The Journal of the International Society for Prosthetics and Orthotics

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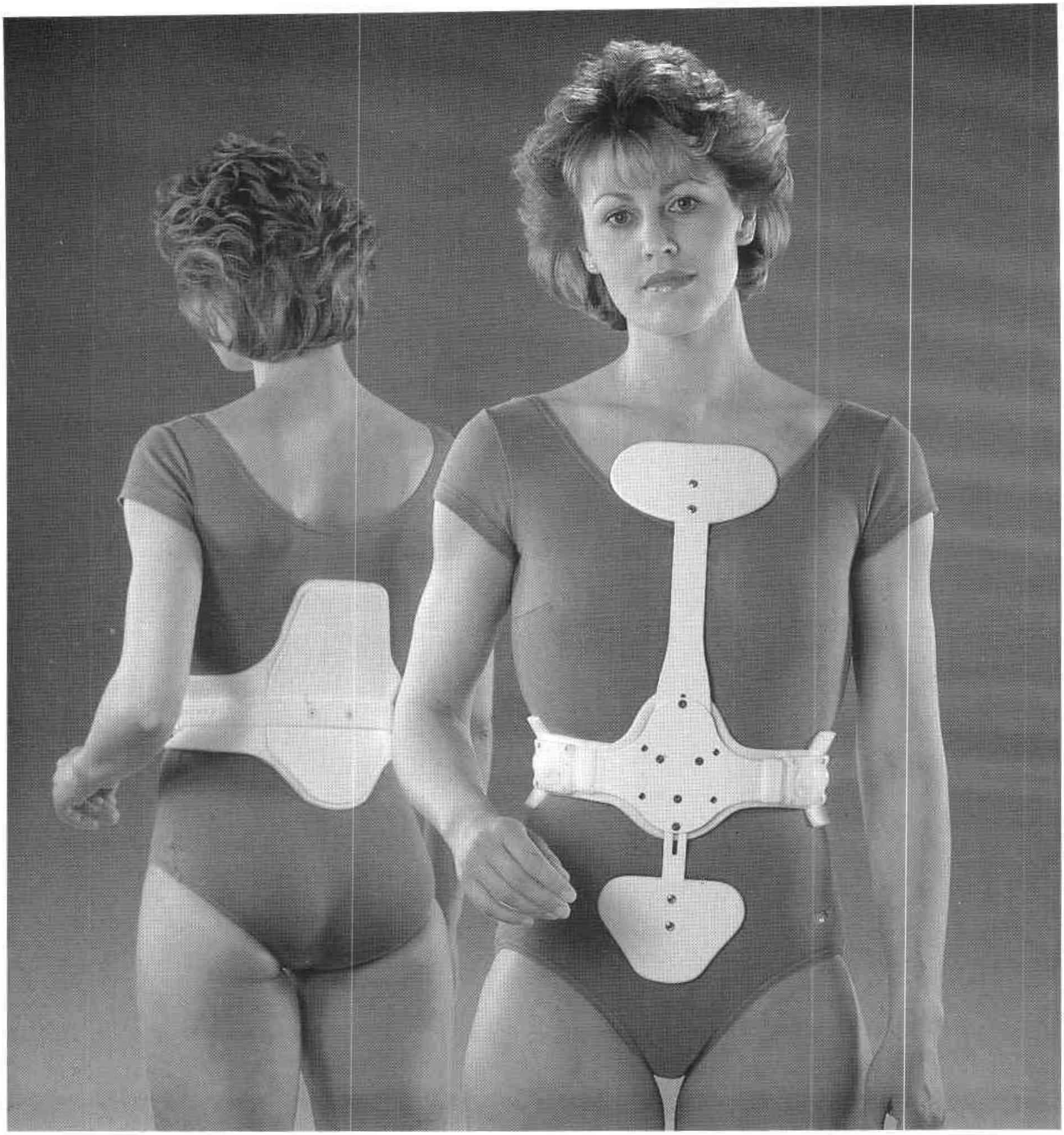

