The Journal of the International Society
for Prosthetics and Orthotics

Prosthetics and Orthotics International

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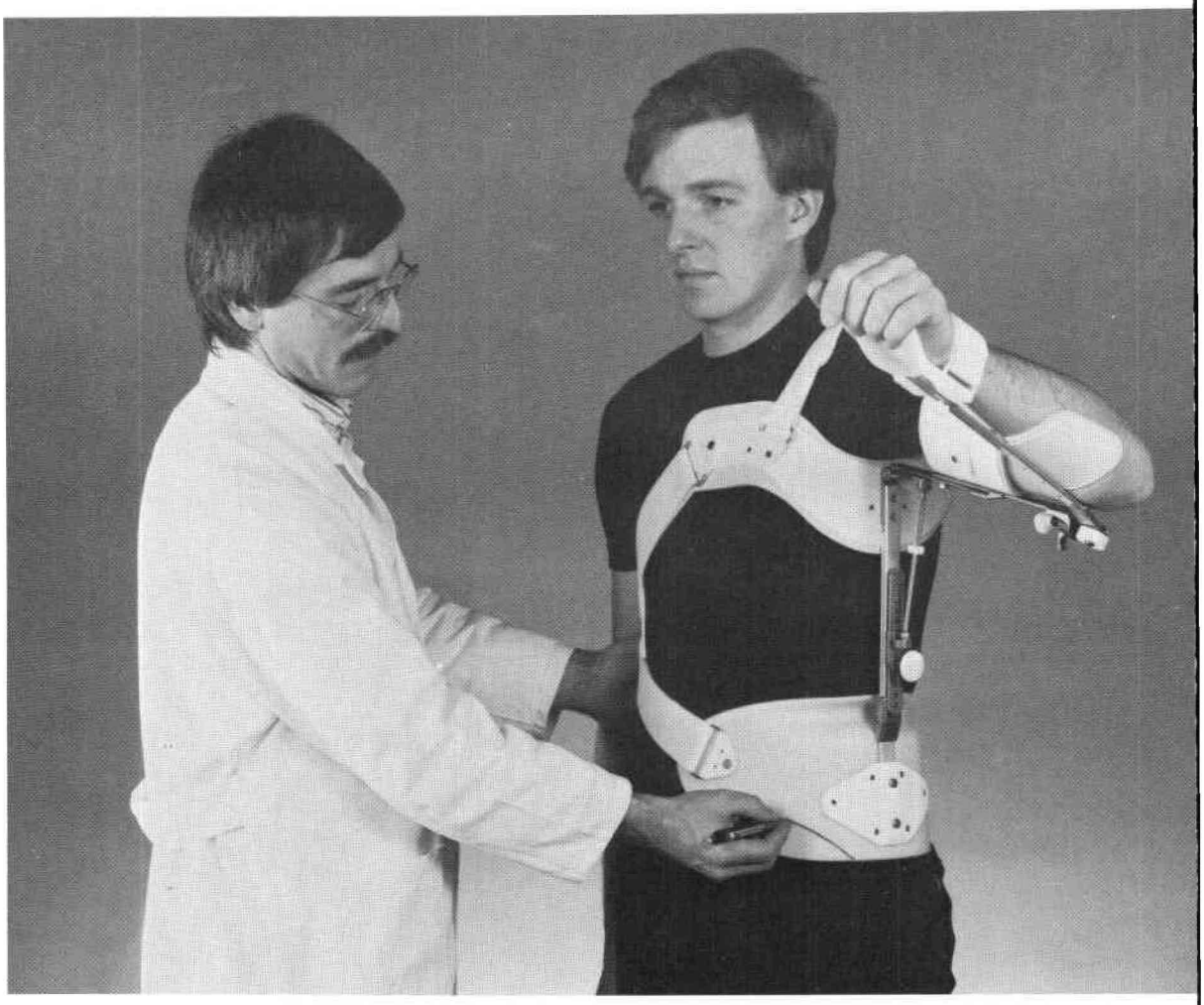

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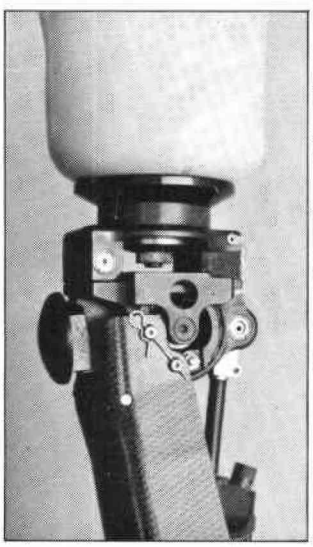

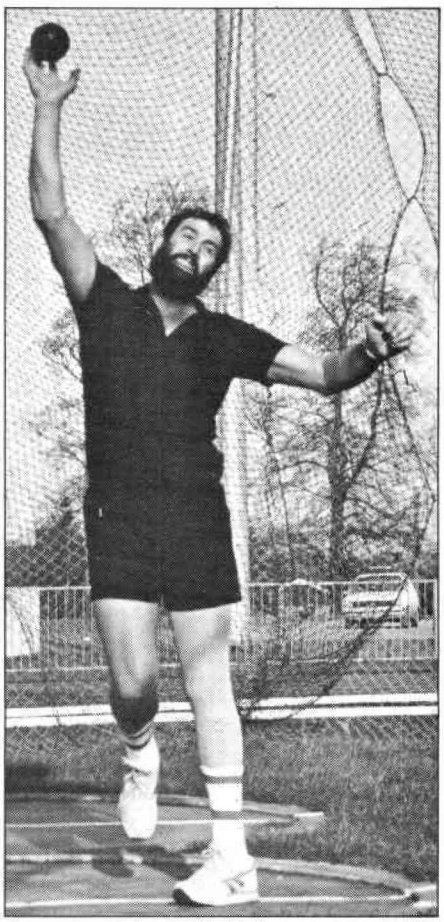

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The Journal of the International Society for Prosthetics and Orthotics

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Editorial

This issue of the Journal displays the financial statement for the year 1988.

The accounting this year is presented differently with the purpose of having the summary statement give information about the basic costs of running an international organization like ISPO. Such costs include the daily expenses of running the Copenhagen office and the professional management of the Society by the Executive Board. It also includes expenses related to ISPO-officers' participation in meetings with other international organizations involved in the practical management of the disabled or in such matters as education. In 1988 officers attended meetings with Rehabilitation International, the American Orthotist Prosthetist Association, the International Standards Organization and World Orthopaedic Concern, as well as taking part in a joint meeting with INTERBOR on strategies for the education of prosthetists/orthotists. This side of ISPO's activities are not normally directly visible to our members, but such contacts have over the years resulted in the high reputation which we have when viewed by other international bodies.

Due to increasing prices internationally, our expenses in the professional management and international work of our Society have increased considerably over the years and the result is an increasing deficit.

In spite of continuing sponsorship from The War Amputations of Canada, The Society and Home for the Disabled, who also still provide office facilities without costs, and the non-imbursed work done by numerous staff members at the National Centre in Glasgow, the expense of the daily activities of the Society cannot be contained within the present membership contributions. It has therefore been reluctantly decided by the Executive Board to increase the individual membership fee, which has been held constant for four years, to 450 DKK in 1990, (175 DKK for developing countries).

The total result of the accounts shows a rather high surplus which, however, more or less matches the deficit of last year. This surplus is in part due to the investment gains following the increasing confidence in the international monetary market. It does, however, also reflect reduced activities for 1988, in supporting courses and conferences, which must be seen as a consequence of the large deficit and high expenses on such activities in 1987.

It is the policy of the Executive Board that so far as possible the day to day activities of the Society should be carried out without touching our investment surplus, accumulated assets or reserves. This on the other hand is the mechanism which can be used to make contributions to educational courses and conferences about new developments possible. In 1988 we did consequently sponsor conferences about CAD/CAM and on the limb deficient child. Publications on these events are presently in preparation and will make a significant contribution to current knowledge.

J. Steen Jensen
Honorary Treasurer

Prosthetics and Orthotics International, 1989, 13, 2–5

I.S.P.O. Statement of Accounts, 1988

Auditors' Report

We have audited the financial statements for the year ended December 31, 1988.

The audit has been performed in accordance with approved auditing standards and has included such procedures as we considered necessary. We have satisfied ourselves that the assets shown in the financial statements exist, have been fairly valued and are beneficially owned by the association and that all known material liabilities on the balance sheet date have been included.

The financial statements have been prepared in accordance with statutory requirements and the articles of association and generally accepted accounting principles. In our opinion the financial statements give a true and fair view of the state of the association's affairs on December 31, 1988 and of the profit for the year then ended.

Copenhagen, February 16, 1989
Schøbel & Marholt
Søren Wonsild Glud
State Authorized Public Accountant

Accounting Policies
Securities
Bonds and shares are carried at market value.

Office equipment
Computer and office furnitures have been valued at cost.
Depreciation is computed, straight line over 5 years.

Income Statement for the Year 1988

		1988	1987
SUMMARY			
Society membership fees		758.759	709.289
Sponsorship (note 3)		107.064	102.583
Conferences, courses etc. (note 4)		(50.019)	(537.185)
Prosthetics and Orthotics International (note 5)		(78.214)	(83.474)
Publications (note 6)		12.212	7.326
		749.802	198.536
Administration expenses (note 1)		(952.306)	(767.059)
Primary result		(202.504)	(568.520)
Interest (note 7)		223.471	234.233
Dividend (note 7)		53.863	74.060
Maturity yield (note 7)		153.022	(10.749)
Change in market value of securities		203.904	(124.000)
Result for the year	DKK	431.756	(394.976)

Balance sheet as of December 31, 1988

ASSETS			
Cash		189.177	15.746
Accounts due			
Dividend tax due		—	16.463
Prepayments		—	30.235
Accrued interest		48.467	109.487
Advertising due		16.910	—
Advance funding of World Congress 1980		87.437	87.437
		152.814	243.622

		1988	1987
Securities (note 8)		3.307.660	2.998.037
Office equipment (note 2)		72.941	97.254
	Total Assets	DKK 3.722.592	3.354.659
LIABILITIES AND CAPITAL			
Liabilities			
Short-term liabilities			
Bank dept		—	141.271
Accrued expenses		37.334	35.766
Prepaid membership fees		4.700	—
Prepaid advertising income		5.359	26.249
Prepaid subscription income		92.070	—
	DKK	139.463	203.286
Provision	DKK	87.437	87.437
Capital			
Capital January 1, 1988		3.063.936	3.426.659
Receipt of Advance Funding of World Congress 1980		—	32.253
Result for the year		431.756	(394.976)
Capital December 31, 1988	DKK	3.495.692	3.063.936
	Total Liabilities and Capital DKK	3.722.592	3.354.659
Contingent liabilities (note 9)			

Notes to the Financial Statements

1. SOCIETY MEMBERSHIP AND ADMINISTRATION

Expenditure			
Executive Board and officers:			
Travel and hotel		(283.307)	(226.906)
Meeting expenses		(32.562)	(45.427)
Meetings with other organizations		(149.785)	(61.953)
	DKK	(465.654)	(334.286)
Secretariat, Copenhagen:			
Travelling expenses, Honorary Secretary and Treasurer		(27.105)	(40.343)
Staff salaries		(277.254)	(252.811)
Labour tax		(7.181)	—
Data service		(25.242)	(14.084)
Stationery printing		(24.979)	(16.716)
Office supplies		(2.098)	(2.499)
Lawyer		(10.648)	—
Accountant		(26.100)	(47.720)
Literature		(11.683)	—
Telephone		(5.219)	(4.759)
Postage		(24.154)	(20.652)
Maintenance		(3.953)	(3.427)
Bank expenses		(5.734)	(4.932)
Depreciation (note 2)		(24.313)	(24.313)
Sundries		(10.989)	(517)
		(486.652)	(432.773)
	DKK	(952.306)	(767.059)

2. DEPRECIATION		1988	1987
Computer equipment (at cost)		95.347	95.347
Office equipment (at cost)		26.220	26.220
		121.567	121.567
Depreciation 1 January 1988		(24.313)	—
Depreciation for the year		(24.313)	(24.313)
		(48.626)	(24.313)
Office equipment	DKK	72.941	97.254

3. SPONSORSHIP			
Contribution from the War Amputations of Canada		32.064	27.583
Contribution from SAHVA		75.000	75.000
	DKK	107.064	102.583

4. CONFERENCES, COURSES etc.			
World congress 1986		—	1.015
World congress 1989		(4.477)	(1.423)
CAD/CAM-Seattle		(46.000)	—
Strathclyde Education Workshop		8.474	(238.022)
Cairo Developing Countries Conf.		—	(47.575)
Israel, Traumatic Amputee Conf.		—	(106.735)
Miami AK-socket Workshop		(1.950)	(144.682)
Heidelberg 88, Limb Deficient Child Course		(6.066)	237
	DKK	(50.019)	(537.185)

5. PROSTHETICS AND ORTHOTICS INTERNATIONAL			
Advertising		174.436	110.997
Subscriptions		108.287	172.104
		282.723	283.101
Printing & mailing		(319.843)	(290.434)
Editorial costs		(18.449)	(35.864)
Meeting expenses		(22.645)	(40.277)
		(360.937)	(366.575)
	DKK	(78.214)	(83.474)

6. PUBLICATIONS			
Book sale		12.212	7.326
	DKK	12.212	7.326

7. INVESTMENT INCOME			
Maturity yield		153.022	(10.749)
Interest, bonds		212.882	228.926
Interest, bank		10.589	5.307
		223.471	234.233
Dividends		53.863	74.060
	DKK	277.334	308.293

8. SECURITIES

		Nominal value	Rate 31/12/88	Original cost	Market value 31/12/88	Interest/ Dividends
Bonds						
Sold securities		—	—	—	—	163.340
9% Kred. Danmark 22.S.2007		2.154.000	97,25	2.007.297	2.094.765	49.542
	DKK	2.154.000		2.007.297	2.094.765	212.882
Investment trust units						
Sparinvest, D		90.000	235,70	224.751	212.130	—
Privat Invest 2		38.000	482,00	227.371	183.160	—
Privat Invest 5		450.000	95,00	453.359	427.500	22.500
Investor-Maximum		343.000	103,50	349.885	355.005	30.013
	DKK	921.000		1.255.366	1.177.795	52.513
Shares						
Københavns Handelsbank		10.000	351,00	26.498	35.100	1.350
	DKK	10.000		26.498	35.100	1.350
Total result	DKK	3.085.000		3.289.161	3.307.660	266.745

9. CONTINGENT LIABILITY

The association is involved in a court trial in connection with the World Congress 1980. The association might be liable to additional cost in this connection. The outcome is at present uncertain.

Prosthetics and Orthotics International, 1989, 13, 6–13

Cervical orthoses

A. BEAVIS*

Oxford Orthopaedic Engineering Centre, Oxford

Abstract

A biomechanical study is presented to compare the effectiveness of three types of off-the-shelf cervical orthoses and one custom-fit collar in restricting cervical spine motion. A group of 10 normal subjects was studied. The measurements of flexion and extension, lateral side flexion and axial rotation were recorded using various measurement techniques. Interface pressures at the chin and occiput were also measured, along with the warming effect of the collars.

The results indicated that all the collars restricted neck movements, for example, the Plastazote collar by 50% of flexion and extension, and that there was no significant difference between off-the-shelf Plastazote and custom-fit collars in restricting movement. Significantly high interface pressures were recorded at the chin, with the subjects wearing the hard and Plastazote orthoses. The warming effect of the soft collar was equal to that of a wool scarf.

The study was aimed at improving prescription and although the subjective observations were not validated, the subjects concluded that the custom-fit collars were more comfortable; an important point with such a high rejection rate.

Introduction

Cervical orthoses are prescribed for a wide spectrum of clinical problems ranging from muscle spasm to serious instability. The main objectives are to rest the neck and give support, to allow muscles to relax and to permit any inflammation to subside. A large number are used as standard treatment in accident and emergency departments for initial immobilization following trauma of soft tissues, as neck injuries result from about 20 per cent of all vehicle accidents (Mealy et al, 1986). These collars are available through the United Kingdom National Health Service as stock items. Almost an equal number are made from sheet material by therapists in outpatient departments for conditions, such as cervical spondylosis and rheumatoid arthritis (Dudgeon, 1984).

There are several categories of cervical orthoses. Johnson (1977), divided them into four groups, namely, the simple collar extending from head to the upper part of the thorax, the "poster brace" with mandibular and occipital supports, the cervicothoracic brace extending over the trunk, and the halo brace involving skeletal fixation. When cervical instability due to trauma or disease is not apparent, then the simple collar is prescribed.

What is the basic rationale of prescription of these simple collars? Lusskin and Berger (1975) stated that collars should act as a reminder to restrict head and neck motions, to mechanically limit flexion, extension, lateral flexion and rotation of the head and cervical spine, and to partially relieve gravitational stress by weight transfer. Since the collar supports a portion of head weight, the cervical spine is partially unloaded. Caillet (1981) stated that whether the problems are acute or chronic, treatment of the painful neck, or of problems related to the neck, employs basic concepts. One such is that a collar, properly made and fitted, and correctly used, should be beneficial. In this context "properly fitted" implies that the collar is made specially for or matched to an individual. Caillet (1981) advocated that the neck should be held in a slightly flexed position so separating the posterior facet joints and opening the foraminae. This position minimizes the need for muscle "splinting", restricts

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excessive motion, and gives sensory cutaneous stimulation and warmth to the neck musculature causing a decrease in pain impulses. Since immobilization is not complete, the neck muscles are allowed to contract isometrically within the collars and atrophy and disuse are thus prevented. However these orthoses may not always match these specifications and Lusskin and Berger (1974) have suggested problems involving,

1. Muscle atrophy and weakness.
2. Tightness and contracture of tissues.
3. Psychological dependence.
4. Symptoms aggravated and undiagnosed disorders progressing.

In this study, the possible effects of the "simple collar" and custom-fit cervical orthoses, were examined in terms of:

1. Limitation of movement.
2. Interface pressures at the occiput and chin.
3. Warming of the skin.

Bearing in mind the prescription specifications and rationale for use.

Materials and methods

The study group comprised ten adults (5 men and 5 women), aged 25–65 years, with no history of neck trauma. The subjects were seated in a geriatric chair with the torso held by diagonal straps to eliminate unnecessary movement of the thoracic and lumbar spines.

The cervical spine movements of each subject were measured when moving freely without an orthosis and repeated when each of the four types of collars were worn. The cervical spine movements measured were flexion/extension, lateral side flexion and axial rotation.

A description of the different cervical orthoses tested is detailed in Table 1 and the orthoses shown in Figure 1.

Table 1. Description of cervical orthoses tested

*Soft Collar:	Made of high density PVC foam, covered in stockinette, fastened by Velcro.
*Hard Collar:	Made of rigid polythene, the contact parts are of foam rubber, covered with soft leatherette, fastened by Velcro.
*Plastazote collar:	A two-piece collar made of Plastazote, strengthened at the front and back, fastened by Velcro.
*Custom fit collar:	Made from a sheet of medium density polythene foam-Plastazote, strengthened at the front by a 2mm thick strip of polythene, fastened by Velcro.

*Details of suppliers are given in the Appendix.

