Proceedings of the Eighth International Symposium on ECHE, 1984, Dubrovnik

COMPARISON OF THE GAIT PATTERN OF PATIENTS WITH A THROUGHKNEE AMPUTATION OR ABOVE KNEE AMPUTATION.

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Summary.

After the introduction of a specific knee-mechanism in aid of a through knee prosthesis it was propagaitd via the rehabilitation centre Het Roessingh in Holland to carry out a through knee amputation instead of an above knee amputation if possible. Theoretical motives for this were among other things the existence of an endbearing long stump, a simple operation and a good possibility for the fitting of the prosthesis.
It was decided to judge the walking performances of 18 patients with an above knee amputation and 18 patients with a through knee amputation and compare them with the help of a gait (pattern) analysis. The attention was directed to the quality of the gait pattern, i.e. the relation of stance-, swing- and double-stance time to one another and the comfortable walking speed.
The results of the research, starting from the above mentioned points of interest, show equal walking performances of the patients with a through knee amputation and those with an above knee amputation respectively. So if the circulatory condition of the knee region is dubious an above knee amputation is to be prefered in view of the lasting disturbances in the healing of the wound of the stump.

Introduction.

During the past 5 years patients with a through knee amputation were regularly admitted into the rehabilitation centre Het Roessingh at Enschede in Holland. Formerly this happened very rarely. The through knee amputation was not popular because of prosthesis-technical problems. Only classical knee-hinges could be employed as knee mechanism.
However, about 10 years ago a special knee mechanism was developed for the through knee amputation. With this the prosthesis-technical objections disappeared. At first the adaptation of the new knee mechanism remained limited but later it increased. It was namely gradually propagaitd from the rehabilitation centre to carry out a through knee amputation instead of an above knee amputation. Motives for this were among others the presence of an endbearing stump, a maximum stump length, little chance of a hipflection contracture, a simple operation and a good possibility for the fitting of the prosthesis. However the question remained whether the motives mentioned would result in better walking performances in practice than those of the patients with an above knee amputation. What did gradually become clear was the fact that patients with a through knee amputation suffered much oftener from lasting disturbances in the healing of the stump. This delayed the rehabilitation process in a manifest way.
In order to try and answer the question mentioned above, it was decided to compare the gait pattern of 18 patients with a through knee

amputation to that of 18 patients with an above knee amputation.

Population of patients.

Thanks to the cooperation of 18 patients with a through knee amputation and 18 patients with an above knee amputation the gait pattern research could be carried out. It concerned 9 women and 27 men.
We tried to let the age build-up of both groups correspond as much as possible and also the walking with a loose or a stiff knee. The average age of the patient with a through knee amputation was 65,4years and of the patient with an above knee amputation 61,2 years. Most patients (29) walked with a prosthesis provided with a loose knee. The age of these patients varied from 17 to 82 years (average 64,5 years). The age of the patients who walked with a prosthesis with a fixed knee varied from 72 to 89 years (average 80,2 years).
The cause of the above knee amputation was 16 times trauma, of which 5 times with a through knee amputation (4 younger than 50 years). Arterial circulation disturbances were the cause of the above knee amputation with 20 patients, of whom 12 patients with a through knee amputation.
In order to be able to judge the gait pattern of the patients with a leg amputation better we also made a gait (pattern) analysis of 20 healthy testees.

Method of research.

The gait pattern of all patients was judged on the hand of a walking distance of 10 and 20 meters. The patients were asked to choose the walking speed which was comfortable for them and to use a necessary support for walking if needed.
It is known from literature that the energy consumption of people with a leg amputation when walking at a comfortable speed corresponds strongly with that of people without a leg amputation.
During the gait pattern analysis the walking speed, stace time, swing time and double-stance time were determined.
The determination of the quantities mentioned was done starting from measure soles under the soles of the shoes (fig. 1). The soles were provided with 5 switches, 2 at heel level and 3 at forefoot-level. These registered the contact of the shoe with the ground. The measure soles were easily and quickly put into place with the help of sticking tape. Thanks to the application of the measure soles the patient was not restricted to a definite walking course and the walking distances were in principle unlimited.
The measure soles were connected with a computer. He detected the foot-surface contact and registered the time of the quantities entered, the stance-, swing- and double-stance time.
Starting from the registered stance-, swing- and double-stance times the average values deviations and symmetrical factors (L-R) were calculated, and also the stridetime and the size of it.

