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Experiences with respect to the ICEROSS system for trans-tibial prostheses

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Abstract

This article describes the authors' initial experiences and those of their patients with respect to the ICEROSS system for trans-tibial prostheses. Up to October 1992, 54 patients attending the "Hoensbroeck" Rehabilitation Centre received such a prosthesis.

With the aid of patients' records an all-round evaluation has been made. In addition, a survey was undertaken and an examination made amongst the 43 patients who responded to a written request. For 26 patients who were provided with the ICEROSS as a second appliance after having used an older kind of prosthesis a comparison was made with the old system. In general these patients considered the new prosthesis as providing a clear improvement.

Introduction

For the past 3 years the authors' experiences with the ICEROSS (Icelandic Roll-on Silicone Socket) system have proven largely positive. This article provides a description and an analysis of those experiences and those of their patients with respect to the ICEROSS.

Any prosthesis necessitates a good suspension in the swing-phase and adequate pressure distribution in the stance-phase. It has been claimed that the use of a silicone roll-on socket with trans-tibial prostheses provides benefits with regard to both of these aspects (Kapp and Cummings, 1992; Madigan and Fillauer, 1991; Roberts, 1986; Sanders *et al.*, 1992; Wetz *et al.*, 1992). Since 1990 the authors have built up experience with respect to the pre-fabricated ICEROSS sockets.

The Icelandic Roll-on Silicone Socket was developed in 1985 by Össur Kristinsson (Kristinsson, 1993). It is an elastic socket which is rolled over the stump and provides good overall contact with the skin. The secure fitting on the skin provides a good suspension and the visco-elastic features of the socket are said to facilitate good pressure distribution.

As a consequence, a reduction in problems to the skin can be expected as well as a reduction in problems which may otherwise result from poor suspension of the prosthesis (Sanders *et al.*, 1992).

Materials, patients and methods

The ICEROSS roll-on sockets are made from silicone rubber and are available in a number of standard sizes. The silicone layer is thicker at the distal end of the socket into which a screwthread has been moulded and into which the means of fixture can be screwed. The socket is unfurled over the stump. The close fitting and the secure attachment to the skin essentially aims for no movement at all between skin and socket. As regards the outer socket the authors generally use a PTB fitting (without knee-strap). The inner and outer sockets are attached to each other by means of a suspension device in the outer socket: sometimes a string attached

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Table 1. Data collected from all patients

From the patient record	*Survey and examination*
Age	Problems with ICEROSS prosthesis
Sex	Length of stump
Double-sided amputation	Skin condition
Length of time since amputation	
Cause of amputation	
Complications vision sensibility fine motory other	

to the outer wall of the outer socket, is used, sometimes a "shuttle lock" is used.

With regard to hygiene it can be said that the silicone material does not absorb any moisture and can easily be cleaned with water.

Either an ID10 or a Quantum foot was used as a prosthetic foot.

The sample population comprised all patients with a trans-tibial amputation who had been provided with a new prosthesis with an ICEROSS inner socket at the "Hoensbroeck" Rehabilitation Centre before October 1992 (n = 54). For some patients it was their first appliance, whilst the rest received such a prosthesis after first having used another type for some time.

Table 2. Additional data in respect of patients with a second appliance

Survey and Examination	
Duration of use of old prosthesis	
Problems with old prosthesis	
Patients' assessment of: donning and doffing ease of maintenance feeling of hygiene suspension standing getting up walking, general walking indoors necessity of walking aid walking speed walking distances walking outdoors on the pavement or street walking on uneven surfaces climbing cycling getting in and out of the car	
Final verdict of patient:	do you wish to keep this prosthesis or get the old one back?

Some 43 of the 54 patients who were written to, took part in the survey. Those who dropped out were either not able to attend (n = 1), could not be traced (n = 2) or did not reply to the second request (n = 8). The response was therefore 78 per cent.

Data on patients were acquired from a status report and by means of an interview with the aid of a standard questionnaire and survey at the out-patients' department. The survey was carried out by a doctor who was not treating these patients. Data were collected with respect to: the cause of amputation, the length of time since amputation, characteristics of the previous prosthesis, the medical reasons for the ICEROSS, skin compalints and a functional assessment of the prosthetic appliance (Table 1).