Measurements of cervical spine movements

The movements were measured using the vector stereograph, an instrument with three extensible strings mounted on bobbins in one plane and joined at an attachment point, as described by Grew and Harris (1979). In the present study the vector stereograph strings were arranged to intersect at a central anterior position on the head with an attachment to a headband, thus allowing for positioning with or without an orthosis (Gant, 1985). For the first combined movement of flexion and extension the subjects were instructed to look forwards and follow a taped line marked on the wall, from the ceiling down to the floor. When completing the second movement of combined lateral side flexion the subjects were instructed to look forwards to a mirror, and bring their ear down to their shoulder, following an arcshaped wall marker. The movement was reversed so that the opposite ear was brought down to the contralateral shoulder. This method with straps pulling downwards over the shoulders helped to limit rotation and involvement of the shoulder and thorax. The stereograph outputs were fed into a minicomputer for subsequent analysis of movement patterns. A goniometer or builders inclinometer, as described by Pearcy (1986), was also used to measure cervical movements of flexion, extension and lateral side flexion. The subjects wore a headband with the inclinometer attached, while strapped into the geriatric chair. All the movements of flexion, extension and lateral side flexion to the right and to the left, were measured in degrees and taken as separate motions. Axial rotation could not be measured satisfactorily using the vector stereograph, and this was measured using two different goniometers. One inclinometer-type goniometer was attached to the top of the subject's head by a headband with the subject in the supine position, while the other horizontal goniometer, the mortar board type, measured head rotation about a vertical axis with the subject seated in the test position (Fig. 2). All movements were repeated on six occasions for each subject.

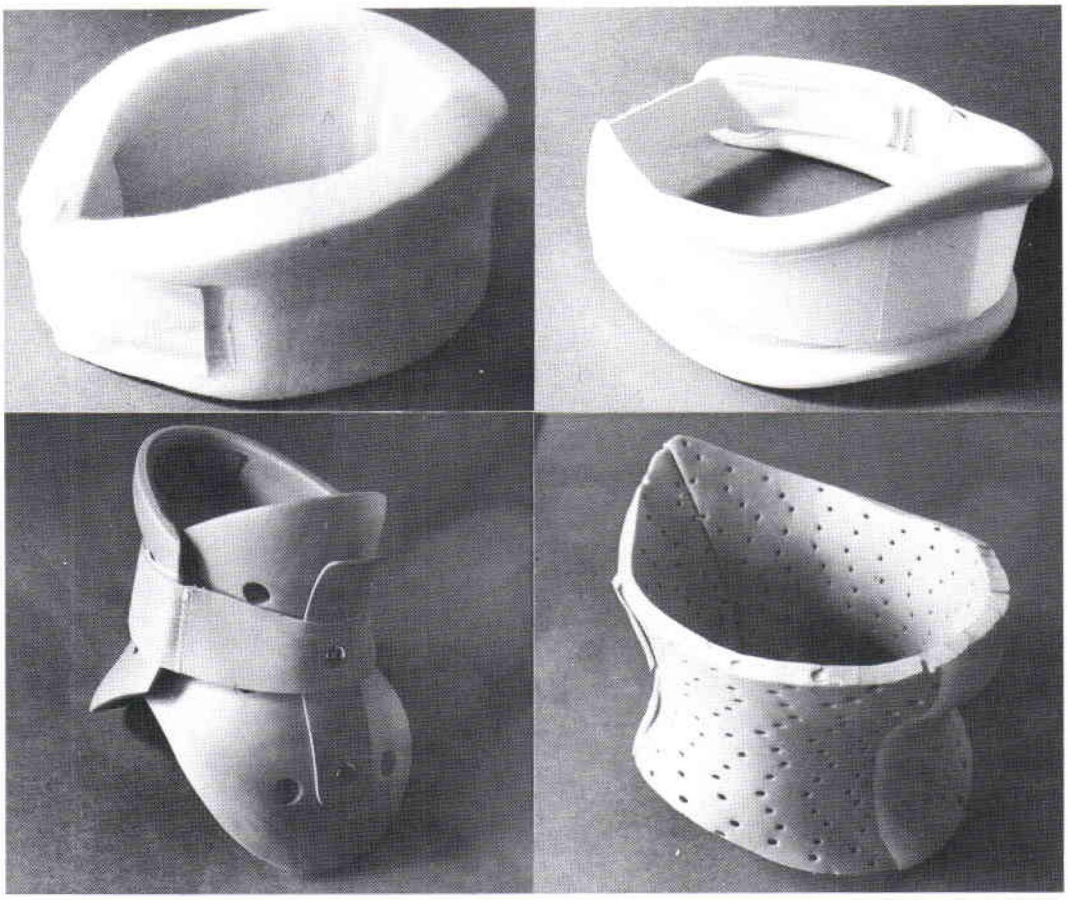

Fig. 1. Types of cervical orthoses used in the trial. Top left, soft collar; top right, hard collar; bottom left, Plastazote collar; bottom right, custom-fit collar.

Interface pressures measurements at the chin and occiput

The interface pressures were recorded using the Oxford Pressure Monitor (Bader and Hawken, 1986) as the subjects were seated in the test position wearing the different collars. Two pressure matrices, each incorporating a row of six pneumatic cells, were employed at the interfaces between the chin and collar and the occiput and the collar. The pressures in millimetres Hg were recorded at rest and at the extremes of the movements of flexion and extension, as recommended by Fisher (1977).

The subject was required to flex the neck to a position which could enable normal reading at lap level. Then an extended neck position was attained with no extreme level of force or movement.

Skin temperature

To assess the warming effect of each collar, skin temperatures were measured at two sites, one in the mid-cervical spine area under the collar, and a second in the mid-thoracic T7 area. This latter site was at a distance from the area of influence of the collar and therefore used as a control, Grew and Deane (1982). The three thermistors (Technoterm 1100) were taped to the skin with porous tape (Micropore 3M) and the electronic thermometer recorded the three temperatures, namely,

1. Skin temperature under the collar
2. Skin temperature at the thoracic spine under normal clothing
3. The ambient temperature

A pilot study indicated that the thermometer registered the change of skin temperature

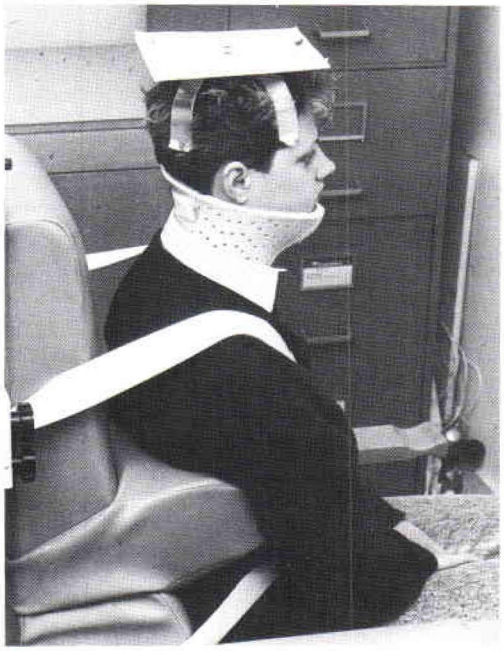

Fig. 2. Subject seated in test position for head rotation measurement using a horizontal goniometer.

under the collars and clothing to within 0.2° of the final temperature within 1 minute 40 seconds.

The subjects had the thermistors taped to their skin in the appropriate areas and recordings made with and without the collars, and with and without a wool neck scarf. Also the subjects skin temperatures were registered indoors and outdoors, in different weather conditions, specifically on a cold January day and a damp May day.

Results

Cervical spine movements

The mean results of movement using the vector stereograph and the inclinometer goniometer are detailed in Tables 2 and 3, respectively. The percentage limitation of movements, as assessed by the vector stereograph and the goniometer, can also be represented in histogram form (Fig. 3). The differences between the two measuring techniques, namely the vector stereograph and the goniometer (inclinometer), for both types of movements were not found to be statistically significant. The results of the rotation measurements by the two different goniometers are indicated in Table 4.

There was no significant difference between using the goniometer (inclinometer) and horizontal goniometer (mortar board type) for measuring rotation in the supine or sitting positions.

A specific comparison was also performed between two Plastazote collars. The restriction with all three types of movement is shown in histogram form (Fig. 4).

Table 2. The mean distance of motion measured by the vector stereograph and percentage reduction of motion from unrestrained normal movement.

	Flexion/ extension	%	Lateral side flexion	%
No collar	362±7	—	299±5	—
Soft collar	310±7	14	261±6	13
Hard collar	206±6	43	186±6	38
Plastazote collar	179±8	51	194±7	35
Custom-fit collar	197±8	46	185±6	38

All values are in millimetres

Table 3. The mean degrees of motion measured by the inclinometer goniometer, and percentage reduction of motion from unrestrained normal movement.

Collar	Flexion	%	Extension	%	Lateral side flexion			
					Left	%	Right	%
None	49±2	—	62±2	—	37±1	—	41±1	—
Soft	30±2	39	45±2	27	32±2	14	32±2	22
Hard	15±1	69	41±2	34	29±1	22	27±1	34
Plastazote	13±1	73	26±3	58	25±2	32	25±1	39
Custom-fit	17±1	65	26±2	58	23±1	38	25±1	39

All values are in degrees

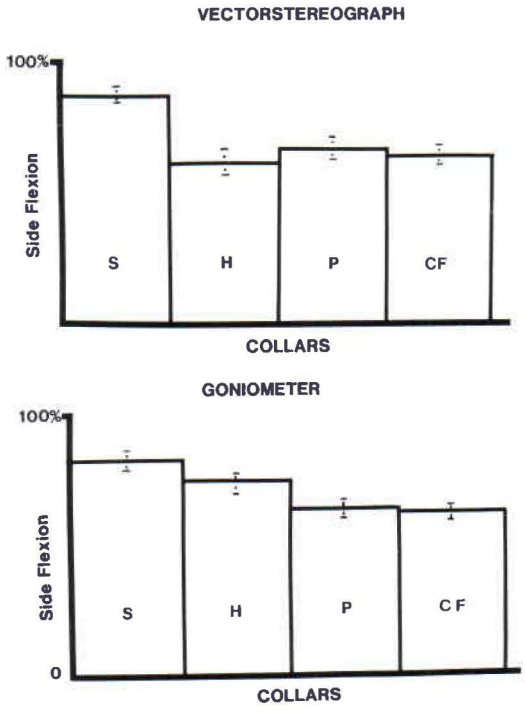

Fig. 3. Top, restriction of movement with different orthoses using the vector stereograph. Bottom, restriction of movement with different orthoses using the goniometer.

Interface pressures

Table 5 gives the mean values of the maximum pressures recorded at the two interface areas. Even at rest, the hard, Plastazote and custom-fit collars produced considerable maximum pressures, which increased by greater than 100 per cent when the subject went into flexion. The occipital pressures were negligible at rest but increased to significant interface pressures during full extension of the cervical spine.

Skin temperatures

In both Winter and Spring climatic conditions the thoracic sensors recorded a constant skin temperature of 35.3°C, and this was taken as the control sensor, as recommended by Grew and Deane (1982). As the subjects moved from indoors with an ambient temperature of 20°C, to outside at an ambient temperature of −1°C, on a January day, the skin in the uncovered cervical area decreased by 8.1°C from 34.1°C to 26°C. However, when either the soft collar or a wool neck scarf was worn on the same day a decrease of only 1.5°C in skin temperature was recorded in the cervical area.

Repeating the same measurement on a May day, when the ambient temperature inside was 27.5°C and outside was 10.5°C, and the control thoracic skin temperature was 35.1°C, the skin temperature in the uncovered cervical area decreased 5°C from 35°C to 30°C. However when either the soft collar or a wool neck scarf was worn a decrease of only 1°C in skin temperature was recorded in the cervical area.

It thus appeared that both the soft cervical orthosis and the wool scarf were equally effective in maintaining neck skin temperature at a comfortable level.

Discussion

The anatomy and movements of the cervical spine are complex, but normally there is a gradual intersegmental flow of movement, which is greatest in the upper part of the neck. There is also a gliding motion at the facet joints, while the discs deform. The amount of anterior shift depends on the obliquity of the articular processes (Fielding, 1964). So in this study, the combined anterior posterior movement measured in the sagittal plane by the vector stereograph was not 'true' flexion/extension of the cervical spine, Kaufman et al (1986). Again,

Table 4. The mean rotation measured by the goniometer inclinometer and the horizontal goniometer, showing percentage restriction of movement from unrestrained rotation.

	INCLINOMETER				HORIZONTAL			
	Left	%	Right	%	Left	%	Right	%
No collar	62±3	—	64±3	—	69±3	—	66±3	—
Soft collar	44±3	30	46±3	28	51±3	27	48±4	12
Hard collar	31±3	50	33±3	48	37±3	46	41±4	38
Plastazote collar	23±3	63	22±3	69	27±3	61	31±3	53
Custom-fit	22±2	65	24±2	62	25±2	64	28±3	58

All values are in degrees

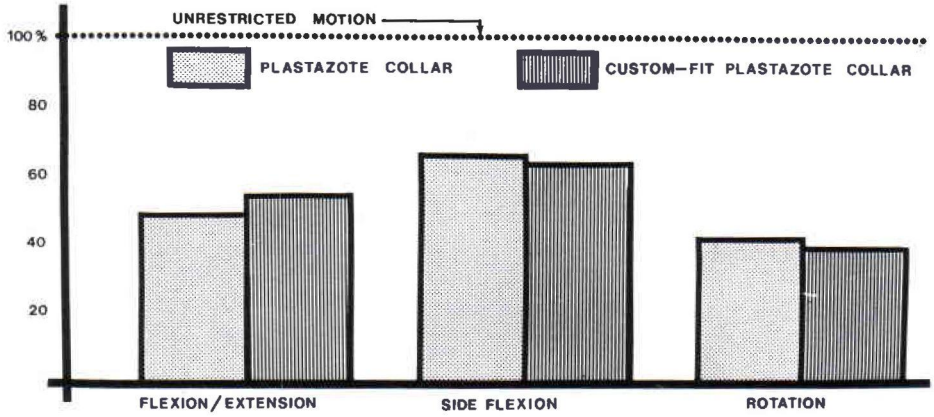

Fig. 4. Restriction of movement of off-the-shelf and custom fitted Plasatzote collars in all three types of movement.

lateral side flexion is not a 'true' movement of side bending, as it is always associated with rotation (Caillet, 1981). However, for the purpose of the present study, each subject was instructed to exert a conscious effort to eliminate unwanted movements, as recommended by other researchers (Hartman et al, 1975; Kaufman et al, 1986).

Two other clinical factors make bracing the neck with a 'simple' type collar even more complicated. Firstly, Caillet (1981) found clinically that 'nodding' first will result in a greater degree of total flexion, so the sequence of acts alters the degree of movement. If the neck is fully flexed first and then the chin is brought into flexion as a second phase, total neck movement is less than if the chin is flexed first ('nod') and then followed by bending the rest of the neck. In addition, when the subjects were restricted by a chin-piece and attempted to flex against it the upper part of the cervical spine extended while the lower part flexed. Fisher (1978) an Colachis et al, (1973) also found that the chin-piece on the collar produced straightening of the upper cervical spine. Caillet (1981) also stated that fitting the collar to an individual is of paramount importance. The 'nodding' and 'chin poking' movements must be considered, as the cervical spine movements of flexion and extension occur about many axes (Kaufman et al, 1980).

In spite of movement complexities, the ten subjects fitted with the different collars showed limitation of movement in all ranges. The soft collar limited flexion/extension and lateral side flexion by approximately 14 per cent, whilst the hard, Plastazote, and custom-fit collars limited the movements of flexion/extension and lateral side flexion by between 43 and 51 per cent.

In the rotation of the cervical spine, 50 per cent takes place at the atlanto-axial joint (Fielding 1964). However, it may be surprising that the soft collar restricted axial rotation by as much as between 13 and 20 per cent and the three other collars restricted rotation by between 42 and 66 per cent.

Bearing in mind the biomechanics of the neck, the study found, using the analysis of variance, three subjects which stood out as having higher than normal variance in their range of movements. One female subject had a long slender neck and the other two male

Table 5. Maximum interface pressures during flexion extension.

	Soft collar	Hard collar	Plastazote collar	Custom fit
Chin-rest	7±1	82±3	65±4	62±4
Occiput-rest	0	0	0	0
Chin-flexion	47±.8	150±3	143±6	172±7
Occiput-extension	14±.5	55±3	40±1	53±3

All values in mmHg

subjects were of a short stocky build. These anomalies did not alter the overall readings in the study, but as already noted the clinical factor of sequence of movement the 'nod' factor and the 'poking chin' factor, i.e. gliding motions of the facet joints may play a part in the anomalous findings with regard to these three subjects in the study.

There was no significant difference between the methods of measuring the movements of the cervical spine, using either the vector stereograph or the different goniometers.

The interface pressures recorded at the chin area were high, especially on flexion, but did not cause discomfort to the subjects. This increase of pressure could act as a reminder to restrict movements to a subject's injured neck. The pressures recorded, especially at rest, do indicate that the collars partially relieve gravitational stress to the neck muscles (Lusskin and Berger, 1975).

All collars had a satisfactory result in keeping the neck warm, but interestingly a wool scarf had an equal warming effect.

All the subjects stated that their custom-made Plastazote collars were very comfortable immediately on donning, and all subjects were convinced that the limitation of movement was greater and the pressures at the chin and occiput were less with these than with the off-the-shelf type of Plastozote collar. However, these subjective observations were not validated. Nevertheless, since the custom-made collars are more comfortable, and the rejection rate of orthoses is always high, subjective feeling of comfort should not be disregarded.

In conclusion, all the cervical collars in the study both off-the-shelf and custom-made, limited the movements of flexion/extension, lateral side flexion and rotation, and the goniometer proved to be a reliable non-invasive clinical tool.

Acknowledgements

My acknowledgement and thanks to Mrs Elizabeth Crowther MCSP, Deputy Superintendant, Aftercare Department, Nuffield Orthopaedic Centre, Oxford, for making and fitting the custom-fit Plastazote collars.

Appendix

*Soft Collar:	Manufactured by Camp Ltd. Northgate House Staple Gardens Winchester SO23 8ST UK
Hard Collar:	Supplied by OEC Orthopaedic Ltd Waterton Industrial Estate Bridgend South Glamorgan CF31 3YN Wales
Plastazote Collar:	Manufactured by Camp Ltd.
Custom-fit collar:	BXL Plastics ERP Division Mitcham Road Croydon Surrey
Velcro:	UK Manufacturer Selectus Ltd.

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Factors related to successful upper extremity prosthetic use

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Abstract

Surveys from 40 upper extremity amputees were analyzed to examine factors related to successful use of an upper extremity prosthesis. Factors which were associated with successful rehabilitation were fewer than two complicating factors, completion of high school education, employment at both the time of amputation and review, rapid return to work, acceptance of the amputation by the time of this review, and perception that the prosthesis was expensive. Factors which appeared unrelated to prosthetic success were age, loss of dominant hand, loss of elbow, marital status, use of rehabilitation services, use of a temporary prosthesis, and whether training in prosthetic use was provided. Many of these factors concurred with earlier studies. Previously unreported factors that may be of importance to the long-term success of upper limb amputees are the number of complicating factors and perceptions about the monetary value of the prosthesis.

Introduction

Although upper extremity (UE) amputees are few in number compared to lower extremity (LE) amputees, the loss of the upper limb is a far greater catastrophe for the individual (Beasley, 1981). The loss of an upper limb results in a major and sudden restriction of function, sensation, and cosmesis. Yet, studies have shown that amputees have demonstrated a greater resistance to accepting upper limb prostheses than to accepting artificial legs (Carter et al, 1969). Many studies conducted over the past three decades have looked at the influence of certain factors in successful long-term use of various UE prostheses. Factors that have been shown to be related to prosthetic success include level of education (Andersson and Berg, 1975), employment status (Andersson and Berg, 1975; Carter et al, 1969; Davies et al, 1970), time from amputation to fitting of a prosthesis (Malone et al, 1981), level of amputation (Carter et al, 1969), age (Andersson and Berg, 1975; Davies et al, 1970; Frank et al, 1984; Northmore-Ball et al, 1980), use of a temporary prosthesis (Bailey, 1970; Jacobs and Brady, 1975; Jones, 1977; Malone et al, 1981; Robinson et al, 1971; Sarmiento et al, 1968), and training in prosthetic use (Carter et al, 1969; Herberts et al, 1980; Munroe and Nasca, 1975). Loss of the dominant hand has not been shown to be a factor that influences prosthetic success (Carter et al, 1969).

