holliday (1978) as their findings indicated that amputees had a less stable standing position than normal control persons. However Fernie and Holliday permitted a position of the feet which the patient felt as most comfortable, while in this study a fairly narrow base was used for the standing position. It is therefore remarkable that a more stable standing position was found. A mathematical comparison between the Fernie and Holliday analysis of speed of sway and those calculated for length of average sway is not possible.

The findings of a more stable standing position in amputated women and younger men and the limited sway in the sagittal direction in the elder amputated men is interesting.

The explanation of the reduced sway when compared to normal persons may be the relatively stiff ankle of the prosthesis and the fact that the normal lower leg only needs slight muscle movements to maintain balance.

If small sway excursions can be interpreted as a stable standing position, the study shows that a well-fitted PTB amputee stands at least as safely as a normal person.

REFERENCES

Brynskov, J., Thyssen, H. H., Jansen, E. C., Munster-Svendsen, J. (1979). Postural stabilitet hos yngre og ældre normale personer malt med kraftmaleplade – – force plate. *Ugeskr. Læger* **141,** 367–368.

Fernie, G. R., Holliday P. J. (1978). Postural sway in amputees and normal subjects. *J. Bone Joint Surg.* **60–A,** 895–898.

Jansen, E. C., Larsen, R. E., Olesen, M. B. (1982). Quantitative Romberg's test: Measurement and computer calculation of postural stability. *Acta Neurol. Scand.* **66,** 93–99.

Overstall, P. W., Exton-Smith, A. N. Imms, F. J. Johnson, A. L. (1977). Falls in the elderly related to postural imbalance. *Brit. Med. J.* **1,** 261–264.

Persson, B. M. (1974). Sagittal incision for below-knee amputation in ischaemic gangrene. *J. Bone Joint Surg.* **56–B,** 110–114.

Sheldon, J. H. (1963). The effects of age on the control of sway. *Gerontol. Clin.* **5,** 129–138.

Thyssen, H. H., Brynskov, J., Jansen, E. C., Munster-Swendsen, J. (1982). Normal ranges and reproducibility for the quantitive Romberg's test. *Acta Neurol. Scand.* **66,** 100–104.