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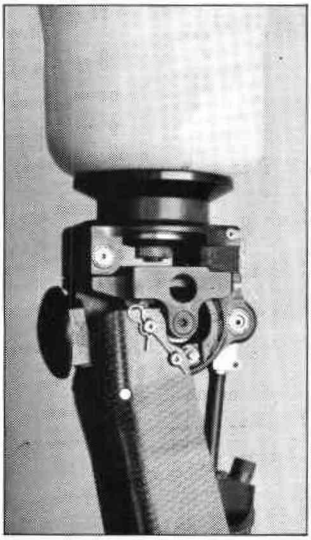

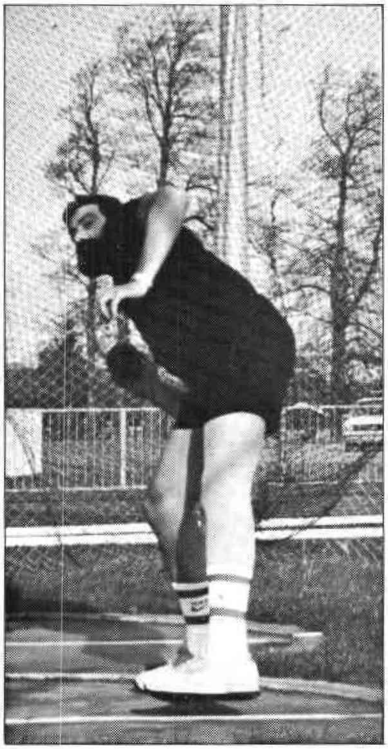

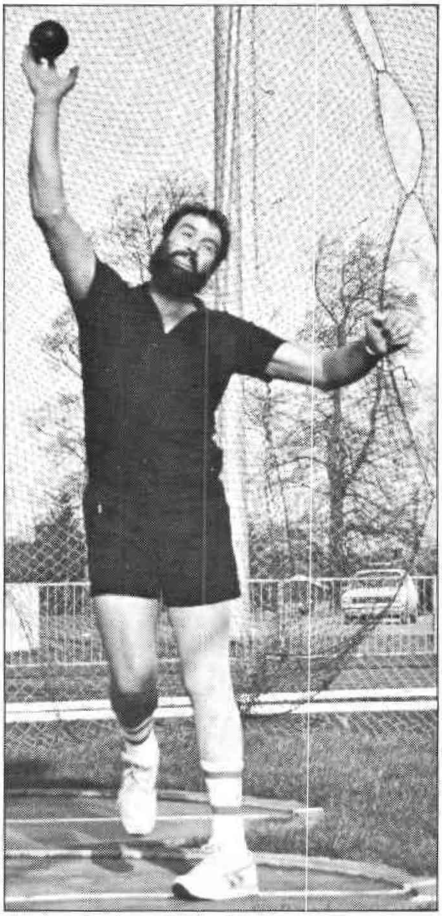

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The Journal of the International Society for Prosthetics and Orthotics

August 1988, Vol. 12, No. 2

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ISPO

Prosthetics and Orthotics International, 1988, 12, 63–64

Editorial

Since its inception, one of the Society's prime areas of interest and effort has been in the field of education and training. Those of us in the industrial world are aware of this on-going activity. We see it in the continuing debate on our prosthetics/orthotics education programmes and the steady raising of standards. We know of the courses, seminars and conferences, national and international, which ISPO and our National Member Societies provide. This emphasis on education is necessary if we are to maintain and improve standards of patient care.

The picture in the developing world is quite different in so far as we can see what that picture is! There are, of course, absolutely no reliable statistics available—only gross estimates. Secondly, the developing world is not a homogenous mass—it is a miscellany of different peoples, religions, cultures, customs, conditions and, of course, different stages of development, or under-development.