The primary purpose of this study was to evaluate amputee factors related to prosthetic success in a group of upper limb amputees and compare these factors to those previously published.

A secondary purpose was to determine whether certain types of prostheses were associated with greater levels of success.

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Method

Questionnaire

Long-term UE amputees who had prostheses were surveyed with a 75-item questionnaire. The questionnaire addressed seven main topics: demographic and personal information, factors related to the amputation, activities of daily living, reliability of the prosthesis, cosmetic aspects of the prosthesis, durability of the prosthesis, and general concerns about the artificial limb.

Respondents were identified through the files of three prosthetic shops in Indianapolis, Indiana, USA, or through visits to the prosthetist in person. Questionnaires were distributed in a fashion that ensured confidentiality of response.

Data Analysis

The data were compiled and stratified as needed. Means were calculated for various demographic items. Chi-square analyses to determine significant frequency differences between classes of amputees were conducted when appropriate. Analyses with an alpha level of .10 or less are noted in the tables and in the text.

Results

Subjects

Eighty-six questionnaires were distributed; 48 (56%) were returned. Eight of the returns could not be analyzed secondary to missing data. Thus, results are based on 40 usable questionnaire responses. Thirty-nine of the respondents were male. Eight had above-elbow amputations, 4 had elbow disarticulations, 17 had below-elbow amputations (one bilateral) and 11 had wrist disarticulations. All but three of the amputations were secondary to trauma. Fifteen amputees lost their dominant hand. Mean age of the respondents was 56.4 years (range 19–81 years). Mean age at the time of amputation was 30.8 years (range 4.5–62 years), and the mean time lapse from amputation to the completion of the questionnaire was 26.6 years (range 5–59 years).

Personal characteristics

Amputees were characterized as successful users, partially successful users, or unsuccessful prosthetic users. Twenty-six successful prosthetic users wore and used at least one prosthesis every day, throughout most of the day. Ten partially successful users wore or used a prosthesis solely for certain tasks or hobbies. Four unsuccessful users did not use a prosthesis, or wore a prosthesis for cosmesis without using it in a functional manner. Table 1 shows personal characteristics of the amputees who were classified as either successful, partially successful, or unsuccessful prosthetic users. Differentiating factors were the presence of more than two complicating factors, and employment at the time of amputation and review. Unsuccessful amputees had more complications (visual handicaps, trauma to other limbs, heart problems, bone or joint

Table 1. Personal characteristics

Characteristic	Successful	Partially	Unsuccessful
Mean age (years)			
at amputation	31.0	30.7	29.3
at review	57.0	57.8	49.5
Mean time since amputation (years)	24.7	27.3	20.3
More than two complicating factors (%)	19.2	20.0	75.0[a]
Traumatic cause (%)	96.2	90.0	75.0
Loss of dominant hand (%)	31.7	20.0	75.0
Loss of elbow (%)	26.9	30.0	50.0
Married (%)			
at amputation	53.8	50.0	50.0
at review	92.3	70.0	100.0
Median education			
at amputation	High school	High school	Grade school Some HS
at review	High school	High school	High school
Employed (%)			
at amputation	96.2	100.0	50.0[b]
at review	96.2	90.0	75.0[c]
Median time to return to work (mos)	6	12	36
Median time to return to leisure activities (mos)	4	8	6

[a] p=.0516
[b] p=.0028
[c] p=.0013

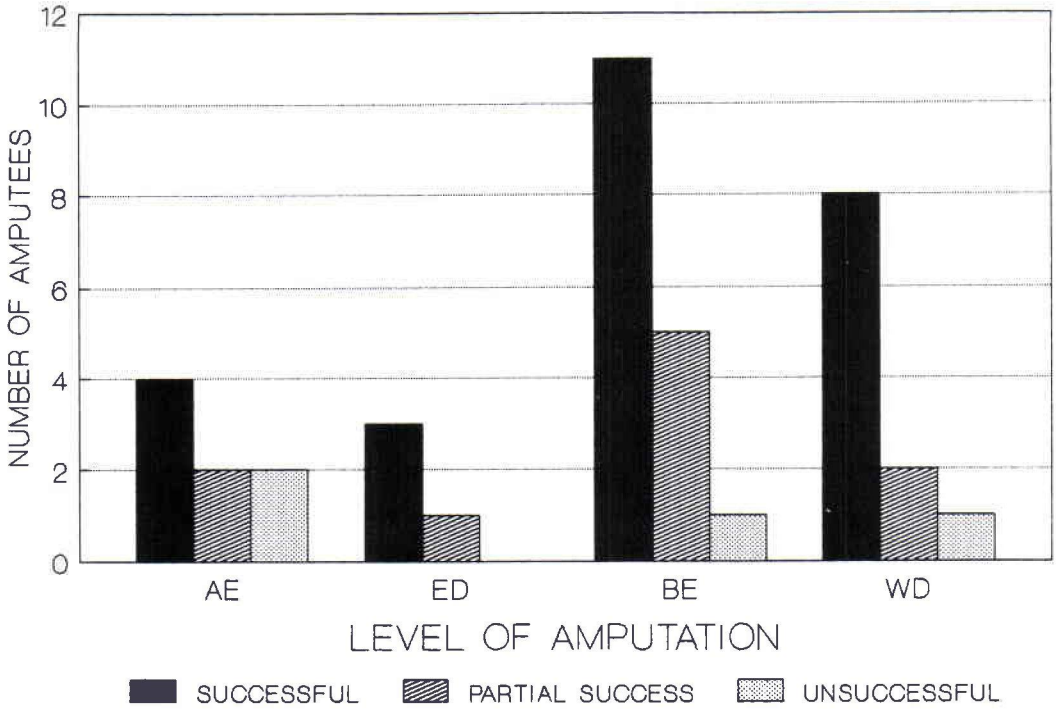

Fig. 1 Amputation level and successful use of a prosthesis.

problems, or phantom pain or sensation), and were less likely to be employed either at the time of amputation or at the time of this review, than their successful counterparts. Though not tested statistically, the successful users had a higher level of education than unsuccessful users, returned to work many times faster, and received their prostheses sooner than the unsuccessful amputees. Factors which did not differentiate between successful and unsuccessful users were age, cause of amputation, loss of dominant hand, and loss of elbow. Figure 1 shows the distribution of amputation levels according to their successful use of a prosthesis. At each level, at least half of the amputees were classified as successful users.

Rehabilitation factors

Table 2 shows rehabilitation factors and their relationship to prosthetic success of each amputee. A significant differentiating factor was the acceptance of the amputation at the time of review. Understandably, the less successful amputees reported less acceptance of their amputations. Factors which did not differentiate between successful and unsuccessful amputees were use of rehabilitation services, and use of a temporary prosthesis.

Prosthetic factors

Many of the items on the questionnaire were designed to elicit information about how particular prostheses met the daily needs of amputees. Unfortunately, the types of prostheses owned by the respondents were very similar. The forty respondents listed a total of 60 prostheses that they had owned since their original amputation. Almost two-thirds (39) were cable-operated prostheses with a terminal hook. Almost one-third (18) were cable-operated with terminal hands. At least four of the cable-operated hand prostheses were secondary prostheses that were used when greater cosmesis than the hook was desired. The remaining three were electrically powered. Thus, comparisons between types of prosthesis did not prove to be very useful, particularly because of the extremely small number of electrical prostheses in the sample. However, some basic data will be presented. A prosthesis was considered functionally useful if it was

Table 2. Rehabilitation characteristics

Characteristic	Successful	Partially	Unsuccessful
Acceptance of amputation			
at amputation (%)	88.5	60.0	75.0
at review (%)	100.0	80.0	75.0[a]
Rehabilitation services (%)	46.2	70.0	75.0
Temporary prosthesis (%)	11.5	20.0	25.0
Time from amputation to ordering of prosthesis (mos)	4.9	5.1	14.4
Time from ordering to delivery (mos)	2.1	1.4	1.0
Training received (%)	38.5	70.0	75.0
Mode of payment (%)			
Self	30.8	20.0	25.0
Others	69.2	80.0	80.0
Perceived cost			
Expensive (%)	76.9	60.0	25.0[b]
Affordable	23.1	40.0	75.0

[a]p=.0467
[b]p=.1001

worn and used every day, throughout most of the day. A prosthesis was considered partially useful if it was used part-time or solely for certain tasks or hobbies. A prosthesis was considered not useful if it was not used at all or was worn only for cosmetic purposes. Of the 52 prostheses with sufficient data for classification, 27 were functionally useful, 15 were partially useful, and 10 were not useful. Figure 2 shows the breakdown of usefulness categories by type of prosthesis. It can be seen that the majority of cable-operated hooks were functionally useful,

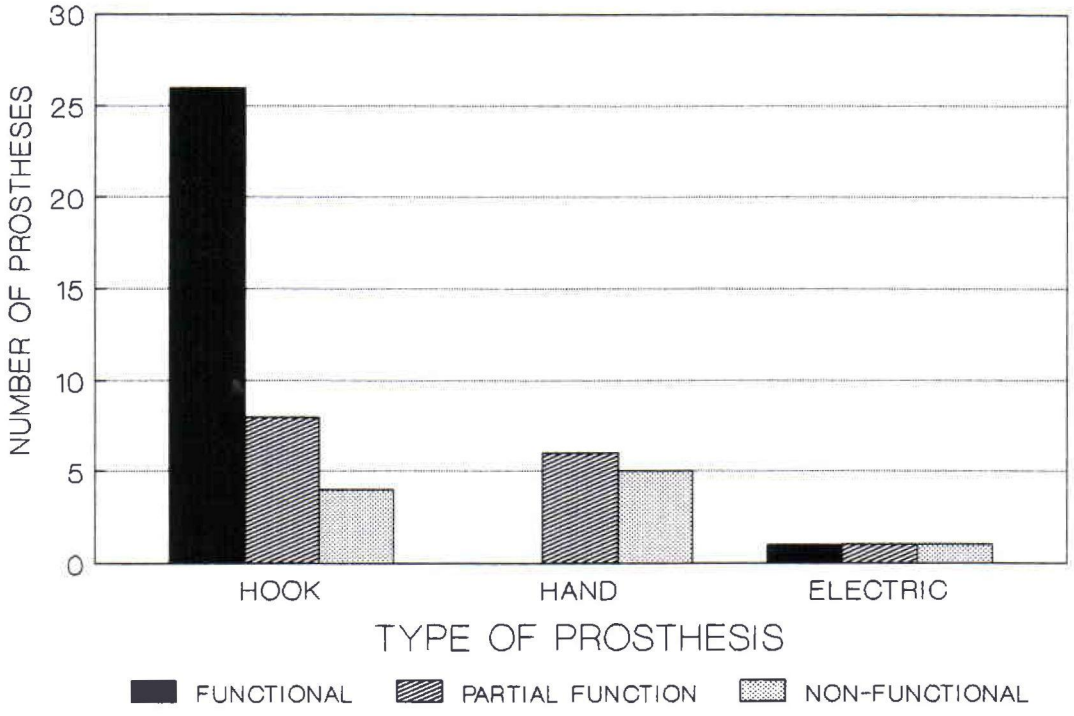

Fig. 2. Types of prostheses and functional categories.

that none of the cable-operated hands were functionally useful, and that one electrically powered prosthesis was in each usefulness class.

Discussion

This study sought to validate the results of others, as well as investigate factors related to prosthetic success that have been overlooked by other investigators. Areas of agreement with other investigators are that education, employment status, and time from amputation to fitting are related to prosthetic success. The authors found, as have others, that the loss of the dominant hand is not a significant differentiating factor between successful and unsuccessful amputees. Areas of disagreement with the published literature are that in this study no differences were found based on level of amputation, use of a temporary prosthesis, or training with the prosthesis. Factors found that have been previously unexplored are the presence of more than two complicating factors and perceived cost of the prosthesis.

One problem with any retrospective survey is that subjects are not randomly selected. In this instance only those amputees who had seen a prosthetist at some point in their course of treatment were included. The return rate of just over 50%, while common for a survey of this type, may distort the sample. We do not know whether the amputees who did not respond have characteristics similar to those who did respond. A second problem with retrospective studies is that one is asking respondents to remember back into time. The accuracy of some of the data related to early rehabilitation could not be determined.

Conclusions

Rehabilitation of upper limb amputees will continue to be a challenge to the amputee and to the health care providers. The number of perioperative complicating factors and the amputee's perception about the cost of the prosthesis are factors that health care providers may wish to consider when evaluating the prosthetic potential of an upper limb amputee. The magnitude of the functional loss that accompanies upper limb amputations makes their study important; the small numbers of upper limb amputees makes their study most difficult.

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Comparison of CAD-CAM and hand made sockets for PTB prostheses

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Abstract

The aim of the present study was to compare sockets for below-knee (BK) prostheses made by Computer Aided Design-Computer Aided Manufacture (CAD-CAM) to those made by hand. The patients in the study were provided with two prostheses each, which apart from the sockets, were identical. One socket was made by the CAD-CAM technique developed at the Bioengineering Centre, Roehampton, University College London and one was made by hand at the OT-Centre, Stockholm, Sweden. The results were based on investigation of eight unilateral below-knee amputees evaluating their own sockets by Visual Analogous Scale with respect to comfort, pressure, and pain. The sockets were evaluated on seven occasions, at two tests, on delivery, after use every second day for six days and every second week for two weeks. All CAD-CAM sockets except one had to be changed once as compared to the hand made of which only two had to be changed. As to comfort it could not be demonstrated that there was any significant difference between the two types of sockets and both types were well accepted by all patients. Differences in pressure and pain were rarely reported. There were obvious differences between the two types of socket with respect to height, width, and inner surface configuration.

The authors feel that CAD-CAM will in the near future be an excellent tool for design and manufacture of prosthetic sockets.

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Introduction

About fifteen years ago industry began to use computers for design and manufacturing i.e. Compter Aided Design and Computer Aided Manufacturing (CAD-CAM). This technique is now being applied to the manufacture of sockets for BK amputees. The form of the stump is digitized and transferred into a computer, which makes standard changes. In addition the form may be changed by the prosthetist on the screen. When the prosthetist is satisfied with the form, a numerically controlled (NC) carver makes a model over which the socket is made.

In the mid 1970's Jim Foort and Carl Saunders began to develop a CAD-CAM system at MERU (Medical Engineering Resource Unit) in the University of British Columbia, in Vancouver. The socket shape is defined by the computer on the basis of manually made measurements of the stump taken at certain predetermined points. Changes can be made subsequently to any area by the prosthetist, via the computer, before carving.

At the Bioengineering Centre, University College London another CAD-CAM system has been developed using a different principle. A plaster wrap is taken of the undeformed stump and placed in a measuring device. The wrap is rotated while a probe follows its inner surface and transfers the form of the stump digitally into the computer. At standard areas the average rectifications of a skilled prosthetist are made by the computer. In addition the prosthetist can change the standard areas as well as the length and width of the socket.

It has been reported that both systems have provided several BK amputees with well

PROTOCOL FOR EVALUATION OF PROSTHETIC SOCKETS

Name: ..... Date of Birth .....

Diagnosis: ..... The patient has had ..... no. of prostheses in ..... years.

Date: ..... Side: L/R

Test 1/Test 2/Deliv./Day 1-2/Day 3-4/Day 5-6/Week

Prosthesis no. ..... was with ..... no. of socks:

Useless Perfect

The socket gave pressure/pain to an extent of:

Maximum None

Mark where:

The prosthesis could not be used during the whole period because of:

.....

Fig. 1. Protocol for evaluation of sockets.

tolerated sockets. However, the inevitable question arises: Is a CAD-CAM-produced socket as comfortable as a manually designed one?

The aim of the present study was to compare the function of sockets made by CAD-CAM to those made by hand.

Materials and methods

Ten unilateral BK amputees, two with heavy, four with rather heavy and two with light employment, who use their prostheses all day were provided with two prostheses each. Apart from the sockets the prostheses were identical. One socket was made by using the UCL CAD-CAM technique. The undeformed stump form was obtained from a plaster wrap taken in Sweden and sent to London. The changes, based on a rectification pattern, produced by a research prosthetist at the Bioengineering Centre were made and a model was carved in London. The sockets were made in Sweden directly on the model, leaving the ridges made by the NC-carver. As a control a second socket was made by hand according to Swedish principles at the OT Centre in Stockholm. Five prosthetists with work experience ranging from 1 to 10 years made control sockets for two patients each. The five different prosthetists were chosen to obtain an average of expected

hand made quality. For each patient both types of sockets were adjusted as many times as needed i.e. until both the patients and the prosthetists were satisfied. All prostheses were aligned by the same prosthetist. It was not indicated to the patients which of the sockets was made by CAD-CAM and which was made by hand. The patients evaluated their sockets by a 100mm Visual Analogous Scale (VAS) with respect to comfort, pressure, and pain (Fig. 1). Both sockets were evaluated seven times i.e. at two tests, on delivery, after use every second day for six days and every second week for two weeks. The patients were taught how to fill in the forms at the two tests and the delivery and carried out the evaluation themselves at home on the other occasions.

Calculations and statistics

For each socket the value of comfort was measured from the VAS in mm. The ratios between the two measurements for the two types of sockets for each patient at each of the seven evaluations were calculated. The mean and standard deviation of the seven evaluations were calculated and used for statistical analysis.

Student's T-test was used for statistical analysis and a significance level of 99% was chosen.

Table 1. Socket changes

CAD-CAM									MANUAL								
Pat. no.	1	2	3	4	5	6	7	8	Pat. no.	1	2	3	4	5	6	7	8
No.	1	1	1	1	1	1	0	1	No.	1	1	0	0	0	0	0	0

Results

Two patients had to be excluded since they had not understood how to fill in the forms properly. The results are based on the remaining eight patients.

All CAD-CAM-sockets but one had to be changed once as compared to the manual sockets of which only two had to be changed (Table 1).