The registration of objective measurements such as changes in walking speed were rejected on the basis that they were unreliable and difficult to measure consistently. It was believed that, the subjective assessment of the prosthesis user is of overriding importance in determining the success or failure of the appliance provided.

The population was then divided into two sub-groups, one comprising those who were given the ICEROSS as a first prosthesis (Group 1) and the other consisting of those who received it as a subsequent appliance (Group 2). Data collected on the second group are displayed in Table 2. The second group are a subject of particular interest, since they could be considered able to make a comparison between this system and the previous suspension system.

Differences between the two groups can be found primarily in the length of time since amputation – which is longer in the case of Group 2 – and in the cause of amputation (Figs 1, 2 and 3).

Group 1 contains relatively more diabetic patients with accompanying vision and sensitivity complications, whilst Group 2 contained more patients having a traumatic amputation with relatively few associated complications.

This latter group is further divided into two sub-groups. One group had KBM prostheses

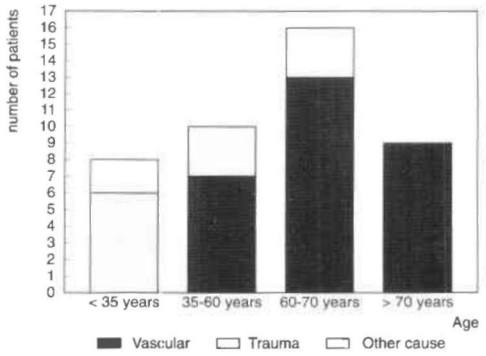

Fig. 1. Cause of amputation: all 43 assessed patients, relation with age.

with a soft inner socket (Group 2a), whilst the other had an older prosthesis type before the ICEROSS, such as a PTB with a leather inner socket, or a conventional prosthesis (Group 2b).

A comparison of the make up of these groups can be found in Table 3.

The group of users with modern prostheses (Group 2a) and the group of users with old-fashioned prostheses (Group 2b) are very similar to each other. They differ mainly with regard to the length of time since amputation, which averages respectively 5.2 years and 16.9 years.

Results

Assessment of ICEROSS general features

In the first few months following the provision of the prosthesis, the groups had all experienced similar problems, namely skin irritation in the form of itching or perspiration. It is interesting to note that after some weeks or months the intensity of these problems diminished markedly, either in combination with anti-perspiration lotion or not.

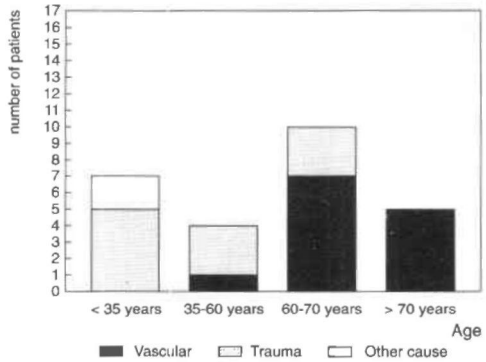

Fig. 2. Cause of amputation: patients with ICEROSS as second appliance, relation with age.

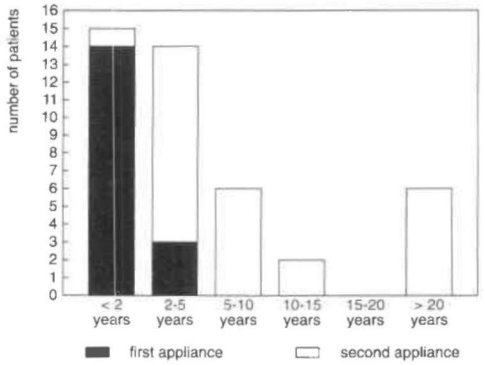

Fig. 3. Length of time since amputation: all 43 assessed patients.

However, compared with the previous prostheses, distinct problems remained.

Table 4 shows how pre-existing skin complaints responded to the ICEROSS for Group 2. Figures 4 and 5 reveal that users of the ICEROSS reacted favourably towards its ease of maintenance and the feeling of hygiene which it gave.

Both groups noted that the donning and doffing processes were simple to carry out. The fact that a number of patients considered it to be worse than their previous prosthesis could be put down to night-time use; the majority of older types of prosthesis could be fitted quickly for going to the toilet, whereas this is not so easy with the ICEROSS.