How many amputees may there be in the developing countries? We should note that the reasons for amputation would be quite different from the experience of most of us. The primary cause would be trauma related to war, work, traffic accidents, civil disturbances, and so on. A recent, very cautious, estimate of the numbers involved is made by the World Health Organization, who suggest that 0.1% of the world population, or about five million people, would be able to use a prosthesis. About two-thirds of these, or 3.5 million, may be estimated to live in the developing countries. From this it may be supposed that if a prosthesis lasts for three years, then needs to be replaced, the annual production in the developing world would need to be about 1.2 million.

The number of people needing orthoses is mainly due to poliomyelitis with resulting paralysis, birth defects, or perinatal problems leading to paralysis or deformity and diseases such as leprosy and tuberculosis in the joints and spine. By far the largest group of the orthosis wearers are the polio cases. A conservative estimate is that a staggering 250,000 children get paralytic poliomyelitis every year. Assuming a mean survival rate of 10 years, this means 2.5 million of these children—all in the developing countries. Perhaps half of these, or 1.2 million, might need an orthosis.

There is a special need for orthopaedic footwear in a group of patients, the largest proportion of which have leprosy. It is estimated that, at present, there are 11-12 million people in the world with leprosy. If 10% of them need shoes every year, this corresponds to an annual demand for 1.1 million pairs of shoes.

All of these figures may be considered as underestimates, as it is suspected that many countries in providing statistics, understate the size of their particular problem

One thing is certain, the trained people, or prosthetist/orthotists, required to produce these massive numbers of appliances are virtually non-existent. WHO estimates that most countries have less than 10% of the staff required—many have only 1–2%. This translates into literally millions of people who would benefit from a prosthesis, or an orthosis, and who go unfitted! In a previous exercise we, in ISPO, concluded that the figure might be 12 million. The above recent estimates from WHO only go to confirm our fears. There is a need for the training of at least between 50,000 and 100,000 skilled workers.

Our Society has a duty to play an active role in tackling this problem. We have, over the last three years, developed an educational philosophy which recognises that, for the foreseeable future, there will be a need for a "mid-level" professional in the developing countries. The relevant curriculum outline for this individual, styled as "orthopaedic technologist", has been developed in a series of workshops organized in Moshi, Tanzania and Jonkopping, Sweden, both of which provided a forum for the major agencies involved, debating the subject in a professional framework provided by ISPO. The establishment of Schools providing this level of education and training throughout the developing countries is a prerequisite to the solution of caring for the neglected millions. We are, with some success, encouraging those funded agencies setting-up such programmes to do so within our guidelines. Those which satisfy our criteria and bear inspection have "ISPO Recognition". Such international approval plays an important part in retaining national support and in raising the level of the profession within the country—an enormous problem in terms both of status and of salary in countries where no such profession has previously existed.

A further education workshop, held within the last year in Glasgow, Scotland, and the report of which will shortly be published, tackled a different aspect of this same problem—namely that of improving the standards of many inadequately trained technicians already providing service in the developing countries. Over the years, many technicians, perhaps as many as 1,500, have been trained in programmes which required little in the way of entry qualifications and were as short as six months in duration. We are currently exploring ways in which the best of those who remain in clinical practice may be given some measure of upgrading. We are, among other options, examining possibilities of providing distance learning schemes and of sending teams to appropriate centres in the developing countries to provide upgrading courses. This requires facilities, money and teams of instructors to back-up those who may be available locally.

ISPO is unique in the expertise embodied in the membership. We must continue to seek ways of harnessing our energies to attack this massive problem. Prosthetics and orthotics is not a luxury to come far behind primary health care. It is a vital force in returning millions of people to a gainful, respected and dignified place in society.