With respect to comfort considerable variations were found in the absolute values (Fig. 2). Analysis of the ratios of comfort evaluation between the two types of sockets, however, showed no significant difference at

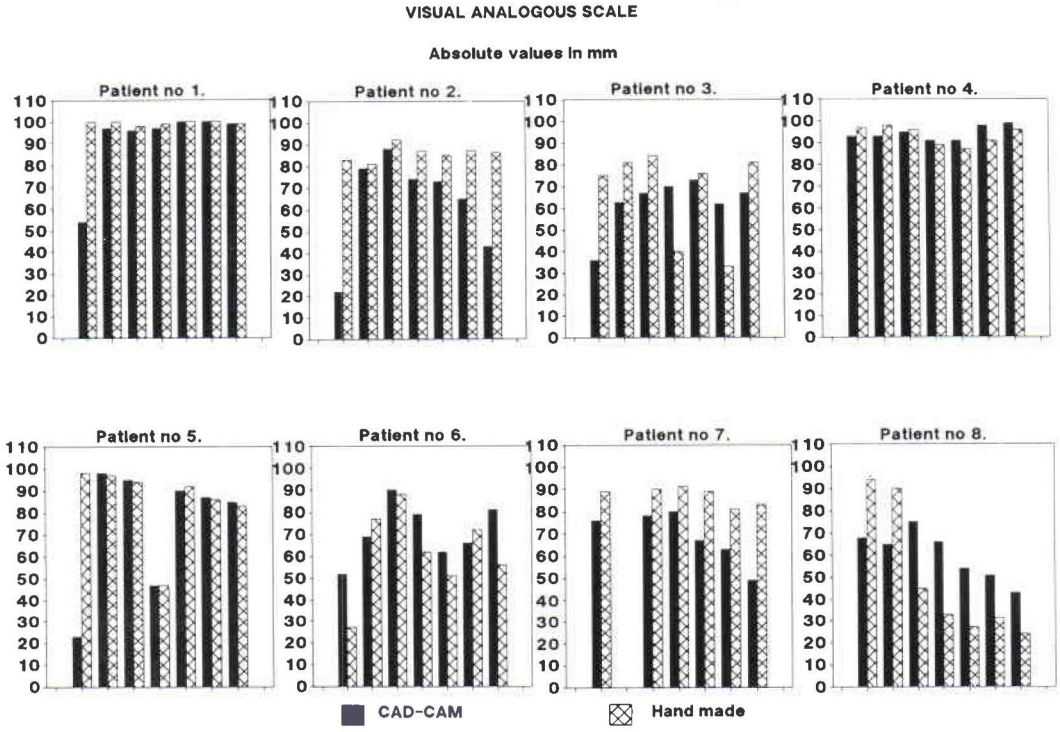

Fig. 2. Absolute values of socket comfort at test 1, test 2, delivery, after use day 1-2, day 3-4, day 5-6, and week 1-2.

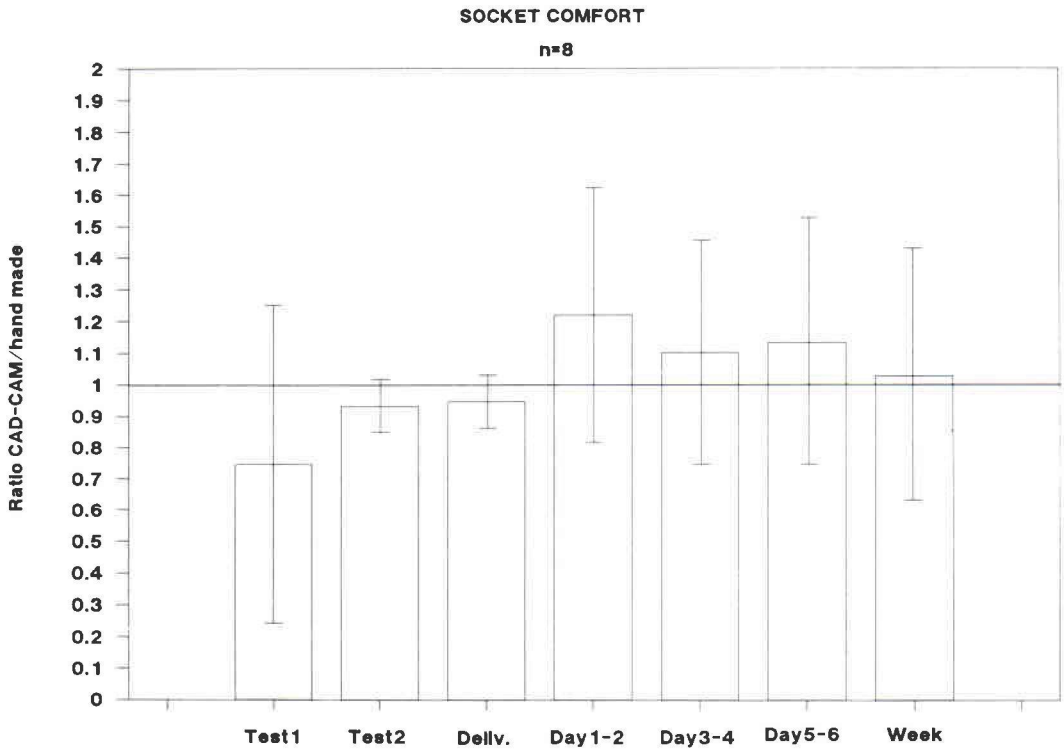

Fig. 3. Means and standard deviations of ratios between absolute values.

any time (Fig. 3). Both types of sockets were well accepted by all patients. As can be seen in Tables 2 and 3 differences in pressure and pain rarely occurred.

In spite of the few differences observed by the patients it was obvious that the two types of socket differed with respect to trim-line, width, and inner surface configuration (Fig. 4).

Discussion

It was found that sockets made by the CAD-CAM technique were equally comfortable when compared to those made by hand.

The degree to which feelings of comfort, pressure and pain are experienced cannot be measured objectively. The only known way to transform such subjective parameters is to use the Visual Analogous Scale (VAS). The relevance of using the VAS for evaluation of socket comfort can be derived from Figure 3. In the interval between test 2 and delivery no changes of the socket or prosthetic alignment were made. Since mean values and standard deviation were almost identical at both occasions there are reasons to assume that the evaluation by VAS is relevant for comparative

Table 2. The amputees' feeling of pressure: y represents pressure, n no pressure and Y difference between CAD-CAM and manual. Patient no 7 felt no pressure and needed no test 2.

Pressure																
CAD-CAM									MANUAL							
Pat. no.	1	2	3	4	5	6	7	8	Pat. no.	1	2	3	4	5	6	7	8
Test 1	Y	Y	y	n	Y	y	n	y		n	n	y	n	n	y	n	y
Test 2	Y	n	Y	n	n	n		n		n	Y	n	n	n	n		Y
Del.	n	n	y	n	n	n	n	y		n	n	y	n	n	n	n	y
Day 1-2	n	n	y	n	n	n	y	y		n	n	y	n	n	n	y	y
Day 3-4	n	n	y	n	n	n	y	y		n	n	y	n	n	n	y	y
Day 5-6	n	Y	y	n	n	n	y	y		n	n	y	n	n	n	y	y
Week	n	Y	y	n	n	n	y	y		n	n	y	n	n	n	y	y

Table 3. The amputees' feeling of pain: y represents pain, n no pain and Y difference between CAD-CAM and manual. Patient no 7 felt no pain and needed no test 2.

Pain																
CAD-CAM									MANUAL							
Pat. no.	1	2	3	4	5	6	7	8	Pat. no.	1	2	3	4	5	6	7	8
Test 1	n	Y	Y	n	n	y	n	n		n	n	n	n	n	n	n	n
Test 2	n	n	n	n	n	n		n		n	n	n	n	n	n		n
Del.	n	n	n	n	n	n	n	n		n	n	n	n	n	n	n	n
Day 1-2	n	n	n	n	n	n	y	n		n	n	n	n	n	n	y	n
Day 3-4	n	n	n	n	n	n	y	n		n	n	n	n	n	n	y	n
Day 5-6	n	Y	n	n	n	n	y	n		n	n	n	n	n	n	y	n
Week	n	Y	n	n	n	n	y	n		n	n	n	n	n	n	y	n

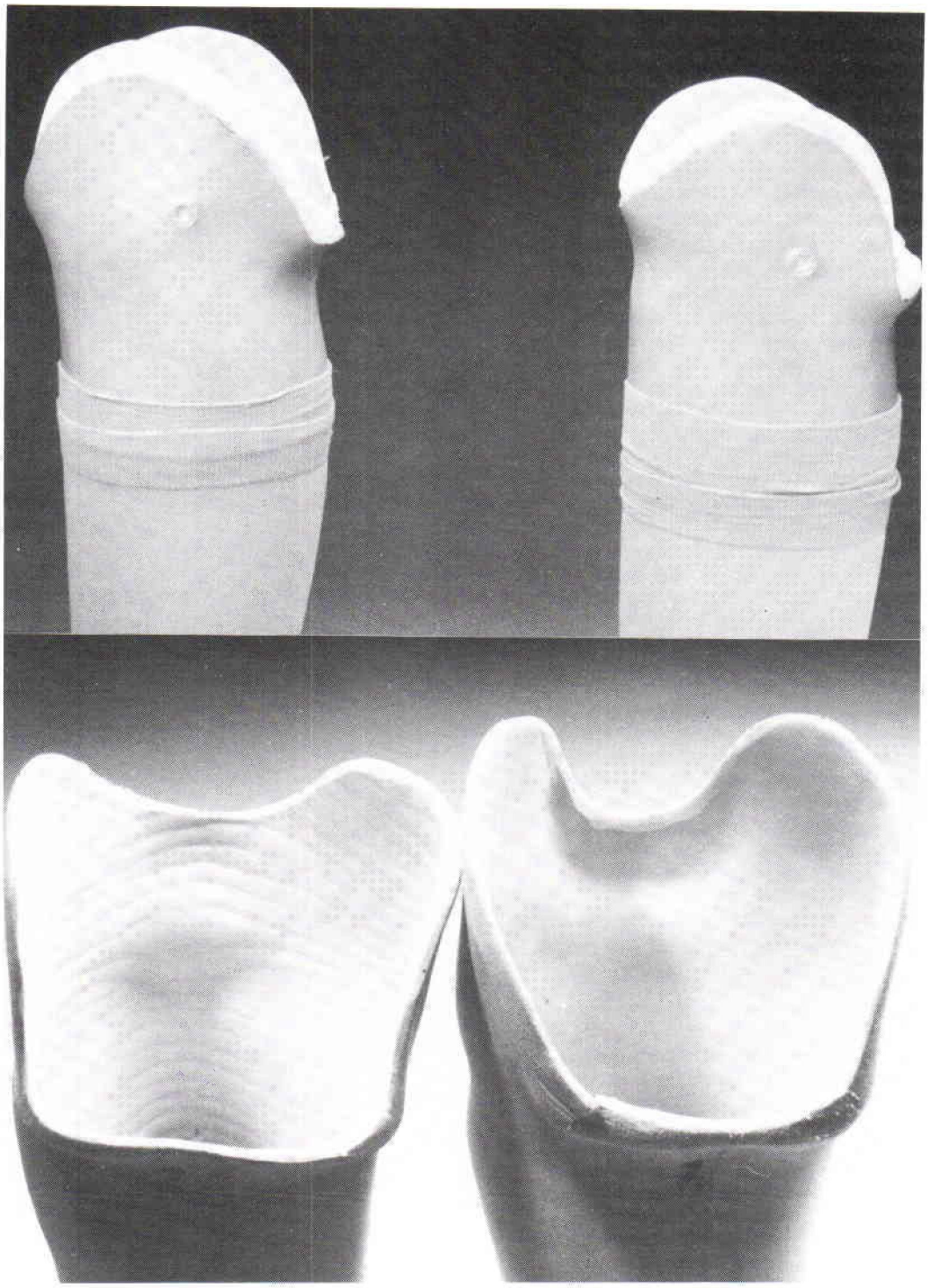

Fig. 4. CAD-CAM and hand made sockets.

studies on socket comfort. Whether the absolute values also can be used in a non-comparative situation is a matter for reasonable doubt. In patient no. 5 for instance the ratio varied very little whereas the absolute values varied from 96 to 45 mm. The absolute values of VAS probably reflect how well the patients have accepted their handicap. There are reasons to assume that patients no. 1 and 4 have accepted their handicap much better than no. 8.

The study was aimed solely at comparing sockets made by CAD-CAM to those made by hand. Since there was no possibility of using the computer system with a Swedish socket design the English one had to be used. This made it necessary to compare not only sockets made by CAD-CAM to those made by hand but also the skill of an English prosthetist with that of a Swedish one. In spite of this difference in socket production technique the patients could not detect any differences in comfort, indicating that the skills are quite compatible.

The material is small but the patients were used as their own controls and the result showed no tendency in favour of any one of the two types of sockets. This fact may justify the conclusion that probably there are no differences in comfort between the two techniques. If there is a difference it seems to be small and to prove this it would be necessary to make an investigation which comprises a very much larger material. This might reach the same conclusion. The amputees were not told which socket was made by hand and which was CAD-CAM made. The ridges made it obvious to those who deal with sockets every day which was which, but none of the patients made any remark on the subject. Moreover, there are no reasons to assume that the patients should be prejudiced against any type of socket thereby biasing the study even if they realised the difference.

The intention was to verify using the VAS the differences between the two types of sockets with respect to pressure and pain. However, the few differences reported by the patients made it irrelevant to make any calculations on the subjects.

None of the patients had any complaints about ridges in the CAD-CAM sockets. Some of the patients even remarked that these sockets were more airy. None of the patients could detect ridges that were 2 cm wide and 0.5 cm high. The reason is probably that two point discrimination of the lower leg is approximately 2.5–3cm making the ridges impossible to detect.

Making the stump form available for the computer from the plaster wrap is a rather complicated process. However an improved tool is now being evaluated. The undeformed stump form is obtained from silhouette pictures as a tv-camera swings around the stump over a three second period. This new technique will simplify the procedure and minimize the time needed for stump measurement.

Despite the CAD-CAM technique being newly applied to patients the authors could not find any differences in socket comfort. Their opinion is that the UCL technique will in the near future be an excellent tool for improved design and manufacture of prosthetic sockets. The technique would also give other advantages such as uniformly high quality, easy storage of stump-forms and improvement in the teaching of prosthetists.

Acknowledgements

The authors wish to express their sincere deeply felt gratitude to Steven J Cousin, Mike Dewar, Joseph Wilkinson and all staff members of the Bioengineering Centre, Roehampton, University College London for their cooperation making the study possible to perform. This study was supported by grants from the Swedish Institute for the Handicapped.

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Prosthetics and Orthotics International, 1989, 13, 25–28

The CAPP terminal device, size 2: a new alternative for adolescents and adults

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Abstract

CAPP Terminal Device, Size #2 for teenaged and adult amputees offers an alternative to hooks and hands available today. CAPP TD 2 is intended to be pleasing in appearance; it blends with the forearm in shape, colour and material to give a continuous flowing natural look. It was designed to provide secure grip through the combined action of a closing spring, a full frictional, resilient cover and an automatic lock. The lock operates as part of the voluntary opening control system and requires no conscious action by the amputee. CAPP TD 2 is a general purpose terminal device which especially serves unilateral amputees by performing functions usually carried out by the non-dominant hand. CAPP TD 2 comes with a built-in wrist connector which is available in two models; both offer quick disconnect. One wrist unit has adjustable friction and the other attaches to an existing friction wrist unit so CAPP TD 2 can be applied to an existing prosthesis. Ten patients have completed the evaluation programme with promising results. Prototypes of CAPP TD 2 are available for patients interested in evaluating it.

The CAPP Terminal Device, Size #2 offers unilateral teenaged or adult amputee patients a unique alternative. It is introduced here in hope of stimulating researchers to explore new mechanical solutions in their component designs. The CAPP research designer, Mr. Carl T. Sumida, CPO, introduced the idea of a non-hand, non-hook TD with the CAPP TD 1 for infants (Sumida and Setoguchi, 1967); that terminal device had more function than a passive hand and it had a softer appearance than a hook. CAPP TD 1 evolved from that infant device and is now used by children up to ten years of age (Shaperman, 1975). Non-hand, non-hook terminal devices, such as the CAPP units, may be approached with caution by clinicians, but are often greeted with enthusiasm by patients who want a TD that is functional, not mechanical appearing, and which does not disguise the fact that they wear a prosthesis.

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Design features of CAPP TD 2

The *appearance* suggests a continuity of line and colour with the forearm through the use of a built-in wrist connector and a full, replaceable soft cover. Patients over a wide age/size range can wear the same size TD due to this feature. Also, the same unit can be applied on the right or left side. Although the shape does not look

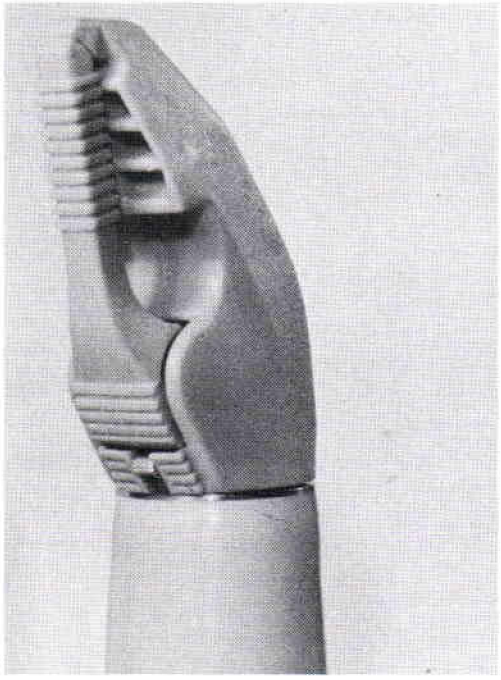

Fig. 1. The CAPP TD 2

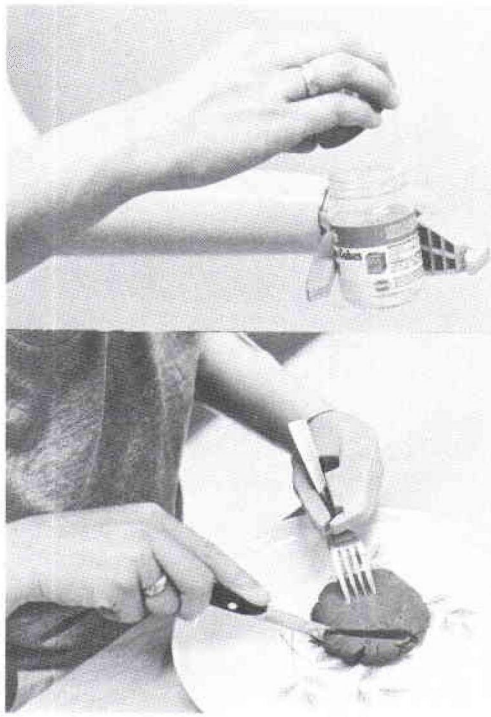

Fig. 2. Top, a variety of object shapes can be held. Bottom, cutting food is possible.

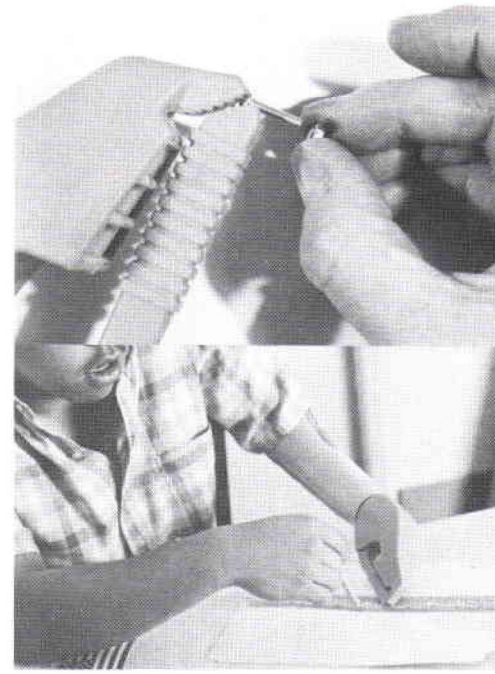

Fig. 3. Top, tiny objects can be held in the tips. Bottom, friction covering aids stabilization.

like a hand, its shape suggests a stylized hand in a grasping position (Fig. 1).