Table 3. Description of respondents

	Group 1	Group 2a	Group 2b
Total	17	13	13
Men	11	9	11
Women	6	4	2
Double amputation	5	0	5
Average stump length (cm)	14	14	13
Complications			
vision	9	4	2
sensitivity	7	1	3
fine motory	4	3	3
other	3	2	2
Length of time since amputation		5.2	16.9 years

Group 1: Patients with an ICEROSS prosthesis as a first appliance.

Group2a: Patients with an ICEROSS prosthesis as a second appliance. The previous appliance was a KBM

Group 2b: Patients with an ICEROSS prosthesis as a second appliance. The previous appliance was not a KBM.

Table 4. Responses of Group 2 with regard pre-existing skin complaints

	Perspiration	Itching	Soreness	Local pressure	Creasing*
Decrease	1	0	2	16	0
Increase	11	12	8	1	10

*Creasing at the back of knee during knee flexion

As regards cosmesis, many viewed the cord, used to fix the ICEROSS to the socket and visible on the outside of the prosthesis, as annoying.

Criticism of quality primarily focused on the over-stockings which have to be slit at the bottom to facilitate fixture and therefore laddered easily. In two cases the ICEROSS itself appeared to split fairly quickly, particularly at the point where the reinforced lower tip meets the rest of the sock.

Assessment of the suspension

Both Groups 1 and 2 reacted positively to the suspension of the ICEROSS on the skin. (Figs. 4 and 5).

Several users appeared to consider the cord, used to connect the ICEROSS to the prosthesis, as insufficiently secure. In some cases it did actually break as a result of insufficient attention having been paid to the wear and tear to which the cord is liable.

This occurred mainly during donning, i.e. in a sitting position, but in two cases it resulted in falls, one of which resulted in a fracture.

Assessment of pressure distribution

In 20 of the 26 cases in Group 2, it was pressure problems which caused patients to be changed to the ICEROSS appliance. For 14 persons these problems disappeared with the ICEROSS, for 5 persons there was no change and for 1 person a deterioration was observed.

Assessment of the functional characteristics

Groups 1 and 2 for the most part reacted favourably towards the functional effects of the prosthetic appliance.

Figures 6 and 7 show the most significant functional items. When Group 2 were asked for a subjective comparison with their previous appliance, a number of items were emphasised. Walking was said to be improved, when measured in terms of distance, speed and difficulty of conditions (such as an uneven surface), as did stair-climbing.

For the other items there were no clear differences found between the old and the new prostheses. Assessment by previous users of modern (Group 2a) and old-fashioned (Group 2b) prostheses was similar.

Discussion

For the patients who had changed from an older type of trans-tibial prosthesis to a trans-tibial prosthesis with a roll-on socket, there were initial skin complaints, for example, more perspiration, itching and soreness.

The back of the knee in particular was somewhat adversely affected by the ICEROSS' creasing. For this group pressure sores occurred considerably less frequently with the new prosthesis than the old.

The formation of blisters, localised on the

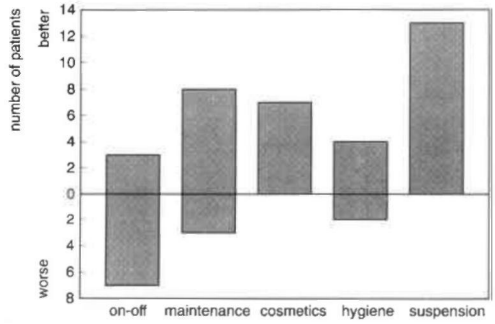

Fig. 4. Assessment of patients: general characteristics. Group 2b: Patients who had not a KBM as previous appliance.

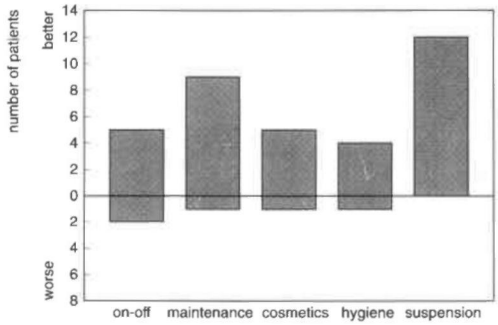

Fig. 5. Assessment of patients: general characteristics. Group 2a: Patients who had a KBM as previous appliance.