John Hughes
President

Prosthetics and Orthotics International, 1988, 65–72

A 15 year survey of Burmese amputees

HLA PE

Hospital for the Disabled, Thaiming, Rangoon

Abstract

A 15-year retrospective study of 2228 civilian amputees was conducted at the Hospital for the Disabled, Thamaing, Rangoon. It was demonstrated that utilization of appropriate technology for development of essential components had enabled the hospital to serve more amputees. The ratio of male to female was 4.23 : 1. The mean age was 31 years, male slightly older than female. Trauma was the leading cause of upper limb amputations (87%). In the lower limb although trauma (47%) was the prominent cause, disease (41%) was a close second. Major specific causes of trauma were gun-shot/explosion (25%), railway accident (20%) and road accident (19%). Leading specific causes of disease were leprosy (25%), vascular disease (24%) and gangrene (23%). Unless appropriate and effective preventive measures are instituted man-power drainage and demand for prosthetic services will continue.

Introduction

When the Hospital for the Disabled was established in Rangoon, in January 1960, prosthetic-orthotic services were introduced for the first time in Burma. Initially, while the administration of the hospital was under the Ministry of Social Welfare, services were provided only to the veterans of World War I and II. Later in January 1965, when the hospital's administration was transferred to the Ministry of Health, the services were also extended to the civilian population.

The purpose of this retrospective study was to investigate the epidemiology and general characteristics of the amputees to assist in future planning of prosthetic services and to identify the possible venues that could contribute towards attainment of Health for All by the Year 2000.

The study

Since its inception the hospital maintained an Amputee Intake form, for all new admissions, recording the common vital characteristics dealing with age, sex, height, weight, and educational, marital and vocational status. In addition, the onset and date of amputation, cause and site of amputation were obtained, the length, shape and condition of the stump and range of joint motions were described. It also included information on prosthetic prescription, duration of prosthetic fabrication, status of check-out and overall period of prosthetic rehabilitation.

The present study covered only a period of 15 years, from January 1969 to December 1983, as data collected prior to this consisted mostly of war veterans and very long-standing amputees. Data analysed in this study was limited to those related to number, age and sex of amputees; educational, marital and vocational status; and level and cause of amputations with particular relationship to different age groups and vocational status. Three periods of 5 years were considered, as much as possible, in the statistical analysis.

Number of amputees

The total number of amputees was 2228. There had been a sharp increase (31%) of admissions during the second period "74–78" and thereafter the increment was slight (2%) (Table 1).

Age

The youngest amputee admitted was 4 months and the oldest was 80 years of age for

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Table 1. Number of amputees admitted in different periods

Periods	Number of Amputees			Percent	Percent Rise
	Male	Female	Total		
69–73	496	116	612	27.47	
74–78	653	148	801	35.95	+31
79–83	653	162	815	36.58	+ 2
Total	1802	426	2228	100.00	

the whole period. During each period, however, the oldest had gradually risen from 74 years to 80 years.

The mean age of amputees for the whole period "69–83" was 31. Male slightly older than female which remained almost constant for all three periods (Table 2).

When the ages were analysed in five specific groups (Table 3), the greatest number of amputees fell within the 21–40 age group (42.73%) and immediately followed by 11–20 (24.24%) and 41-60 (23.70%) age groups. If different age groups were considered for each period there was a rise of nearly 3% each in 21–40 and above 61 age groups at the expense of other groups.

Sex

Among the 2228 amputees there was a strong preponderence of 1802 males (80.88%) compared with 426 females (19.12%). The overall male to female ratio was 4.23 : 1 and remained fairly constant in all three periods (Table 1).

On comparing the sex distribution within the specific age groups, there were more females in the younger age groups. The ratio of male to female was 0.70 : 1 and 2.80 : 1 in below 10 and 11–20 age groups, respectively (Table 4).

Table 2. Mean age in different periods

Sex	Periods			Total 69–83
	69–73	74–78	79–83	
Male	31	32	33	32
Female	26	31	27	28
Whole group	30	32	32	31

Table 3. Distribution of age groups in different periods

Age groups	Periods			Total
	69–73	74–78	79–83	
below 10	47	37	43	127 (5.70%)
11–20	157	194	189	540 (24.24%)
21–40	251	345	356	952 (42.73%)
41–60	145	196	187	528 (23.70%)
above 61	12	29	40	81 (3.63%)
Total	612	801	815	2228 (100.00%)

Education status

On admission the majority of amputees 66.03% (None—14.68% and Read & Write—51.35%) had little or no education. Only 10.46% had passed the middle school and a few completed high school (2.37%) (Table 5).