CAPP TD 2 *functions* as a general purpose terminal device substituting for the non-dominant hand; it primarily provides secure static grip but also has useful fine pinch (Figs 2 & 3). The friction cover is useful for passive stabilizing (Figs 3 & 4) and there is an area for "hooking" grasp. The functional design features were planned to provide secure grip without requiring high operating forces. In this voluntary opening, body powered terminal device, the grip feature includes three design elements. First, a frictional, resilient cover increases surface contact on objects and resists shear forces. Second, an automatic lock engages whenever tension is relaxed from the control line; the lock releases whenever the amputee places tension on the line[1] (Fig. 5). Third, a torsion spring closes the TD; since the spring and cover aid grip, a softer than usual spring may be used, but the measured pinch force is not an accurate indicator of the effectiveness of grip.

Mechanical features include a centre-pull control line; this precludes, at this time, fitting patients with very long stumps. There is a line inter-connector at the wrist; this eases line repairs for the prosthetist or patient and gives several fitting options. Also, the built-in wrist connector incorporates a quick-release feature and comes in two models; one allows retro-fit to an existing prosthesis. Additional information is available from the authors, and detailed illustrated fitting and maintenance procedures are provided with the terminal device.

Clinical evaluation of CAPP TD 2

Clinical trials have been organized to learn whether CAPP TD 2 meets its design objectives relative to function, acceptance and mechanical factors. Measurement variables are listed in Table 1. The protocol includes three evaluation sessions over a four-month period. Ten patients have completed the testing programme with

[1]The automatic lock is essentially a one-way clutch that prevents the terminal device from opening further when outside forces act on the "thumb". This keeps objects from dropping out, but it does not increase the measured pinch force. The amputee has no fear of locking onto an object with this system. The lock operates without any conscious action by the amputee as part of the voluntary opening control motion.

Fig. 4. A notch provides hooking action.

promising results. They range in age from 10 to 31 years. Seven are males and three are females. All have unilateral limb absence and are previous prosthesis wearers; seven wore CAPP TD 1 and three wore hooks. Clinical trials are continuing, but a brief descriptive summary of the preliminary findings may be useful.

Table 1. Dependent variables measured in the evaluation of CAPP TD 2

Factor	**Dependent Variable**
Function	Security of grip Versatility of object positioning Simplicity of operation Visibility of objects held
Acceptance	Acceptability of shape Cosmetic effect of continuity of line/colour
Durability	Reliability of structure and mechanism Convenience repair
Ease of fitting	Adaptability of installation to existing limbs Simplicity of assembly and line fitting

Appearance was acceptable to all of the patients; some teenagers were initially concerned about peer response, but reported positive comments such as, "It's like a space-age hand" or "It looks high tech". Size (same as adult hook) concerned some patients initially, but all of them adapted to this. Some patients said CAPP TD 2 was too heavy at first (240g or 8½ oz), and one patient objected to the limited choice of cover colours (only two standard colours are available). Nine of the ten patients chose to continue wearing CAPP TD 2 after the evaluation period.

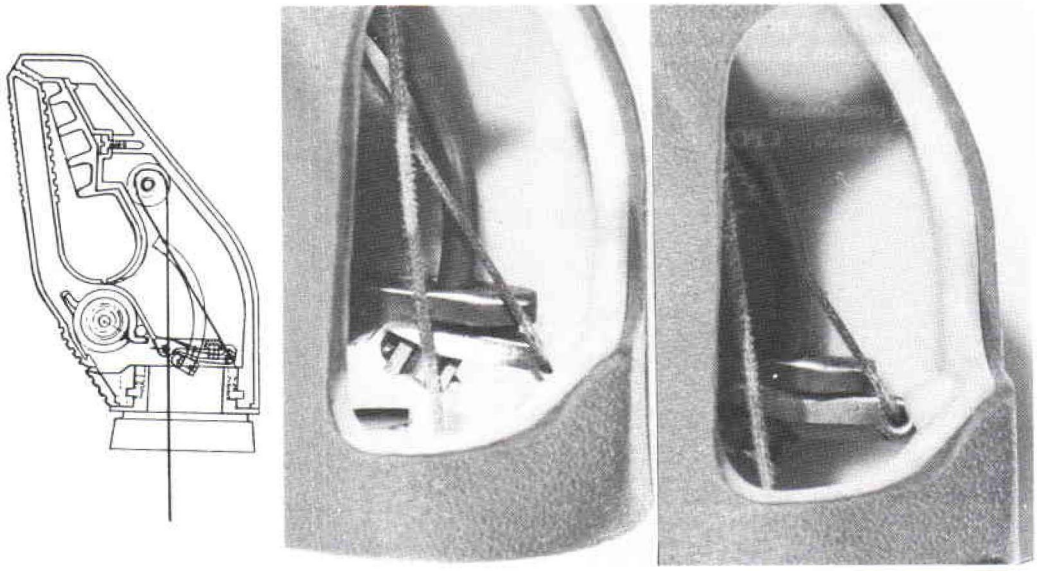

Fig. 5. The automatic lock. Left, lock and operating mechanism. Centre, lock is engaged when control line is slack. Right, lock is released when there is tension on the line.

Function was a positive factor for patients; all identified the lock as the most important benefit of the TD. Three patients needed to be reminded to relax cable tension during task performance or they would cancel out the locking feature. Patients could position and hold a wide variety of objects in the TD, but some needed instruction, or a period of trial and error, to become familiar with hold patterns of the new TD. Patients were able to perform work/office, dressing, homemaking, and recreational tasks. One patient reported difficulty seeing very tiny objects held in the TD.

Mechanical problems were rare. Incorrect line threading and accumulations of large amounts of dirt caused some problems and the wrist-lock release mechanism malfunctioned on two TDs. Urethane covers have worn well, clean easily, and are easily replaced when needed. Patients living a great distance from the testing centre are participating in the evaluation with remarkably little "down-time".

Future plans

Additional prototypes are available for patient evaluation; inquiries are invited.[2] Transfer to a manufacturer for production and marketing should occur within the coming year. Since many parts of CAPP TD 2 are made in moulds which were constructed during the development period, a prolonged development period for production should not be needed.

Summary and conclusions

Carl T. Sumida, CPO, designed and developed CAPP TD 2 as an alternative for adolescent and adult amputees, and to demonstrate some new concepts in prosthesis design. CAPP TD 2 is intended to offer secure grip on objects, easy operation, pleasing appearance and reliable service for general purpose applications. Preliminary evaluation results suggest that appearance and function features will meet objectives and that very few mechanical changes will be needed in the transition from testing to production. Additional information and/or prototypes for patient evaluation are available from the authors.

Acknowledgements

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The authors are indebted to Carl T. Sumida, CPO, who conceived the design and conducted the research and development work that resulted in the production of CAPP TD 2. Mr. Sumida died in September, 1985.

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[2]Requests for information on the evaluation programme of CAPP TD 2 should be sent to CAPP, Shriners Hospital for Crippled Children, 3160 Geneva Street, Los Angeles, Ca. 90020–1199, USA.

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Questionnaire assessment of patient satisfaction with lower limb orthoses from a district hospital

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Abstract

A questionnaire survey of patient satisfaction with the provision of lower limb orthoses from a district general hospital was conducted. Lower limb orthoses included "made-to-measure" footwear, knee braces and ankle-foot-orthoses (AFO's). Prescriptions for footwear and AFO's during a one year period, and knee braces over a two year period were assessed. The survey did not confine itself to a single medical condition. The level of patient dissatisfaction with the various orthoses was as follows: AFO's 16%, footwear 24%, knee braces 42%. This level of dissatisfaction amounts to considerable financial waste. Although several recommendations can be made on the basis of these results, this study highlights the need for more detailed audit and research into the prescription and provision of orthoses in order to reduce this wastage.

Introduction

There has been increasing awareness of the need for audit of medical practices. Surgical techniques and therapeutics are two subjects which receive close attention and are well researched. Conversely, the physical management of many rheumatic conditions is still poorly researched. One specific area which has received scant attention is that of orthotics. An official report on the Artificial Limb and Appliance Service in England and Wales in 1987 was critical of the organization and mentioned similar inadequacies in the provision of orthoses (Review of artificial limb and appliance services, 1986).

In view of the lack of basic information it was decided to conduct a simple study of patient satisfaction with a variety of orthoses prescribed for the lower limb from a district general hospital over a specified period of time. The orthoses chosen were made-to-measure footwear, ankle-foot orthoses and knee braces. Surgical footwear consitutes the "lion's share" of the Appliance Department budget and previous studies report levels of patient dissatisfaction varying from 17 to over 50 per cent (Bainbridge, 1979; Dixon and Franklin, 1968; Haslock and Wright, 1969; Park and Craxford, 1981; Klenermam and Hughes, 1986). There have been few reports of patient satisfaction with AFO's or knee braces (Butler et al, 1983; Jawad and Goodwill, 1986).

Methods

Information was obtained from Appliance Request forms (AOF1) held at a central Appliance Office for the district. Details were obtained of all patients receiving made-to-measure footwear and AFO's in a one year period (July 1983 to June 1984 inclusive), and for knee braces over a two year period (July 1983 to June 1985). In some instances the requests for footwear were for repeat prescriptions. Questionnaires were sent to all patients except those under 16 years of age.

The questionnaire sought information about delays in the provision of the orthosis and the number of times alterations had been necessary. Details about the appliance included its comfort, fit, cosmetic acceptability and frequency of wear. Patients were asked reasons for either continuing or stopping using the orthosis. Finally, a general question was asked about satisfaction with the orthosis and the service.

None of the patients had to pay anything towards the cost of the orthosis.

In view of the problem of under-reporting from questionnaire surveys a percentage of patients who were satisfied, and all the patients who were dissatisfied were invited to attend for a personal interview.

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Table 1. Return rates and details obtained from questionnaires

	MTM footwear	Knee braces	AFO's
No. of forms sent	291	136	98
No. of forms received	181 (62%)	78 (57%)	55 (56%)
No. of patients died or moved from district	46 (16%)	20 (15%)	21 (21%)
Details not specified on AOF1 forms			
Clinician's name	47 (24%)	30 (38%)	18 (27%)
Diagnosis	44 (24%)	27 (35%)	11 (16%)
Affected side	N.A.	25 (35%)	13 (24%)

Results

The return rate of completed questionnaires and the quality of information provided on the standard Appliance forms is shown in Table 1. Information was often inadequate with basic details such as the name of the referring clinician, patients' medical diagnosis and even the side of the affected limb frequently omitted. In some instances the writing on the form was illegible. Details about the presence of oedema or ulcers and sites of pain or tenderness were not mentioned in the majority of cases. Similarly, in virtually no instance was the aim of the appliance stated; for example whether the knee brace was primarily to afford stability or relieve pain.

This study did not confine itself to a single diagnostic group. The frequency with which each appliance was prescribed for different diagnostic groups (where known) is shown in Table 2.

Table 2. Medical diagnoses of patients provided with lower limb orthoses

Condition	MTM footwear	Knee braces	AFO's
Inflammatory arthritis	84	20	4
Osteoarthritis	19	17	6
Cerebrovascular accident	9	4	16
Lower motor neurone lesion	1	0	11
Trauma	0	7	2
Diabetes or ulceration	6	0	0
Miscellaneous	18	3	5
Not specified	44	27	11
Total	181	78	55

Table 3. Delay in provision of orthoses.

	MTM footwear	Knee braces	AFO's
Delay			
(mean wks.)	8	1	3.8
(range)	2–52	0–12	0–13
Alterations			
×0	85 (48%)	67 (86%)	40 (74%)
×1	45 (26%)	6 (8%)	12 (22%)
×2 or >2	45 (26%)	5 (6%)	2 (4%)
Not known	6	0	1

Delay in provision of orthoses

The delay in provision and frequency of alterations prior to the supply of the orthosis is shown in Table 3. Most of the knee braces and some of the "cosmetic" AFO's were "off-the-shelf" and hence incurred minimal delay in provision. This contrasted with the long delay of two to three months in providing made-to-measure footwear, the custom-made knee braces and some of the calipers.

Patient satisfaction with the three different orthoses will be dealt with separately.

Made-to-measure footwear

Patient satisfaction with made-to-measure footwear is shown in Table 4. Dissatisfaction with the footwear was expressed by 39 (21.7%) patients, 15 of whom were also dissatisfied with the delay in provision of the footwear. The total number of patients dissatisfied with some aspect of the provision of this type of orthosis was 43 (24%). The medical conditions of these dissatisfied patients is also shown.

Table 4. Patient satisfaction with made-to-measure footwear.

	Satisfied (%)	Not satisfied (%)
Provision of footwear*	160 (89)	19 (11)
MTM footwear*	141 (78)	39 (22)
Condition		
Inflammatory arthopathy	70	14 (17)
Osteoarthritis	8	11 (58)
CVA	6	3 (33)
Diabetes mellitus	5	1 (2)
Miscellaneous	17	1 (6)
Not specified	35	9 (19)

** One patient did not reply about satisfaction with the footwear and 2 patients did not comment about satisfaction with the providing service.*

Females constituted 18 of the 19 patients dissatisfied with the delay in provision of shoes and 35 of the 39 patients dissatisfied with the footwear. The ages of the 39 dissatisfied patients varied from 23 to 85 years and did not show any difference from the total group. There appeared to be a proportionately higher number of patients with osteoarthritis who were dissatisfied compared with patients with rheumatoid arthritis. Many of the patients who were dissatisfied had more than one criticism. There were also some patients who, although describing themselves as generally satisfied, nevertheless passed criticisms or made suggestions about ways to improve the footwear. The main criticisms were that the footwear did not fit (14), were too heavy or clumsy (16) and were cosmetically unacceptable (10). Seven patients complained that the footwear had rubbed sores or ulcers on the toes and foot, and a further six patients claimed that the footwear increased the discomfort in the foot and reduced their walking ability.

Other suggestions that were made included a request for a greater choice of styles, colours and types of material by making a wider selection of catalogues available. Another frequent comment was the lack of suitable footwear in the summer months, when the weight, bulk and colour of "winter" footwear became cosmetically unsuitable and uncomfortably hot.

The frequency of wear of made-to-measure footwear is shown in Table 5. The frequency of wear reflected the patient satisfaction with the footwear in the majority of cases but at least 10 patients continued to wear the footwear regularly i.e. for sometime every day, despite their dissatisfaction and having major criticisms. The reasons for this varied but in some cases patients could not obtain any alternative footwear.

Table 5. Frequency of wear of made-to-measure footwear.

Frequency of wear	*No. of patients*
Most of the time, every day	92
Every day, for some time	42
A few days every week	20
Rarely or never	24
Not specified	3

Personal interview

Ten patients who had expressed satisfaction with the made-to-measure footwear provided were seen. The interview did not uncover any new criticisms or problems. Most of the patients had such severe foot deformities that it was impossible for them to find ordinary "shop" shoes to fit. The provision of made-to-measure footwear had resulted in greater comfort and improved mobility. Eighteen of the 30 dissatisfied patients agreed to attend. It is impossible to draw any firm conclusions from such a small number but the interviews served to highlight some important points. First, for some patients the cosmetic appearance of shoes is more important than comfort. Second, some people are prescribed made-to-measure footwear unnecessarily. There were several instances of patients with hallux valgus and wide feet but no other toe deformities being provided with "surgical shoes" when simple advice about commercial shops stocking a range of wider fitting shoes would have been adequate and more appropriate. Third, although it was not the remit of this study to compare one contractor with another, there was an impression that considerable differences in quality of made-to-measure footwear did exist between firms. It is felt that this area needs to be investigated further.

Finally, patients described feeling very vulnerable and frustrated when they received unsatisfactory footwear. In several instances the footwear had been back and forwards for alterations so many times that the patient felt "pressurised" into accepting it even though it was clearly unsatisfactory. Complaints to the prescribing doctor tended to result in a resumption of the endless alterations. Two patients requested an independent referee to help identify the problem and suggest a solution. This is one of the areas where the employment of an independent orthotist might improve the service to patients.

Knee orthoses

The knee braces most commonly supplied were "off-the-shelf" type such as the simple hinged brace e.g. Cinch splint, or the Telescopic Varus/Valgus Splint (T.V.S.). Only 9 of the 78 patients had received specialized custom-made braces.

There was a high level of dissatisfaction with

Table 6. Patient satisfaction with knee braces.

Type of knee brace	*Satisfied (%)*	*Dissatisfied (%)*
Hinge e.g. Cinch splint	32 (57)	24 (43)
T.V.S.	6 (46)	7 (54)
Lennox-Hill	4 (80)	1 (20)
Swedish knee cage	1	0
Custom-made hinged brace	2	1
Total	45 (58)	33 (42)

knee braces as shown in Table 6. Patient dissatisfaction with the orthosis did not appear to be associated with medical diagnosis (where this was known).

The most common reasons for dissatisfaction and rejection of the brace were that it was heavy, cumbersome and cosmetically unacceptable. In many cases the brace tended to slip down and chafe the opposite knee. This criticism was also mentioned by patients who expressed themselves as satisfied with the splint. Other criticisms were the difficulty in applying the orthosis securely, especially in the presence of arthritis of the upper limb e.g. patients with rheumatoid arthritis. Personal interview with approximately 20% of the respondents did not identify any new problems. It did, however, highlight that virtually no patient was asked to return the brace if unsuitable, or attend themselves for the orthotist to check that it was satisfactory. Most patients signed to accept the brace before they had had a chance to give it a trial. Patients who were dissatisfied with the splint had usually decided not to wear it within the first two weeks. The frequency of wear of the knee brace usually mirrored the level of satisfaction. The exceptions to this observation were the four patients provided with Lennox-Hill splints for ligamentous injuries who only wore the orthosis during sport or vigorous activities i.e. only for a few hours each week.

An informal discussion with junior medical doctors working in the Department of Rheumatology revealed a patchy knowledge about knee braces. Some doctors were not aware of the range of different knee orthoses, their uses and limitations. Most doctors had had no formal education about orthoses and expressed a desire for more information on this topic.

Table 7. Patient satisfaction with ankle foot orthoses.

	Satisfied (%)	*Dissatisfied (%)*
Provision of AFO	52	3 (7)
AFO	46	9 (16)
Type of AFO		
"Cosmetic" AFO	18	4
Below-knee caliper	26	5
Not specified	2	0

Ankle foot orthoses

The types of AFO provided included 31 calipers and 22 "cosmetic" plastic drop foot splints. In two cases the type of AFO was not specified. Patient satisfaction with the AFO's is shown in Table 7.

Only three patients (7%) were dissatisfied with the delay in providing the AFO, and these three were included in the nine (16.4%) who were dissatisfied with the orthoses.

The medical diagnosis of the nine dissatisfied patients was as folllows: upper motor neurone lesions (3), lower motor neurone lesion (2), and inflammatory joint disease (1). The diagnosis was not specified in three of the nine.

The commonest criticism was that the caliper was heavy and cosmetically unacceptable, or that it failed to improve mobility. The "cosmetic" AFO's were criticized for not fitting into the shoe or for being poorly moulded to the foot.

Discussion

There has been little research of patient satisfaction with various orthoses or into standards of provision of orthoses from different manufacturers. Several studies on patient satisfaction with made-to-measure footwear have been reported usually assessing a single diagnostic group such as rheumatoid arthritis, but there is very limited audit of knee braces or AFO's.

The cost of made-to-measure footwear constitutes the greater part of the general orthosis budget. It has been estimated that the cost of "surgical" shoes to the National Health Service in Britain is over £12 million each year. (Klenerman and Hughes, 1986). For many patients the provision of specialized footwear is essential. It can improve the comfort of the foot and prevent a deformed foot from developing pressure sores. Consequently, against the initial high cost of providing footwear should be set

the long durability of such shoes and the reduced patient morbidity.