Results of the research.

The quality of the gait pattern can be judge on the hand of the relation of the stance-, swing- and double-stance time L and R to one another. The stance- and swing time are complementary in this. In figure 2 the relation between the average swing phase and

double-stance phase has been reported of the healthy testees. As part of the stride time the swing phase is 38-39% and the double-stance phase 10-12%.
Corresponding values are found in literature.
The relation between the swing phase and the double-stance phase was also determined of the patients with a leg amputation. Roughly speaking 3 categories can be distinguished (figure 3). The first category is marked by a swing phase of 35-45% and a double-stance phase of 5-15%. Therefore the quality of the gait pattern of this category of patients corresponds strongly to that of the healthy testees. The second category concerns patients with a prolonged double-stance phase. This comes to 15-30% (the swing phase 20-35%). The third category demonstrates a very long double-stance phase and a short swing phase (<20%).
Almost all patients from category 1 walk without a walking aid, whereas the patients from category 2 all walk with the help of a walking stick or an elbow crutch and the patients from category 3 with the help of a walking rack.
The comfortable walking speed was determined on the hand of a walking stretch of 10 and 20 meters. The walking speed was practically the same with all patients at both walking distances and it could be well reproduced at each distance.
In figure 4 the walking speed of all patients has been reported in relation to their age. Besides we have stated of every patient the cause of the leg amputation, to which qualitative walking category the patient belongs and which (prosthesis) knee mechanism (loose-fixed) is used.
The patients younger than 50 years all have a comfortable walking speed which is 50% or more of that of the healthy testees. These patients are also the qualitatively good walkers (category 1). The prostheses have a loose knee.
There are no significant differences between the patients with a through knee amputation and patients with an above knee amputation. The walking speed of the patient with an above knee amputation averages out higher than that of the patients with a through knee amputation in the group of patients with an age of 50 up to and including 70 years. This is however especially brought about by 3 patients with an above knee amputation due to a trauma. The walking speed is usually less than 50% than that of the healthy persons. All patients walk with a loose knee.
Of the 6 patients with a through knee amputation 5 belong to the qualitative walking category 2 and 1 patient to category 1. Of the 7 patients with an above knee amputation 5 patients walk according to the norms of category 1 and 2 patients belong to category 2. Whereas with patients younger than 50 years only traumatic leg amputations occur, the vascular amputations preponderate with the patients who are between 50 and 70 years old. (9 out of 14).
Patients older than 70 years only have vascular amputations. The walking speed is low. About 2/3 of the patients (11 out of 16) walk with a fixed knee. The quality of the gait pattern is moderate to bad (category 2 and 3). The patients with a through knee amputation preponderate (10 out of 16 patients) in this group (>70 years). Two patients with an above knee amputation walk qualitatively still reasonable, comparatively speaking, and at a reasonable speed (0,6 - 0,7 m/sec). For the rest there are no striking differences between patients with a through knee amputation and an above knee amputation.
A complementary gait pattern analysis was done with 11 patients with a

comfortable walking speed of more than 50% than that of healthy persons and using a loose knee. After fixation of the loose knee the gait pattern was registered again. The fixation of the knee mechanism resulted with most patients (8) in a lower walking speed and a qualitatively slightly less good gait pattern (still category 1).

Dissertation and conclusions.