Marital status

A high percentage of amputees were unmarried (53.55%) and (39.27%) were married at admission (Table 6). Married males were proportionately higher than married females. Pre- and post-amputation marital status of both sexes were insignificant.

Table 4. Male to female ratio in each age group

Age groups	Periods		
	69–73	74–78	79–83
below 10	1.63	1.30	0.70
11–20	3.50	3.60	2.80
21–40	5.30	7.10	5.80
41–60	5.80	4.55	6.15
above 61	5.00	1.40	3.40

Table 5. Education status of amputees

Education Status	69–73	74–78	79–83	Total
None	115	114	88	327 (14.68%)
Read & Write	305	408	431	649 (51.35%)
Passed Primary School	131	164	176	471 (21.14%)
Passed Middle School	52	93	88	233 (10.46%)
Passed High School	9	22	22	53 (2.37%)
Total	612	801	815	2228 (100.00%)

Vocational status

As the majority of amputees were dependents on admission an attempt was made to identify their occupation at the time of amputation or onset. It was revealed that 701 were dependents (31.46%) (including 274 congenital amputees), followed by 464 labourers (20.83%), 376 cultivators (16.88%), 261 students (11.71%), 245 self-employed (11.00%) and 181 managerial personnel (8.12%). Most of the labourers were seasonal and semi-skill workers. Policemen and office workers were included in the managerial group. Dependents consisted of housewives, monks (clergy) and unemployed. However, although students were dependents they were classified separately for statistical purposes. When the two extreme periods were compared, the cultivators rose by 8% and students fell by 6% (Table 7).

Table 6. Martial status of amputees

Marital Status	69–73	74–78	79–83	Total
Single	343	425	425	1193 (53.55%)
Married	234	308	333	875 (39.27%)
Widow/Widower	23	44	36	103 (4.62%)
Divorced/ Separated	12	24	21	57 (2.56%)
Total	612	801	815	2228 (100.00%)

Table 7. Vocational status of amputees

Vocational Status	69–73	74–78	79–83	Total
Cultivator	71	147	160	376 (16.88%)
Labourer	141	135	189	464 (20.83%)
Managerial	39	70	68	181 (8.12%)
Self-employed	74	92	82	245 (11.00%)
Student	82	119	60	261 (11.71%)
Dependent	206	238	257	701 (31.46%)
Total	612	801	815	2228 (100.00%)

Levels of amputation

Among the 2228 amputees there were 1684 lower limb (75.58%), 436 upper limb (19.57%) and 108 multiple limb (4.85%) amputees, the ratio being 15.59 : 4.04 : 1. Multiple limb amputees had bilateral, one sided, triple and quadruple limb involvements.

The levels of amputation are indicated in Table 8. The commonest variety was below-knee (49.42%); followed by above-knee (20.87%), below-elbow (8.48%) and above-elbow (6.64%) amputations.

The age distribution of 436 upper limb amputees is shown in Table 9. Fifty-six percent (244 amputees) were in 21–40 age group and next was 11–20 age group with 112 amputees (25.69%).

When the age distribution of 1684 lower limb amputees was analysed (Table 10), here also the majority of amputees were found in the 21–40 age group (39.31%). Next was 41–60 age group (26.90%) and third was 11–20 age group (23.34%).