The Department of Health studied the problem of the provision of footwear in the U.K. for the whole range of medical conditions in 1978 (Bainbridge, 1979). Dissatisfaction with the orthotics service varied from 13% as a result of delays in provision, to 35% due to a criticism about insufficient pairs of shoes. Most of the other reports looking at this subject have studied a single diagnostic group, usually patients with rheumatoid arthritis. Dixon and Franklin in 1968 found over 50% of 70 patients with RA to be dissatisfied with their footwear. Haslock and Wright (1969) however, found the level of dissatisfaction to be lower at 17.5% of 90 patients with RA. A further study by Park and Craxford (1981) found that over 90% patients of 71 RA patients experienced relief from foot symptoms but that 50% had some criticism. A recent report by Klenerman and Hughes (1986) looked at patient satisfaction with "ready-made" extra depth shoes and made-to-measure shoes. Direct comparison between the shoes is difficult because of selection bias. Ready-made shoes reduce the long delay in supply, but do not appear to provide greater comfort than MTM shoes and are not worn as frequently.

There have been few studies which looked at knee braces. A review by Butler et al (1983) suggested that approximately 50% of knee braces are rejected within the first 2 weeks, but failed to specify how this result had been obtained. The review dealt with the mechanical problem of knee braces and analysed a selection of those most frequently prescribed. Their general conclusion was that apart from the full length knee-ankle-foot orthosis, the short "arm" knee braces provide little benefit in mechanical terms.

Jawad and Goodwill (1986) reported the use of the T.V.S. brace in 31 patients, 18 had osteoarthritis (OA) and 13 had rheumatoid arthritis (RA). All patients had varus or valgus deformity. The brace helped to reduce pain on weight bearing in 78% of the OA patients but only 38% RA patients. The T.V.S. brace was not helpful in patients who had significant rest pain, or whose knees were grossly swollen or unstable.

The study reported here set out to assess the level of patient satisfaction with selected lower limb orthoses provided in a District Hospital. There are many difficulties and limitations in the type of study described here. Firstly, the questionnaire allows large numbers of people to be assessed but the quality of information is limited by the poor return, or inadequate completion of the forms. In particular, in this survey it was designed to leave at least 12 months after the prescription of the orthosis before issuing a questionnaire to give the patient adequate time for assessment. The consequence was that questionnaires were often sent 2 to 3 years after prescription of an orthosis by which time a significant number of patients had either moved home or died. It has not been possible to trace any of the non-responders. They did not appear to differ significantly from the responders with regard to age, sex or medical diagnosis. Another problem is the under-reporting of complaints on a questionnaire form, although the personal interview did not uncover any new criticisms.

The prescription and subsequent patient satisfaction of an orthosis depends on many factors. Firstly, the clinician has responsibility for assessing the patient's medical problem and prescribing the correct appliance. Secondly, the orthotist must fit the patient with either an "off-the-shelf " orthosis or take accurate measurements for a "custom-made" orthosis. Thirdly, the orthosis must be manufactured, usually at a site distant from the hospital by other workers relying on the specifications provided by the orthotist. The distance of the factory from the hospital has a direct effect on the time taken to provide the orthosis. Finally, satisfaction will depend on the patient's perception and ability to accept the orthosis.

This study was designed to report the level of patient dissatisfaction and detail specific complaints. It did not set out to analyse the reasons for dissatisfaction or apportion "blame" for the failure of an appliance, nor did it aim to compare performance of different manufacturers.

Most prescriptions were issued by the departments of Orthopaedics, Rehabilitation and Rheumatology. It was found that the orthotist was often given inadequate information on the AOF1 request form about the patient's medical condition and relevant associated disabilities. The writing on many forms was illegible or failed to mention essential details such as patient's age, hospital number,

referring consultant and side of the affected limb. The aim of the orthosis was rarely mentioned. The type of knee brace or AFO required was rarely specified and in such cases there was insufficient information on the form to assist the orthotist determine the appropriate orthosis. It is recognised that in some cases an orthotist will have been attending the clinic and have communicated directly with the prescribing doctor, but nevertheless, this is not a frequent event. An informal discussion with "junior" doctors suggested that they are not given any formal training about prosthetics or orthotics and are frequently not aware of the types of orthoses available or of their indications or limiting factors.

This survey found levels of patient dissatisfaction with the delay in providing orthoses ranging from 2% for knee braces, 7% for AFO's, and 11% for made-to-measure footwear. Patient dissatisfaction with the actual orthosis ranged from 16.4% for AFO's, 21.5% for made-to-measure footwear to 42% for knee braces.

In the patients dissatisfied with footwear there was a higher proportion of females and patients suffering from osteoarthritis than in the total group but no difference in the mean ages. There was no significant difference in sex, age or medical diagnosis between satisfied and dissatisfied patients provided with either knee braces or AFO's.

This level of dissatisfaction represents a considerable financial waste. For example a pair of made-to-measure footwear costs between £220 and £300, not including the cost of extra items such as wedges, raises or insoles.

Recommendations

On the basis of this and previous studies the following guidelines are recommended to cover the provision of lower limb orthoses:

1. Medical information given to the orthotist by the clinician must include the diagnosis and the aim of the orthosis.
2. Junior medical staff should be trained in the provision of orthoses before being allowed to issue prescriptions. The clinician should assess the orthosis and check that it is acceptable to the patient before payment is made to the supplying firm.
3. Patients should be given more information about the orthosis. This is especially important with regard to the appearance of made-to-measure footwear. Greater choice of styles, colour and materials for footwear should be made available. More effort should be made to identify the patients who will refuse to wear MTM shoes on cosmetic grounds *before* embarking on manufacture.
4. A statutory two-week period for non-custom-made knee braces should be negotiated with suppliers to give time for full assessment by the patient. No payment should be made until all modifications are complete.
5. A more detailed and extensive study of patient satisfaction with non-custom-made knee braces is urgently required with a view to improving clinical practice and the design and manufacture of such orthoses.
6. A controlled study to compare patient satisfaction with the service and orthosis provided by different orthotic contractors would be useful. Such a study would require random allocation of patients with the same medical condition by a single prescriber to different firms followed by a "blind" assessment.
7. The appointment of a hospital orthotist whose principal loyalty is to the patient rather than the manufacturer should be considered in all Health Districts.

Conclusions

This study has identified an unacceptably high level of patient dissatisfaction with lower limb orthoses supplied over a one year period (or two years in the case of knee braces) within the Southampton district. This dissatisfaction with orthoses, including dissatisfaction with delays in their provision, varies from 16% for AFO's, 24% for made-to-measure footwear to 42% for knee braces. This represents a considerable waste of resources. The greatest financial loss occurs with footwear due to its much higher unit cost compared to "off-the-shelf" knee braces. A number of simple administrative procedures would avoid some of the problems and more careful audit would enable the other problems to be addressed.

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Use of the Femurett adjustable prosthesis in the assessment and walking training of new above-knee amputees

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Abstract

The Lic Femurett(Tm)[1] adjustable training prosthesis was evaluated on 51 above-knee amputees attending the Oxford Disablement Services Centre. In the elderly it proved superior to the Pneumatic Post-Amputation Mobility Aid (P.P.A.M.-Aid)(TM)[2] in the assessment of their ability to use a prosthesis, and is useful for walking training once the stump is fully healed; it does not replace the P.P.A.M-Aid at the early post-operative stage.

Object

The purpose of the study was to evaluate the Femurett adjustable training prosthesis for above-knee amputees, and to compare its use and role with that of the Pneumatic Post-Amputation Mobility Aid.

Introduction

A recent study showed that less than 30% of elderly dysvascular above-knee amputees were regularly walking with a prosthesis two years after amputation. (Sethia et al, 1986). There is therefore a need for thorough assessment before supplying a prosthesis. A physical examination is often not sufficient and some new amputees have unrealistic expectations. A multi-use early walking aid should save a prosthesis having to be made on a 'try it and see' basis. The P.P.A.M.-Aid, as described by Redhead (1983), is very useful for below-knee amputees, but it does have limitations in the accurate assessment of above-knee amputees. The Femurett can be used on above-knee, through knee and Gritti Stokes levels of amputation. It is manufactured by Lic Orthopaedi (Sweden) and is available in the United Kingdom from R. Taylor and Son (Orthopaedic) Ltd. of Walsall. It is a multi-use adjustable pylon which, like the P.P.A.M.-Aid, is used in the hospital environment and is *not* issued to individual patients for use at home. It consists (Fig. 1) of a neutral uniaxial ankle and foot, a tubular lower leg section adjustable for

Fig. 1. Femurett prothesis showing adjustable components.

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[1]The Femurett is manufactured by Lic Orthopaedi, S–171 83 Solna, Sweden, and distributed in England by R. Taylor & Son (Orthopaedic) Ltd., Compton Works, 49 Woodwards Road, Pleck Walsall, WS2 9RN.

[2]The Pneumatic Post–Amputation Mobility Aid is manufactured by Vessa Ltd., Paper Mill Lane, Alton, Hampshire, GU34 2PY, England.

length and toe out, a single axis knee joint with extension spring and lock, a thigh section adjustable for length and rotation and different sizes of adjustable (laminated plastic quadrilateral) sockets which are readily interchangeable. The sockets are available in three sizes: small, medium and large and in left and right fittings; a simple adjustment permits the correct amount of socket ab– or adduction. It is not possible to adjust the 5° of socket flexion. All the adjustments are made using one Allen key. For the purpose of this study, it was decided only to purchase the small and medium sized sockets as the measurements of the large sockets seemed abnormally large. A single shoulder strap, attached to the socket, is the only suspension (Fig. 2).

Method

All the patients who used the Femurett in the first two years after it was acquired by the Oxford Disablement Services Centre (previously Artificial Limb and Appliance Centre) were included in the study. The majority of these had used a P.P.A.M.-Aid in the early post-operative period before their first visit to the Limb Fitting Centre. After examination by the Medical Officer the patients were introduced to the Physiotherapist who then fitted the Femurett between parallel bars. The patients who used the Femurett fell into two categories: those who needed further pre-prosthetic assessment because their ability to cope with an artificial limb was in doubt, and those who were waiting for supply of their first prosthesis and whose stump was sufficiently healed to start walking training with a rigid socket. For patients in the assessment category, their ability to walk between parallel bars, under instruction, was tested (along with comprehension, balance, ability to transfer and exercise tolerance). For those in the walking training category, a programme of training was given similar to that employed for patients starting with a conventional temporary prosthesis. The effect on the duration of rehabilitation until safe independent ambulation was achieved was noted. Patients were reviewed six months later.

Fig. 2. The prothesis in use.

Results

Fifty-one patients were studied. These were 32 men and 19 women. The age range was from 19 to 89, all but 3 were between 50 and 89 years. The Femurett was used by 47 patients for pre-prosthetic assessment; of these, 34 were considered able to benefit from a prosthesis and were measured for limbs. Thirteen were not initially considered able to benefit from a prosthesis, but three of these were successfully fitted at a later date. Of the 37 measured, 33 were successfully using a prosthesis six months later. A total of 13 patients used the Femurett for walking training.

For three patients the fit of the Femurett was not satisfactory, but in two of these the fit was still sufficient to assess ability. In two cases the Femurett was not short enough (the shortest length from ischium to floor is 0.67m). The other misfit was due to the stump being too large for the medium size socket so in this case it would have been useful to have the large socket available.

Subjectively, all the patients who had previously used the P.P.A.M.-Aid commented on how light the Femurett felt. The presence of a foot was of psychological benefit in terms of

appearance, as well as assisting in balance. The comfort of the socket was preferred to that of the P.P.A.M.-Aid by most patients due to greater rigidity and security. On one occasion the ischial seat was too uncomfortable but padding with Plastazote relieved this.

The rigid socket greatly improved stability, especially for those with short above-knee stumps, thus giving a clearer picture of the patient's walking potential than the P.P.A.M.-Aid, which can be misleading when the stump is not well contained in the inflated bag. Because the Femurett has a foot, the amputees' balance could be assessed more accurately. For the Gritti Stokes amputation level the Femurett did not provide any end-bearing, but the open ended socket allowed for the extra length as did the posteriorly placed knee joint. The application of the Femurett, including the necessary adjustments, did not take long, and with practice the whole assessment was completed in approximately 15 minutes. The fit and function of the Femurett being similar to that of a prosthesis, it gave patients a more realistic impression of what a prosthesis would be like than the P.P.A.M.-Aid, and made the initial practice on the first custom-made prosthesis easier, but did not speed the overall walking training in the elderly. The younger patients who used the Femurett purely for walking training, were all able to progress from parallel bars to sticks, resulting in a speedier transition to independence. For the majority of patients it was possible to adjust the chosen socket to provide an adequate fit with one wool sock, but in the others either an extra sock, or a folded stump sock placed anteriorly in the socket was required to locate the ischial tuberosity accurately on the seating. The lack of adjustment for socket flexion was not detrimental to alignment in the patients studied, due mainly to the flexibility of the uniaxial ankle. However, the Femurett would not be suitable for patients with fixed flexion of more than 30° at the hip.

The single shoulder strap was not adequate as the only means of suspension, and a second 'yoke' strap looped round the shoulder strap and placed around the chest wall assisted in keeping the shoulder strap in place. The knee flexion, available by pulling the unlocking lever, enabled the patients to sit down while wearing the Femurett. The extension spring, which enabled an easy locking movement when standing from sitting, proved too strong to enable the patients to walk with a free knee (although in most of these patients this was not an objective). The P.P.A.M.-Aid was more effective in reducing stump oedema, and more comfortable and less traumatic for stumps which were still tender and not fully healed.

Conclusion

The hard socket and positive ischial seating are important factors in the timing of the use of the Femurett; the stump must be fully healed before the socket can be safely applied. The P.P.A.M.-Aid remains the walking aid of choice in the early post-operative stage and provides better control of oedema. Once the stump is healed, the Femurett proved superior; it is a valuable aid in assessing an above–knee amputee's ability to walk with a prosthesis, and more closely reflects the properties of a custom-made prosthesis than the P.P.A.M.-Aid. It is also a useful walking aid while the patient is waiting for delivery of his own prosthesis.

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Development of a universal wheelchair narrower

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Abstract

A wheelchair user's mobility may be hampered by narrow doorways and restricted turning spaces. Mobility may be improved by undertaking expensive building alterations in the wheelchair user's own home and work environment. However, other environments, including modes of public transport, may still present considerable difficulties.

One way of improving mobility is to reduce the overall width of a wheelchair with the occupant still seated within it. This is achieved by using a clamp, known as a "wheelchair narrower" which can be fitted and operated either by the wheelchair user or an attendant. The narrower takes advantage of the inherent design of a wheelchair which permits folding for storage.

A universal wheelchair narrower was manufactured and tested at Tayside Rehabilitation Engineering Services. It was designed to be used on 69% of wheelchairs issued through the National Health Service in Scotland. Tests revealed that wheelchairs could be narrowed by between 38 and 127 mm depending upon the type of wheelchair. Active wheelchair users reported that the device was particularly useful when travelling.

Introduction

The architecture of the environment is generally not suitable for wheelchair users. Mobility is frequently hampered by narrow doors and corridors through which wheelchairs cannot manoeuvre.

A typical house builder in Scotland uses two sizes of doorway based on British Standard doors of widths 726 and 826 mm, the former being more common. After allowing for fitting tolerances and after deducting the thicknesses of the door-stop plate and the doors themselves when in the fully open position, the clearances are about 685 and 785 mm, respectively. The Scottish Housing Handbook Bulletin Number 3 advises home architects to allow for a wheelchair width of 635 mm. The majority of wheelchairs issued in the U.K. have widths less than this specification (Table 1) and therefore no difficulties should be expected. In practice, however, access can still be impeded by obstacles in the path of travel and by restricted turning spaces. Moreover, the overall width of bathroom doors in some modern houses can be 635 mm and toilet areas in particular can be very restricted. Expensive building alterations may be necessary to adapt a wheelchair user's home for his or her use and these may in some cases delay discharge from hospital. Mobility problems may still arise when visiting other homes and when using modes of public transportation such as ferries, trains and aeroplanes.

One method of improving mobility is to reduce the overall width of a wheelchair by taking advantage of its inherent design which permits folding for storage. This can be achieved by using a clamp, known as a "wheelchair narrower", which can be fitted and operated either by the wheelchair user or an attendant. The clamp draws the seat frame towards the armrest, tending to fold the chair with the occupant still seated in it, thus narrowing its overall width. Such clamps are available on a limited scale commercially but it appeared that a universal clamp which fitted the principal adult chairs issued through the United Kingdom National Health Service did not exist.

There are approximately 5,000 wheelchairs issued annually in Scotland (population about

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5.5 million) and 21,000 are currently in use; 69% of these comprise the U.K. Department of Health and Social Security models 8BL and 8L (both self-propelled), 9L (attendant propelled) and the Everest and Jennings self-propelled and attendant propelled wheelchairs. It was decided to develop a wheelchair narrower which could be fitted to these wheelchairs thereby improving accessibility. The criteria which were applied to its development were;

a) the narrower should be capable of fitting to the 8BL, 8L, 9L and the Everest and Jennings wheelchairs
b) no modifications should be made to the wheelchairs themselves
c) active wheelchair users should be able to apply and operate the narrowers easily without assistance
d) the narrowers should be robust and reliable
e) they should be cheap and easy to manufacture.

Method

It was found that the overall widths of used wheelchairs which had been returned to stock, marginally differed from the specified widths given in Department of Health and Social Security's specifications (Table 1). The principal reason for this was wear in joints and hinges. Accordingly, the narrower was designed to fit a sample used stock.

A wheelchair narrower was designed and manufactured. It comprises two hollow cylindrical tubes which telescope together. The small diameter tube has a threaded insert welded at one end and a hardened steel hook at the other. The curve of the hook matches the 19 mm diameter steel tube used in the construction of the seat chassis. The large diameter tube has a flat steel plate brazed onto its side and a brass bush is pressed into the top end. The end of the steel plate is shaped so that it will hook over the armrest. The plate is also reinforced with a strut to prevent bending when loaded. A length of M8 studding is inserted through the brass bush to engage with the threaded nut in the small diameter tube. The upper end of the studding is attached to a small lever, on the end of which is a plastic handwheel. When the lever is turned, the two tubes telescope together through a total distance of 70 mm. Thus the unit functions by drawing together the armrest and seat (Fig. 1).

Tests were performed on each of the differing types of wheelchair. The overall maximum widths of the chairs before and after using the narrower were recorded (Table 1).

The required structural strength of the narrower was determined by inserting a modified load cell between the narrower and a wheelchair armrest. The clamping force required to collapse a chair with a 70 kg occupant was recorded whilst the narrower was used on various surfaces. Tests were performed on an 8L chair with partially deflated tyres. The clamp was then loaded to destruction in a tensile testing machine and the load at failure compared with the recorded functional tests.