The quality of the gait pattern (the relation of the stance-, swing- and double-stance time to one another) and the comfortable walking speed dertermine the functional walking performance to an important degree. With the help of a gait (pattern) analysis the walking performances of 18 patients with a through knee amputation an 18 patients with an above knee amputation have been judged. Before this research was done we had the presupposition, based on theoretical grounds, that patients with a through knee amputation should be capable of better walking performances than patients with an above knee amputation. The most important arguments were the long and endbearing stump with more propitious muscular relations than with the above knee amputation.
However, the results of the research don't show any better walking performances as to comfortable walking speed and the quality of the gait pattern by the patients with a through knee amputation than the patients with an above knee amputation. The walking performances of both groups of patients do not differ essentially. Age plays an important part in the walking performances, as was to be expected. Both the speed and the quality of the gait pattern decrease with the increase of age. It is obvious that when the quality of the gait pattern is better (category 1) the walking speed increases.
Furthermore in view of the experiences with the younger patients, who walked with a loose and a fixed knee, a fixed knee appears to reduce the walking speed usually and it has only a slight negative influence on the quality of the gait pattern.
Prosthesis technically it is possible to make a very usable prosthesis both for an above knee amputation and for a through knee amputation. The absence of a tuberseat and the fact that it is often not necessary to fix the pelvis with the elderly enlarge the wearing comfort of the through knee prosthesis versus the above knee prosthesis.
The conclusion of this research is that it is no longer right to stringently propagate the carrying out of a through knee amputation instead of an above knee amputation. In case of a dubious circulatory condition at the level of the knee joint and the femurcondyles an above knee amputation is to be preferred.
This decision is justified by the equal walking performances with a through knee amputation respectively above knee amputation on the one hand and the possibility of prolonged disturbances in the healing of the stump wound.

References

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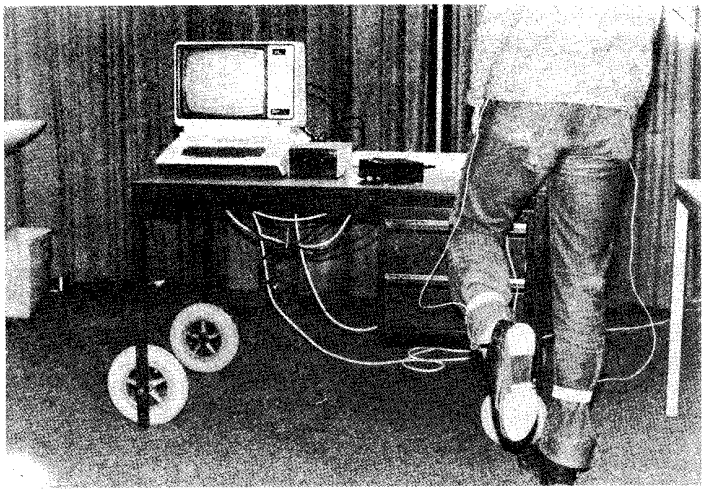

Fig. 1. Measure sole.

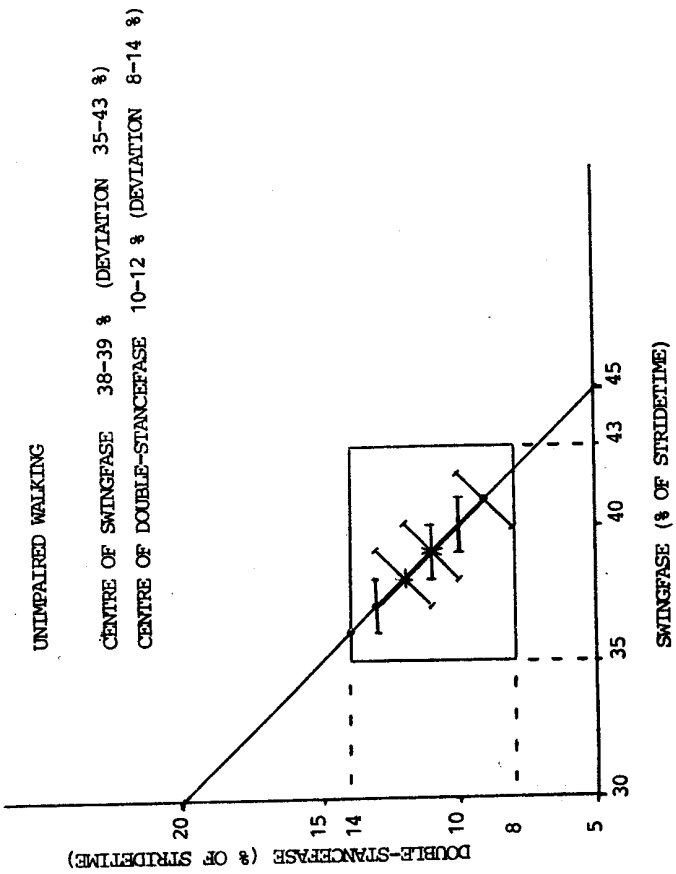

Fig. 2. Gate-pattern of healthy testees.