The predilection for left and right side

Table 8. Levels of amputation

Levels of amputation	Number	Percent
UPPER LIMB		
Shoulder disarticulation	25	1.12
Above-elbow	148	6.64
Elbow disarticulation	15	0.67
Below-elbow	189	8.48
Wrist disarticulation	59	2.65
Sub total	436	(19.57)
LOWER LIMB		
Hip disarticulation	14	0.63
Above-knee	465	20.87
Knee disarticulation	44	1.98
Below-knee	1101	49.42
Syme	60	2.69
Sub-total	1684	(75.58)
MULTIPLE LIMB (Sub-total)	108	(4.85)
Grand Total	2228	100.00

Table 9. Age distribution of upper limb amputees

Age groups	Levels of amputation					Total	
	S/D	A/E	E/D	B/E	W/D	Number	Percent
below 10	–	6	1	9	1	17	3.90
11–20	10	36	4	50	12	112	25.69
21–40	11	88	9	102	34	244	55.96
41–60	4	17	1	27	11	60	13.76
above 61	–	1	–	1	1	3	0.69
Total	25	148	15	189	59	436	100.00

Table 10. Age distribution of lower limb amputees

Age groups	Levels of amputation					Total	
	H/D	A/K	K/D	B/K	Syme	Number	Percent
below 10	3	12	9	69	5	98	5.82
11–20	7	129	12	231	14	398	23.34
21–40	2	190	14	433	23	662	39.31
41–60	2	122	8	305	16	453	26.90
above 61	–	12	1	63	2	78	4.63
Total	14	465	44	1101	60	1684	100.00

amputations was almost equal in the lower limb amputees. In the upper limb amputees, however, the left side involvement was 8% higher than the right side (Table 11). This may be due to a high incidence of sword-cut injuries to the upper limb, resulting from fights and quarrels, where the victims tend to protect with the left upper limb.

Causes of amputation

Trauma (55.25%) was the leading cause of amputation, followed by disease (32.45%) and congenital (12.30%). Trauma (87.16%) was the main cause of upper limb amputations. In the lower limb amputations both trauma (46.73%) and disease (40.74%) appeared to be almost equally responsible. Out of 108 multiple limb amputees trauma was the cause for 59%. In congenital, lower limb amputees (77.01%) were most predominant (Table 12).

Specific causes of trauma were considered under "railway", "road" and "domestic/farm/industrial" accidents; and "gun-shot/explosion"

Table 11. Side of amputation

Side	Upper limb	Lower limb	Total
Left	234 (54%)	846	1080
Right	202 (46%)	838	1040
Total	436 (100%)	1684	2120

Table 12. Causes of amputation

Causes	Upper limb	Lower limb	Multiple limb	Total
Disease	22 (5.04%)	686 (40.74%)	15 (13.89%)	723 (32.45%)
Trauma	380 (87.16%)	787 (46.73%)	64 (59.26%)	1231 (55.25%)
Congenital	34 (7.80%)	211 (12.53%)	29 (26.85%)	274 (12.30%)
Total	436	1684	108	2228 (100.00%)

and "sword-cut" injuries. Farm and industrial accidents were actual work related injuries, whereas domestic accidents were those sustained by individuals falling from trees and huts/houses, and injuries received during pursuit of their personal livelihood. Gun-shot/explosion injuries were not combat oriented except those incurred by policemen.

Specific causes of disease were considered under "gangrene", "bone and joint infection", "leprosy", "tumour" and "vascular disease". "Gangrene" consisted essentially of diabetics, those resulting from prolonged application of tourniquet after snake-bite and other noni-traumatic unspecified causes. Bone and joint

Table 13. Specific causes of amputation by age groups

Causes	Age groups					Total
	<10	11–20	21–40	41–60	>61	
DISEASE						
gangrene	—	18	36	83	26	163
bone & joint infection	4	18	36	42	11	111
leprosy	—	8	86	75	13	182
tumour	1	26	38	25	3	93
vascular	1	6	82	79	6	174
Sub-total	6	76	278 (38.45%)	304 (42.05%)	59	723
TRAUMA						
railway	12	111	87	32	7	249
road	5	63	110	55	6	239
domestic/farm/ industrial	9	97	185	61	1	353
gun-shot/explosion	2	68	176	54	7	307
sword-cut	1	9	57	15	1	83
Sub-total	29	348 (28.27%)	615 (49.96%)	217	22	1231
CONGENITAL (Sub-total)	92 (33.58%)	116 (42.34%)	59	7	—	274
GRAND TOTAL	127	540	952	528	81	2228

infection was usually tuberculous in the young and those diagnosed as osteomyelitis. The latter were chronic sufferers consequent to inadequate management received after minor wounds or cuts. The most dominant pathology in "vascular disease" was thrombo-angiitis obliterans affecting particularly the males of working age.