Twelve further prototypes were constructed and ten active home-based wheelchair users

Table 1. The reduction in overall wheelchair width which can be achieved with the use of the wheelchair narrower when it is shortened by 70 mm. Actual narrowing may be limited in practice by the width of the wheelchair occupant's pelvis which restricts the drawing together of the seat supports

Chair type	Wheelchair narrower proving test. Specified and measured distances between outer edges of wheelchair wheels							
	DHSS specification		Measured fully open		Measured fully clamped		Narrowing achieved	
	mm	in	mm	in	mm	in	mm	in
8BL small adult self-propelled	584	23.00	578	22.75	540	21.25	38	1.50
8L standard adult self-propelled	629	24.75	629	24.75	578	22.75	51	2.00
9L attendant propelled	660	26.00	641	25.25	572	22.50	69	2.75
Everest and Jennings self-propelled junior	648	25.50	705	27.75	578	22.75	127	5.00

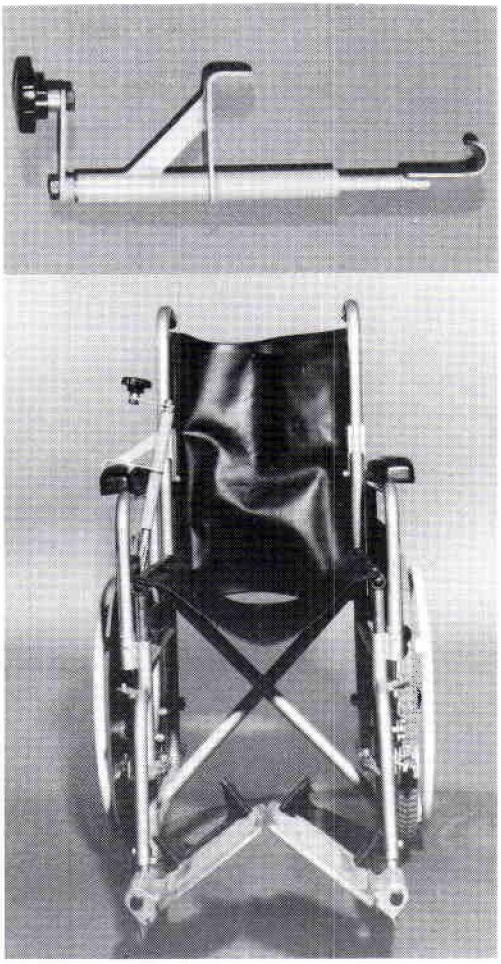

Fig. 1. Top, the wheelchair narrower. Bottom, the narrower fitted to a standard self-propelled wheelchair.

were supplied with the clamp. The users were asked to use it as often as possible for six months and then complete a questionnaire.

Results

It was found that the chairs could be narrowed by between 38 and 127 mm depending upon the type of chair (Table 1). In practice however, the limitation in the extent of narrowing occurs when the two tubular steel frames which support the canvass seat compress the pelvis of the wheelchair occupant.

Table 2. Maximum force recorded: 1,000 Newtons

Force required between wheelchair armrest and main chassis to clamp an 8L wheelchair on a variety of surfaces (test performed with occupant weighing 70 kg-average of three readings)

Surface	Clamping force Newtons
Rough tarmac	834
Coir mat	800
Thin pile carpet	784
Linoleum	684
Smooth concrete slope inclined 15° (left to right)	616
Gravel	600

The forces exerted between the clamping points ranged between 550 Newtons and 1,000 Newtons. Rough tarmac and coir matting were found to require the greatest force and gravel the least (Table 2). The destructive test performed upon the clamp resulted in failure at a tensile force of 2,600 Newtons, giving a safety factor of 2.6.

The patient trial revealed two specific points. The device fulfilled its purpose and it was so successful that the narrowers were not returned to the Centre, the users wishing to retain them.

Discussion

The clamp has been shown to fulfil its design purpose and has been successfully used by wheelchair users. The narrower provides wheelchair users greater mobility in their homes. Active users found the device useful when travelling. Bathroom doors are frequently found to be insufficiently wide and the narrower enabled easier entry.

Ferry, train and aircraft cabin doors and corridors have similarly been found to be accessible with the device which gives wheelchair users more confidence when travelling.

Conclusion

A wheelchair narrower has been designed to fit 69% of U.K. Ministry issue wheelchairs. The device can be operated by both the occupant or an attendant. Further details of the device can be obtained from Tayside Rehabilitation Engineering Services.

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Measurements of pressure on the sole of the foot in plaster of Paris casts on the lower leg

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Abstract

Pressure on the sole of the foot inside three different types of plaster cast, used in treatment of fracture of the lower leg, was measured on six normal persons. No significant difference was found between these pressures in below-knee plaster, full length plaster including the thigh and patellar-tendon-bearing plaster. Only occasionally a relief in pressure was found in patellar-tendon-bearing plasters.

Introduction

Patellar-tendon-bearing (PTB) plaster of Paris cast is often used in the treatment of fracture of the lower leg. From experience gained with the PTB prosthesis it may be assumed that this type of cast is able to transmit considerable axial forces from the knee region onto the cast. Correspondingly a considerable relief of force on the fracture might be assumed.

To test this assumption, measurements were made of pressure between the foot and four types of casts. The four plaster cast types were: a full length plaster including the thigh (FC), a below-knee plaster (BC), a patellar-tendon-bearing plaster (PTB) and a below-ankle plaster — which has no clinical use — (TC).

For this purpose a simple and inexpensive pressure transducer was developed.

Material and method

Six volunteers were studied, aged twenty to forty, and without disease in the motor system.

By means of an instrumented treadmill, continuous measurements of the foot-to-ground reaction forces could be obtained. The treadmill consisted of two conveyor bands, one for each foot, driven by hydraulic motors and suspended by transducers, making it possible to obtain recordings of the foot-to-ground reaction forces in three directions. Vertical, saggital and transverse force components for each foot were recorded on an analogue tape recorder (Lyrec TR86).

The analogue signals were sent through an A/D converter and processed by an IBM-AT computer, yielding curves of the ground reaction forces describing the average walking cycle.

Two minutes of continuous walking were recorded at each trial, at a constant walking speed of 2 km/h (0.56 m/s). The sampling frequency was 33 Hz (Jansen 1974, Jansen et al. 1982).

The casts FC, BC and PTB were applied as described below. A home-made transducer, shaped as a sole, was installed inside the cast in order to obtain measurements of the pressure applied by the foot onto the sole of the cast. The signals from the sole-transducer were sent through the same recording and computing equipment as mentioned above and recorded simultaneously with the foot-to-ground reaction forces. Continuous curves of the pressure applied to the sole during a walking cycle were

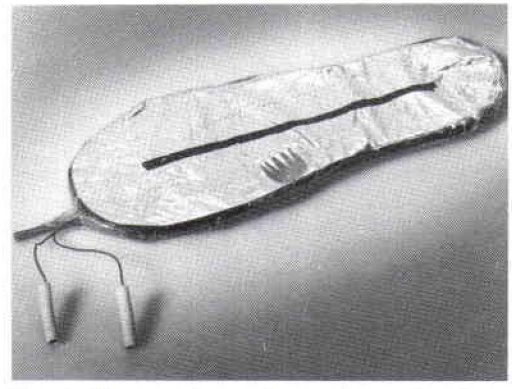

Fig. 1. The transducer-sole consisting of a foot-shaped piece of conductive foam wrapped in aluminium foil.

All correspondence to be addressed to Dr. K. Lauridsen, Department of Orthopaedic Surgery T, Herlev Hospital, DK–2730, Herlev, Denmark.

obtained. The transducer-sole consisted of foot-shaped piece of conductive foam (Conductive Insertion Foam, 3M Company, USA). The material is usually used to wrap sensitive electronic components. The transducer-sole was covered with equally shaped aluminium foil electrodes on both sides. An adhesive plastic wrapping protected the electrodes and foam from moisture (Fig. 1).

The electrical resistance across the foam decreased with increasing compression; thus the sole acted as a resistive transducer.

No zero-level drift could be detected during each test. The relation between the foot-sole pressure and the ground-reaction force was found to be linear (regression coefficient > 0.9 determined at pilot trials). A new sole was used for each subject.

Since the study was designed to compare paired data (each test person was tested with all four types of casts used) no attempts were made to produce exact calibration curves for the transducer-soles used. The values of pressure monitored from within the casts were thus indicated in comparable arbitrary units. Increasing pressure yielded decreasing values (derived from the decreasing resistance of the sole).

Maximum pressure was read from the gait curves at the point of mid-stance. This was defined as the point at which the antero-posterior force shifted from negative to positive values. Gait curves representing two minutes of gait were searched for maximum value at each trial.

Friedman's test was used to compare the slopes of the regression lines at a significance level of $p < 0.05$.

Procedure

All four gait tests for each person followed a common scheme. After 2 minutes of adaption to treadmill walking the following 3 minutes of gait were recorded. The speed of gait was 2.0 km/h (0.56 m/s).

First an FC was applied on the right leg of the test person with the transducer-sole interposed between the foot-sole and the cast. A rocker was mounted on the FC and a wooden shoe of convenient height was worn on the left foot. In the second test the cast was cut down to a BC and new measurements performed. In the third test the BC was remodelled to a PTB cast (Fig. 2) and in the fourth the cast was cut down to below ankle level ("tennis-shoe cast") to obtain measurements from the sole and the treadmill when all axial force from the right leg was transmitted through the sole. The casts and the modifications were all made by the same expert orthotist.

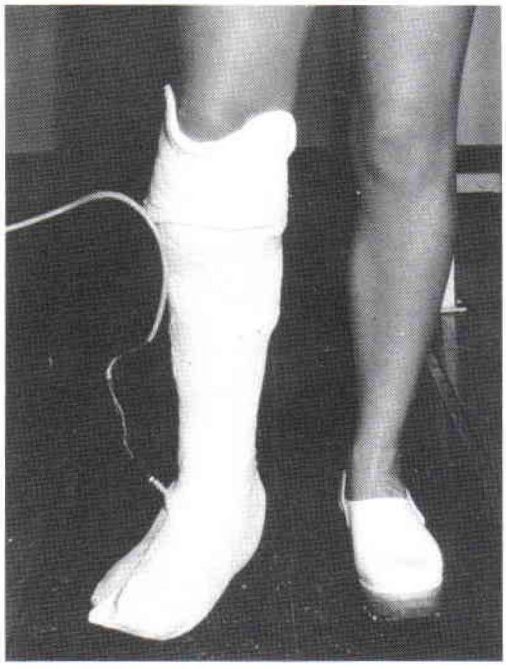

Fig. 2. One of the volunteers with PTB plaster of Paris cast on the treadmill during measurement.

Results

Graphs of measurements from the transducer-sole, indicated in volts versus vertical force (Newtons) measured during treadmill walking are presented in Figure 3. Regression lines are superimposed. Table 1 shows the maximum sole/cast pressure values read from the gait

Table 1. Maximum force in mid-stance phase, listed in arbitrary units.

Subject	FC	BC	PTB	TC
A	43.0	51.7	84.6	35.9
B	55.6	53.1	50.8	42.3
C	38.3	26.5	44.8	39.3
D	32.3	33.1	38.6	44.5
E	38.9	48.7	111.9	46.8
F	33.9	45.2	48.6	58.1

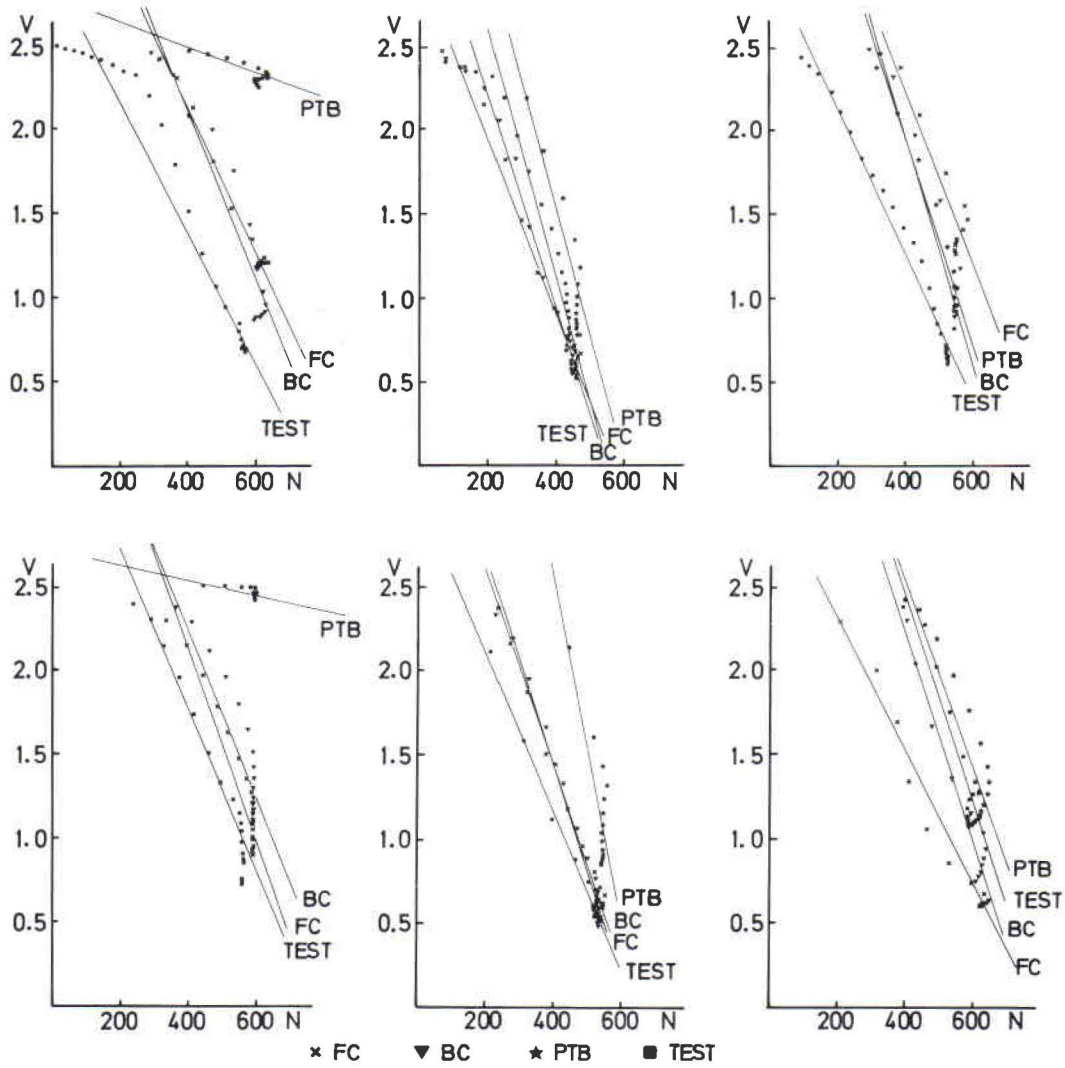

Fig. 3. Graphs of measurements from the transducer-sole, indicated in volts versus vertical force (Newtons), measured during treadmill walking by the six persons investigated with four types of cast.

curves (numeric values were listed on print). Note that increased pressure is indicated by decreased arbitrary units.

Only in two cases is there an obvious relief of pressure on the sole of the foot related to the use of PTB plaster of Paris. The FC did not seem to offer any significant relief in pressure compared to the BC or the "tennis-shoe cast".

No significant difference was found between the slopes of the regression lines from the four types of cast used ($p > 0.05$).

Discussion

One might think that the FC could relieve some of the axial load from the lower leg, as the muscles of the thigh might act as a plug in the cone-shaped plaster, thus preventing sliding movements of the leg within the cast and some transmission of axial forces. This did not seem to be the case, despite the fact that three of the volunteers had very well developed thigh muscles.

A plaster should protect the fracture site from bending and rotary movements. The bending movements should not be difficult to prevent but rotary stability might be more complicated to ensure. It is not known whether

the PTB cast offers as much rotary stability as the FC does.

A certain amount of compression of the fracture site might have a beneficial effect on fracture healing. Letting a patient walk with one of the above-mentioned casts, compression seems to be unavoidable. If one wishes to take some load off the lower leg, achieving this appears to be a matter of chance when using a PTB cast.

REFERENCES

JANSEN, E. (1974). Computer analysis of gait — preliminary report. Proceedings of the combined meeting of the Danish and Dutch Orthopaedic Associations. Edited by Biermans, A.R.M. et al. Nijmegen: D.D.O.A. pp. 85-87.

JANSEN, E. C., VITTAS, D., HELLBERG, S. & HANSEN, J. (1982). Normal gait of young and old men and women: ground reaction force measurements on a treadmill. *Acta Orthop Scand* **53,** 193-196.

Prosthetics and Orthotics International, 1989, 13, 46–47

International Newsletter

Worldwide, ISPO members involve themselves in a myriad of scientific, educational, and service-oriented pursuits. Very often, the national member society is the vehicle for these endeavours. Because the happenings in one country are likely to inspire similar undertakings elsewhere, organizers of professional meetings should share programmes with the Newsletter Editor, Joan Edelstein, New York University, 317 East 34th Street, New York, NY 10016, United States, In addition, achievements of individual members, such as books and journal articles published, honours awarded, and recent appointments, are important news items.

Thailand National Member Society members presented two training courses in myoelectric arm prostheses and above-knee modular prostheses, the first at the Pramong-Kutklao Army Hospital, and the second at Siriraj Hospital. In October, a five-day conference was devoted to Asian/European exchange of experience in orthopaedic technology, sponsored by the War Veterans Organization of Thailand. The International Conference on Accidents and Injuries of the Musculoskeletal System in the Work Place was held in Bangkok. Bangpoon, Pratumthane, and Chiengmai Universities were host to a training course in prostheses and orthoses presented by the Industrial Rehabilitation Centre of Japan. Thamrongrat Keokarn, MD, announced that three programmes pertaining to the development of orthotic technology are planned for 1989 at Lerdsin Hospital and two other sites, as well as another training course in prostheses and orthoses by the Industrial Rehabilitation Center of Japan.

United Kingdom National Member Society Honorary Secretary, R. G. S. Platts, MD, reported that the Annual Scientific Meeting held in York University was highly successful. Speakers discussed the causes of congenital abnormalities, facial prostheses, bone resorption, and implanted neurological stimulators. A new category of free paper, Clinical Notes, was well received; participants offered five-minute papers providing anecdotes on techniques and problem case solutions. The format was repeated at the Bath University scientific meeting which featured special topic sessions on above-knee prosthetics, orthoses for paraplegics, mobility for the disabled, and clinical gait analysis. Invited speakers also covered rehabilitation services, limb salvage, and the reorganization of the artificial limb service. Following the McColl Report, the government established a special Health Authority to assume administration of the Artificial Limb and Appliance Centres in England, Wales, and Northern Ireland and oversee their transfer to the National Health Service by 1991. The government also instituted a study of the orthotic service in the National Health Service. ISPO co-sponsored an international conference on wheelchairs and special seating in Dundee and an interdisciplinary symposium on the biomechanics and orthotic management of the foot. Congratulations are extended to Colin Peacock, recently elected to Fellowship of ISPO.

Japan was host to the 16th World Congress of Rehabilitation International in September 1988. ISPO President John Hughes addressed the plenary session on "Technology Creating New Realities." ISPO was also represented by President-Elect Willem Eisma who was the chairman for the session, "Changes in Prosthetics and Orthotics with Regard to New Technology." John Hughes (Scotland), Valma Angliss (Australia), M. K. Goel (India), and Hideo Watanabe, Eiji Tazawa, and Seishi Sawamura (Japan) participated. The Japan National Member Society displayed a poster exhibition of ISPO activities.

Approximately a thousand members attended the annual meeting of the Japanese Association of Prosthetics and Orthotics, where 250 papers were presented. President Hideo Watanabe organized a special exhibition of prostheses and orthoses originated in Japan.

Seishi Sawamura, Secretary of the Japan National Society, reported on the enthusiastic cooperation of all ISPO national member societies and the International Congress Committee with regard to the VI World Congress of ISPO in Kobe, November 12–17. The local organizer is now contacting the coordinators of each session and the organizers of the instructional courses. Every ISPO member will receive a complete announcement of the Congress, containing detailed information about the scientific programme, social events, hotel accommodations, and transportation. The Congress will be a successful scientific meeting in a warm, hospitable atmosphere.