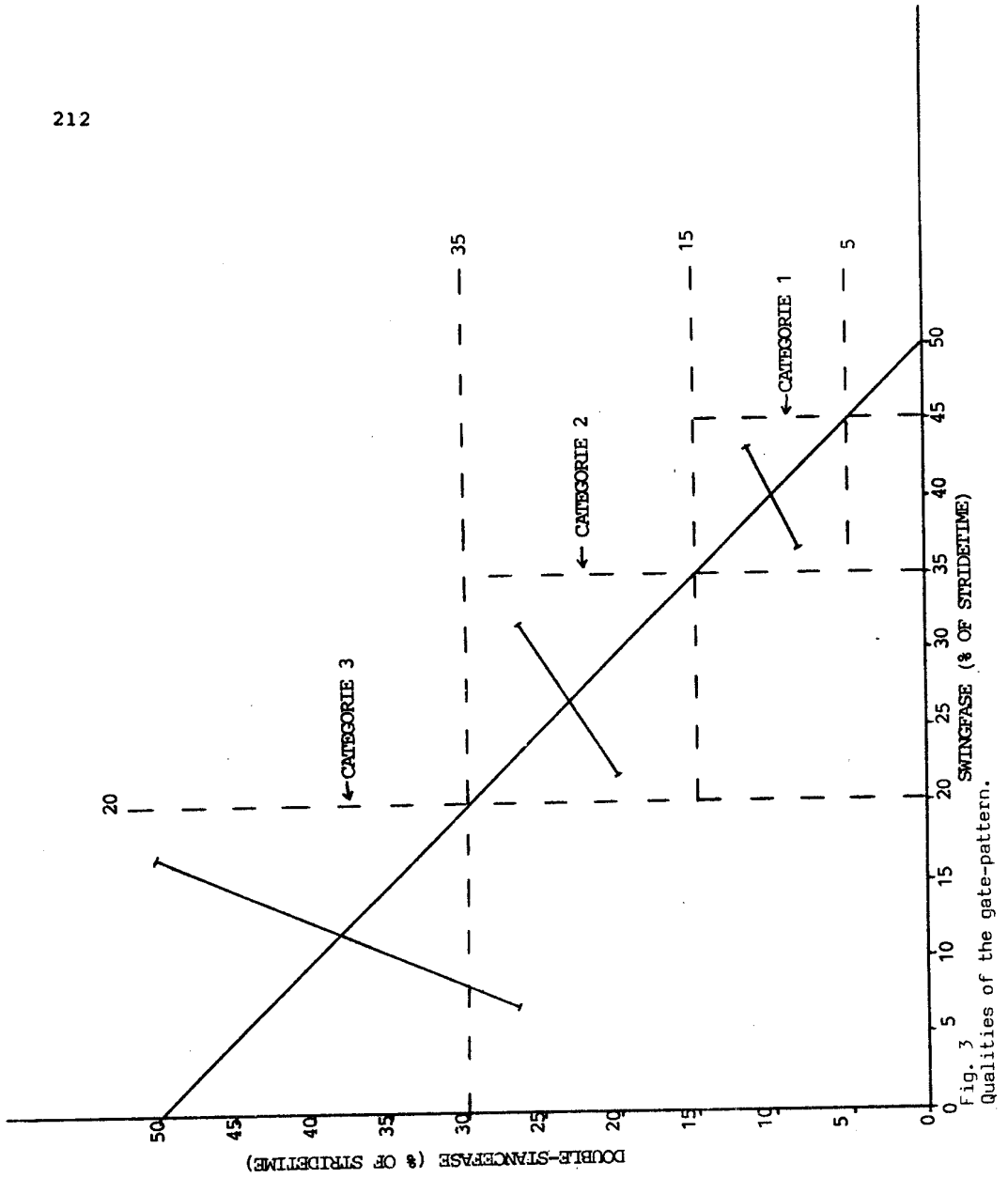

Fig. 3
Qualities of the gate-pattern.