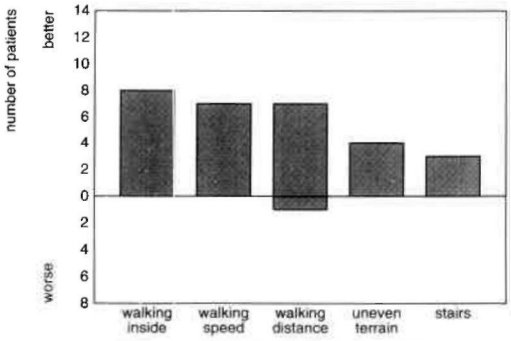

Fig. 6. Assessment of patients: functional characteristics. Group 2b: Patients who had not a KBM as previous appliance.

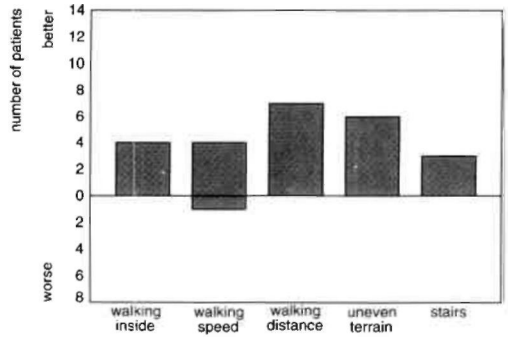

Fig. 7. Assessment of patients: functional characteristics. Group 2a: Patients who had a KBM as previous appliance.

upper lip of the roll-on socket, appeared in general to be a passing phenomenon.

Technical problems appeared to consist primarily of defects to the fixture of the cord between the roll-on socket and the outer socket. This problem has since been satisfactorily overcome by the design of a more durable construction, where the cord is led through the socket in such a manner that rubbing along the sharp edges is prevented, counteracting the effects of wear and tear. Nowadays the "shuttle-lock" closure is more frequently used. Laddering to the over-stockings is currently averted by the prior application of glue at the point where the opening occurs.

Donning and doffing

Although more operations are required when donning and doffing the roll-on socket prosthesis, most users did not consider this a problem. For a number of users however it did provide problems when they wanted to do it quickly for going to the toilet at night. A "shuttle-lock" proved to be more appropriate when the vision was impaired.

Cosmesis

In comparison with the old prosthesis this aspect was in general favourably received. The cord for the fixture, partly visible on the outside of the prosthesis, was found to be annoying, particularly by women who liked to wear a skirt. This complaint is overcome however, with the used of the "shuttle-lock".

Suspension

The improved suspension was clearly the most significant advantage of the roll-on socket. All patients felt positive about this.

Function

The findings above illustrated that most patients experienced the change to the roll-on socket as beneficial with respect to function. This applies equally to patients who had used a KBM prosthesis for their previous appliance and those who had previously had a prosthesis with a different suspension.

From the 26 patients who were provided with the roll-on prosthesis as a second appliance, 22 said that they did not wish to go back to the old system, 2 had doubts and only 2 were unsatisfied with the roll-on system.

Comparisons with existing literature

In the consulted literature no reference was found to large samples of patients who have worn a roll-on prosthesis. The small numbers of existing samples are generally positive towards the effects attained.

The authors' experiences are, in general, able to support the cited findings in the literature, i.e. the improvement of suspension (Madigan and Fillauer, 1991; Wetz *et al.*, 1992; Roberts, 1986; Kapp and Cummings, 1992) and pressure distribution (Fillauer *et al.*, 1989).

The high level of user satisfaction expressed has led to the situation today where the authors have come to consider the prosthesis with the roll-on socket as the standard appliance for a trans-tibial amputee.

If sufficient care is given to skin complaints which may temporarily arise, and to patient training, it is believed there will be few adverse symptoms. High standards are to be expected

with respect to the knowledge and expertise of the prosthetist and the rehabilitation team must be willing to acquaint themselves with the system.

As regards supply, the extra cost of the roll-on socket in relation to the KBM prosthesis and the extra time demanded of health-care workers may prove problematic.

Conclusion

The ICEROSS roll-on socket was perceived to be of benefit in a subjective assessment by a group of patients. Previously difficult suspension and pressure problems have been considerably remedied. The numerous skin complaints experienced at the trial stage do not prevent patients from being ultimately satisfied with improvements in respect of suspension and increased function.

As such it is important for rehabilitation teams to be fully aware of these improvements.

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