Netherlands National Member Society, according to Secretary J. H. Arendzen, sponsored a mini-congress in January, featuring papers by P. C. Prakke, J. F. T. Bredie, F. J. van Hulten, J. In der Maur, C. Veld , J. Smeets, D. Wever, G. A. J. de Baere, R, Bahner, and A. L. H. de Lange which focussed on orthotic and surgical management of foot disorders. Future symposia are scheduled on the themes of orthopaedic shoe technicians, rehabilitation engineering, parawalkers and reciprocators, rehabilitation of patients with burns, and insensitive foot problems. Five workshops intended to upgrade the practical skills of clinicians are also scheduled, including prosthetic training for the lower-limb amputee, practical orthopaedic prosthetic techniques, amputations and prostheses for the lower limb, ORLAU parawalker, and ischial containment above-knee socket design. The Society has also inaugurated a biannual national newsletter publishing domestic news and announcements of international professional meetings, with the financial support of advertisers of orthopaedic products.

Australian National Member Society was the co-sponsor of the annual scientific meeting in Perth with the Department of Veterans' Affairs. Valma Angliss, ISPO secretary, indicated that international speakers included Charles Pritham of the United States who presented a pre-meeting workshop on the Fillauer suction suspended below-knee prosthesis. He also served as keynote guest speaker, and was joined by Lanny Wiggins from the United States and John Shorter from the United Kingdom who also made special presentations. ISPO executives are W. G. Doig, FRCS, FRACS, Chairman; Margaret Powell, Vice Chairman; Valma Angliss, Honorary Secretary, and Martin Masson, Honorary Treasurer. Members of the Committee are Jean Halcrow, Andrew Harding, Raelene Jarvis, and Andrew Nunn MD. Ms. Angliss and Dr. Doig represent Australia at the International Committee. Australian ISPO and Department of Veterans' Affairs is organizing a course on upper extremity prosthetics May 11–14, 1989 in Melbourne. The course has been approved by the Australian College of Rehabilitation Medicine. The World Federation of Occupational Therapists has selected Melbourne for its triennial congress in April 1990.

United States National Member Society held its Annual Meeting in cooperation with the American Academy of Orthotists and Prosthetists in Orlando, Florida in February. The Keynote speaker was Ernest Burgess, MD, who presented "An Objective View of the Team Concept." Michael Schuch, ISPO Secretary, spoke on "Reciprocal Gait Prostheses for Bilateral Lower-Limb Amelia;" John Edelstein ISPO Vice Chairman, discussed "Biomechanics of Canes and Crutches." Other speakers in the ISPO programme segment included Diane Atkins, Robert Meier MD and Milo Collier on "Special Needs for Special Patients;" Frank Gottschalk, MD reviewing "Prosthetics and Orthotics in South Africa;" Albert Rappoport described "UCLA System for Computer Aided Socket Design" while Ron Davies, PhD., reported on "The Role of Computers in the Design and Manufacture of Prostheses." Other topics explored at the meeting include consumer advice; AIDS: risks and responsibilities; management of myelomeningocele; the Oregon laminated orthotic system; orthotic management of ankle fracture; new splints for lower-limb deformities; body-powered and electric upper-limb prostheses; trans-radial Surlyn myoelectric sockets; amputation secondary to brachial plexus injury; above-knee socket designs; Syme amputation for diabetic patients; energy-storing prosthetic feet; adjustable below-knee socket; hydraulic ankle; hypobaric suspension of prosthetic sockets; historic prostheses; Advantage spinal system; scoliosis management; orthotic application of narrow mediolateral technology; new sock materials and thickness designations; orthotic control of the ankle; and myoelectric prehension orthosis.

ISPO members, particularly Chairman Maurice LeBlanc and Martin Carlson, were active in the recent meeting of RESNA, the Association for the Advancement of Rehabilitation Technology. RESNA's new journal is *Assistive Technology,* to be published quarterly by Demos Publications, 156 Fifth Avenue, Suite 1018, New York, NY 10010, USA. The *Journal of Prosthetics and Orthotics* published its first issue, under the joint sponsorship of the American Academy of Orthotists and Prosthetists and the American Orthotic and Prosthetic Association; subscriptions are available from the Academy at 717 Pendleton Street, Alexandria, VA 22314, USA. The *Journal of the Association of Children's Prosthetic-Orthotic Clinics,* edited by Joan Edelstein, is a quarterly which offers subscriptions to those who contact its office at 317 East 34th Street, New York, NY 10016, USA. Its sponsor, the Association of Children's Prosthetic-Orthotic Clinics, will hold its annual scientific meeting in Chicago, Illinois June 7–10, 1989.

Joan E. Edelstein
Editor

Prosthetics and Orthotics International, 1989, 13, 48–49

Reviews

Scoliosis — an information booklet
Scoliosis Association (UK),
380–384 Harrow Road,
London W9 2HU
£3.95 plus 30p post and packing.

The Scoliosis Association (UK) has produced a well written booklet of 44 pages aimed at patients with scoliosis, their families, and others who have contact with children who may develop scoliosis. The aims of this society is to put people with scoliosis in touch with each other for support and also increase the general awareness with regard to scoliosis. The booklet is a well written and clearly set out account of the problems associated with scoliosis. It explains the importance of early diagnosis so that the curve can be monitored and treated if its shows signs of deterioration. There are sections describing the disorder, its possible causes, treatment and the place of school screening. Advice is given on the clothing which can be worn in patients who are being treated in a brace and it also provides a useful list of addresses of organizations which can be helpful to patients with scoliosis.

The only reservation about this booklet is that the illustrations which are reproductions of photographs of patients and x-rays are of very poor quality and it would be much better if these were to be replaced by line drawings. Some of the braces illustrated are not ones that are now commonly used and their appearance may alarm the more sensitive patient. Osteopathy along with the Alexander and Chiropractic techniques are discussed but it is not clearly stated that they have absolutely no part to play in the treatment of children with structural scoliosis. Apart from these reservations the reveiwer would have no hesitation in recommending this booklet to patients with scoliosis or their parents.

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Eairmilehead,
Edinburgh, Scotland.

Biomechanics and Orthotic Management of the Foot
D. J. Pratt and G. R. Johnson, editors.
Orthotics and Disability Research Centre,
Derbyshire Royal Infirmary,
London Road, Derby DE1 2QY,
United Kindom

The editors of this simple paperback volume express the laudable hope that their book will promote an interchange of ideas between the many different professions involved in the management of foot disorders and stimulate others to seek a multidisciplinary approach to these problems.

The contents of the book are drawn from a conference held at Nene College, Northampton, England, on the 4th and 5th of September, 1986.

The book is organized in three sections: Bioengineering, Orthopaedic and Podiatry, however all three sections contained a general mix of subject material.

The Bioengineering section commences with a useful general review of the current state of knowledge regarding biomechanics of the foot and ankle by Dr. A. Nicol of the University of Strathclyde, who was the keynote speaker at the conference. There are a number of other basic biomechanical contributions scattered throughout the book dealing with a diverse range of topics including the function of the midtarsal joint, the elastic behaviour of the spring ligament, the mechanisms of stair climbing and descending and an interesting Swedish study which employed stereophotogrammetry to study the complex movements of the foot joints.

A number of contributors describe methods of assessing ankle/foot function both as a part of the prescription process and to assess the result of treatment. Techniques described include the use of force plate accelerometry, the electrodynogram footprint analysis and simple goniometry.

The third group of papers are those which describe specific methods of treatment and their results. One paper deals with a surgical

method of treatment of hallux valgus, however the majority are concerned with orthotic management. The topics described include the use of insoles or inserts to reduce pain at heel strike, prefabricated inserts to control pronation and metatarsal domes to relieve pressure on rheumatoid feet. In addition there is an interesting paper on the use of rocker soled footwear to reduce forefoot pressure in diabetics.

The final paper is a description of a modular system for providing bespoke footwear for patients with orthopaedic problems, particularly rheumatoid arthritis, developed at Oxford. This is an important development, however the clinical results described are insufficient to reliably judge the success of the system.

The single most important message from this conference would appear to be the enthusiasm with which all the disciplines concerned have accepted the need to adopt reliable methods of measurement at all stages of the asessment and treatment of patients. Hopefully this trend will result in future advances in the understanding of foot problems and further developments in their treatment. This is a useful book for all interested in this challenging area of medical care.

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United States
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600 Arlington Avenue,
Greenville SC,
29601 U.S.A.

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Calendar of events

3–6 May, 1989
British Orthopaedic Association Scientific Meeting, Rhodes, Greece.
Information: B.O.A., 35-43 Lincoln's Inn Fields, London, WC2A 3PN, England

3–6 May, 1989
Annual Scientific Meeting of the International Medical Society of Paraplegia, Rome, Italy.
Information: Prof. S. Giacobini, Via Cassia Antica 240, 00191 Rome, Italy.

3–7 May, 1989
6th Annual Meeting of the Southern Orthopaedic Association, Edinburgh, Scotland.
Information: Sherrie Coffee, Southern Orthopaedic Association, PO Box 190088, Birmingham, Alabama, USA.

4–7 May, 1989
Pediatric Orthopaedic Society, South Carolina, U.S.A.
Information: POS, 222 South Prospect, Park Ridge, IL 60068, U.S.A.

11-14 May, 1989
Course on Upper Limb Prosthetics and Orthotics, Victoria, Australia.
Information: V. Angliss, Hon. Sec. ISPO, C.D.U. at Repatriation General Hospital, Heidelberg, Victoria, Australia.

15–19 May, 1989
16th Annual Meeting of the International Society for the Study of the Lumbar Spine, Kyoto, Japan.
Information: S. Wiesel, M. D., Secretary, International Society for the Study of the Lumbar Spine, Sunnybrook Medical Centre, Room 3009A, 2075 Bayview Ave., Toronto M4N 3M5, Canada.

5–9 June, 1989
European Congress of Physical Medicine and Rehabilitation, Madrid, Spain.
Information: Congress Europeo de Meditina Fisicia y de Rehabilitacion. Facultad de Medicina, Universidad Complutense, Ciudad Universitaria, 28040 Madrid, Spain.

8-10 June, 1989
6th Alpine-Adriatic Symposium on Rehabilitation, Gratz, Austria.
Information: Ing Kaiser, Kongressburo der Allgemeinen Unfallversicherungsanstalt, Adelbert-Stifter-Strauss 65, A-1200 Wien, Austria.

11–15 June, 1989
American Physical Therapy Association Annual Conference, Nashville, U.S.A.
Information: Bonnie Polvinale, Director of Conference/Meeting Services, A.P.T.A., 1111 N. Fairfax St., Alexandria, VA 22314, U.S.A.

12–15 June, 1989
American Orthopaedic Association Annual Meeting, Colorado Springs, U.S.A.
Information: AOA, 222 South Prospect, Park Ridge, IL 60068, U.S.A.

13–16 June, 1989
International Conference of the Netherlands Society for Physiotherapy, The Hague, Netherlands.
Information: Nederlands Genootschap voor Physiotherapie, PO Box 248, NL-3800 AE Amersfoort, Netherlands.

13-17 June, 1989
Canadian Physiotherapy Association Congress, Edmonton, Canada.
Information: P.R. Dept., C.P.A., 44 Eglington Ave. West, Suite 201, Toronto, Ontario M4R 1A1, Canada.

14 June, 1989
Multidisciplinary Conference on Rehabilitation Technology.
Information: Course Administrator, Mary Marlborough Lodge, Nuffield Orthopaedic Centre, Headington, Oxford OX3 7LD, England.

21–23 June, 1989
4th Canadian Congress of Rehabilitation, Toronto, Canada.
Information: CRCD Congress Secretariat, Suite 2110, One Yonge St., Toronto, Ontario M5E 1E5, Canada.

25-28 June, 1989
15th Canadian Medical and Biological Engineering Conference, Toronto, Canada.
CMBES Secretariat, c/o NRC, Rm. 302, Building M-50, Ottawa, Ontario K1A 0R8, Canada.

26–30 June, 1989
12th Annual Conference of RESNA Rehabilitation Technology, New Orleans, U.S.A.
Information: RESNA, Association for the Advancement of Rehabilitation Technology, Suite 700, 1101 Connecticut Ave., NW, Washington, DC 20036, U.S.A.

26–30 June, 1989
12th International Congress of Biomechanics, Los Angeles, USA.
Information: 12th ISB Congress Secretariat, Dept. of Kinesiology, 2854 Slichter Hall, UCLA, Los Angeles, CA 90024–1568, USA.

9–14 July, 1989
31st International Congress of Physiological Sciences, Helsinki, Finland.
Information: International Congress of Physiological Sciences, PO Box 722, SF 00101 Helsinki, Finland.

10-13 July, 1989
French Society of Orthopaedic Surgery National Meeting, Paris, France.
Information: Convergences, 16 Rue Jean Jacques Rosseau, 75001 Paris, France.

23–28 July, 1989
19th International Congress of Pediatrics, Paris, France.
Information: Jean Frezal, P.M.V. Congres/Pediatrie 89, 130 rue de Clignancourt, 75018 Paris, France.

24–26 July, 1989
2nd International Federation for Medical and Biological Engineering Pan-Pacific Symposium, Melbourne, Australia.
Information: Louise Read, Sue Wood & Associates Pty. Ltd., 387 Malvern Rd., South Yarra 3141, Victoria, Australia.

3-5 August, 1989
Annual Scientific Meeting of ISPO Australian National Member Society, North Sydney, Australia.
Information: V. Angliss, Hon. Sec. ISPO, C.D.U. at Repatriation General Hospital, Heidelberg, Victoria, Australia.

3-6 August, 1989
5th Annual Summer Meeting of American Orthopaedic Foot and Ankle Society, Idaho, U.S.A.
Information: A. Napolilli, AOFAS, 222 S. Prospect Ave., Park Ridge, IL 60068, U.S.A.

24-26 August, 1989
9th International Congress of the Hungarian Orthopaedic Association, Budapest, Hungary.
Information: Prof. T. Viskelety, Dept. of Orthopaedics, Semmelweis University, H-1113 Budapest, Karolina ut. 27, Hungary.

28-31 August, 1989
Engineering and Physical Sciences in Medicine, Hamilton, New Zealand.
Information: Mr. G. Coalter, Division of Scientific Services, Waikato Hospital, Hamilton, New Zealand.

29 August-1 September, 1989
5th Mediterranean Conference on Medical and Biological Engineering, Patras, Greece
Information: Dept. of Medical Physics, University of Patras, 265 00 Patras, Greece.

31 August-2 September, 1989
International Congress on Disability Prevention and Rehabilitation in Traumatology, Budapest, Hungary.
Information: MOTESZ Congress Bureau, PO Box 32, Budapest H-1361, Hungary.

3–6 September, 1989
11th Brazilian Conference on Biomedical Engineering, Sao Paulo, Brazil.
Information: Comite Organizador do XI CBEB, Caixa Postal 8091, 05403, Sao Paulo SP, Brazil.

3–6 September, 1989
Annual Scientific Meeting of the Biological Engineering Society, Bristol, England.
Information: Ms. J. Upton, BES, The Royal College of Surgeons, 35–43 Lincoln's Inn Fields, London WC2A 3PN, England.

13–15 September, 1989
British Orthopaedic Association Scientific Meeting, London, England.
Information: BOA, 35–43 Lincoln's Inn Fields, London WC2A 3PN, England.

17-23 September, 1989
Combined Meeting of Scoliosis Research Society and European Spinal Deformities Society, Amsterdam, The Netherlands.
Information: Scoliosis Research Society, 222 S. Prospect, Suite 127, Park Ridge, IL 60068, U.S.A.

20–22 September, 1989
Annual Congress of the Chartered Society of Physiotherapy, Harrogate, England.
Information: PR Dept., Chartered Society of Physiotherapy, 14 Bedford Row, London WC1R 4ED, England.

2–8 October, 1989
American Orthotic and Prosthetic Association Annual National Assembly, Reno, U.S.A.
Information: AOPA, 717 Pendleton Street, Alexandria, VA 22314, U.S.A.

11–15 October, 1989
Eastern Orthopaedic Association, Montreal, Canada.
Information: EOA, 301 8th St., Suite 3F, Philadelphia, PA 19106, U.S.A.

November, 1989
3rd World Congress of Disabled People's International, Bogota, Colombia.
Information: DPI General Secretary, Box 36033, S-10071 Stockholm, Sweden.

12–17 November, 1989
ISPO World Congress, Kobe, Japan.
Information: Secretariat, 6th ISPO World Congress, c/o International Conference Organisers Inc., 5A Calm Building, 4-7 Akasaka 8-chome, Minato-Ku, Tokyo 107, Japan.

1990

22–28 January, 1990
American Academy of Orthotists and Prothetists Annual Meeting and Scientific Symposium, Phoenix, USA.
Information: AAOP, 717 Pendelton St., Alexandria, VA 22314, USA.

8–13 February, 1990
American Academy of Orthopaedic Surgeons Annual Meeting, New Orleans, U.S.A.
Information: AAOS, 222 South Prospect, Park Ridge, IL 60068, U.S.A.

April, 1990
British Orthopaedic Association Scientific Meeting, Glasgow, Scotland.
Information: BOA, 35-43 Lincoln's Inn Fields, London WC2A 3PN, England.

1-6 April, 1990
6th World Congress on Pain, Adelaide, Australia.
Information: L. Jones, International Association for the Study of Pain, 909 NE 43rd St., Suite 306, Seattle, Washington 98105-6020, U.S.A.

2-6 April, 1990
W.F.O.T. 10th World Congress, Melbourne, Australia.
Information: W.F.O.T. 10th World Congress Secretariat, 1st Floor, 387 Malvern Rd., South Yarra, Victoria, 3141, Australia.

15-20 June, 1990
13th Annual RESNA Conference, Washington, U.S.A.
Information: Susan Leone, RESNA, 1101 Connecticut Ave. NW, Suite 700, Washington, DC 20036, U.S.A.

24-28 June, 1990
Annual Conference of the American Physical Therapy Association, Anaheim, U.S.A.
Information: Information Dept., APTA, 1111 N. Fairfax St., Alexandria, Virginia 22314, U.S.A.

26-31 August, 1990
1st World Congress of Biomechanics, San Diego, U.S.A.
Information: Prof. G. W. Schmid-Schonbein, AMES-Bioengineering M-005, Univ. of California, San Diego, La Jolla, CA 92093, U.S.A.

September, 1990
British Orthopaedic Association Scientific Meeting, Birmingham, England.
Information: BOA, 35-43 Lincoln's Inn Fields, London WC2A 3PN, England.

8–15 September, 1990
SICOT 90 — 18th World Conference, Montreal, Canada.
Information: SICOT 90, Sorelcomm Inc., 1425 Boul. Dorchester West, 8th Floor, Montreal, Quebec H3G 1T7, Canada.

11–16 September, 1990
American Orthotic and Prosthetic Association Annual National Assembly, Boston, USA.
Information: AOPA, 717 Pendelton St., Alexandria, VA 22314, USA.

1991
19-24 March, 1991
AOPA Annual Meeting and Scientific Symposium, San Diego, U.S.A.
Information: AOPA, 717 Pendleton St., Alexandria, Virginia 22314, U.S.A.

23-27 June, 1991
Annual Conference of the American Physical Therapy Association, Boston, U.S.A.
Information: Information Dept., APTA, 1111 N. Fairfax St., Alexandria, Virginia 22314, U.S.A.

28 July-2 August, 1991
11th Congress of the World Confederation for Physical Therapy, London, England.
Information: Secretariat, WCPT, Conference Associates, 27A Medway St., London SW1P 2BD, England.

1–6 October, 1991
American Orthotic and Prosthetic Association Annual National Assembly, Calfornia, USA.
Information: AOPA, 717 Pendelton St., Alexandria, VA 22314, USA.

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International Exhibition, Kobe, Japan – November 1989.

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