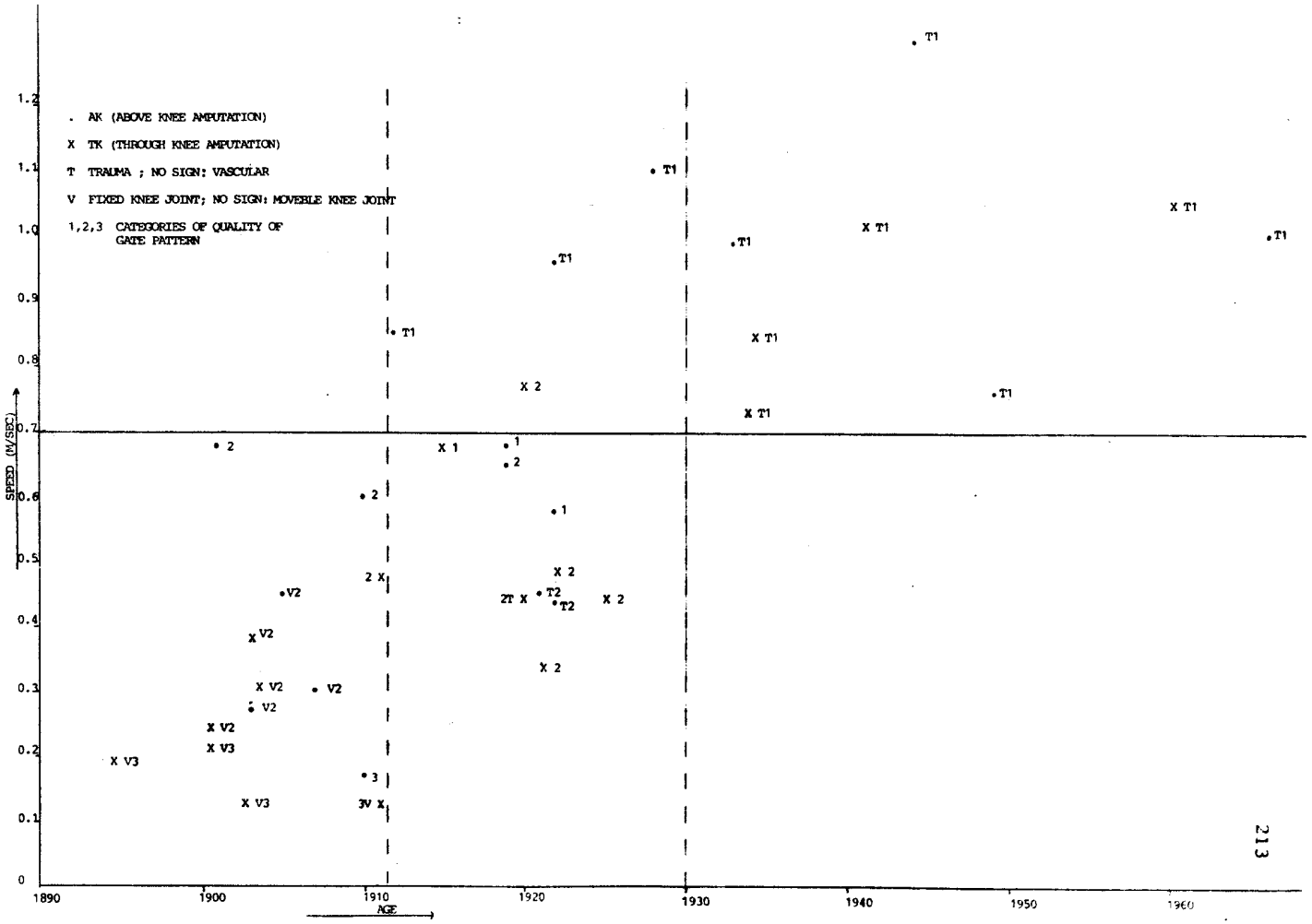

Fig. 4. Walking speed of all patients in relation to their age.