Specific causes of amputation analysed against five different age groups are shown in Table 13. Among 1231 trauma amputees the 21–40 age group (49.96%) was most affected. The leading specific cause, in this age group, was domestic/farm/industrial accident (30%), closely followed by gun-shot/explosion (29%). Among 723 disease amputees the 41–60 age group (42.05%) was primarily involved, followed by 21–40 age group (38.45%). Within the 41–60 age group the specific causes of amputation, were, gangrene (27%), vascular disease (26%) and leprosy (24%). Whereas in 21–40 age group the prevalent specific causes were leprosy (31%) and vascular disease (29%). Congenital amputees usually came forward for assistance between 11–20 years of age (42%) and before 10 years of age (34%).

Specific causes of amputation analysed against six different vocational groups are indicated in Table 14. In trauma, 330 labourers (26.81%) were most affected but only 42%

Table 14. Specific causes of amputation by vocational groups

Causes	Vocational groups						Total
	Cultivator	Labourer	Managerial	Self-employed	Student	Dependent	
DISEASE							
gangrene	28	28	11	32	8	56	163
bone & joint infection	33	5	7	20	6	40	111
leprosy	27	29	11	29	5	81	182
tumour	18	10	10	13	18	24	93
vascular	28	62	35	32	2	15	174
Sub-total	134 (18.53%)	134 (18.53%)	74	126	39	216 (29.88%)	723
TRAUMA							
railway	22	36	12	39	86	54	249
road	21	76	17	31	43	51	239
domestic/farm/ industrial	76	137	13	20	58	49	353
gun-shot/explosion	84	67	57	23	29	47	307
sword-cut	39	14	8	6	6	10	83
Sub-total	242 (19.66%)	330 (26.81%)	107	119	222 (18.03%)	211	1231
CONGENITAL (Sub-total)	—	—	—	—	—	274	274
GRAND TOTAL	376	464	181	245	261	701	2228

were due to domestic/farm/industrial causes the remainder were from other traumatic causes. Two hundred and forty-two cultivators (19.66%) were the next victims of trauma but they were more prone to gun-shot/explosion (35%) than to farm accidents (31%). Out of 222 students (18.03%), the third largest group of traumatic amputees population, 39% were susceptible to railway accidents.

In disease, 216 dependents (29.88%) were the primary victims and the leading causes were leprosy (38%) and gangrene (25%). The next, equally common victims were 134 cultivators (18.53%). Cultivators were more prone to bone and joint infection (25%), followed equally be gangrene and vascular disease (21% each) and leprosy (20%). Labourers were most susceptible to vascular disease (46%).

Discussion

The total number of amputees reported did not include members of the armed services and civilians who were unable to come forward for socio-economic reasons. The increase of 31% in amputees, during "74–78", may be attributed to more liberal admissions; because from 1976 the hospital was able to produce SACH type natural rubber prosthetic feet, capable of wearing traditional slippers, and socket and ankle blocks from locally available Ye-ma-nay wood (Gmelia arborea).

The overall male to female ratio was 4.23 : 1 (Table 1). Female amputees had progressively increased during the three periods in the below 10 and 11–20 age groups (Table 4). In the former the females exceeded the males, as in India (Narang & Jape, 1982); probably because parents were anxious to have their daughers treated early to avoid future untoward consequences. In the latter, probably because young girls in the rural areas, who were seasonal cultivators and dependents, and traditionally fetched water and vegetables, were frequently injured by anti-personnel land mines sown by insurgent-terrorists around water sources and vegetable patches. The mean age of the amputees was younger (Table 2), in the early 30s, than in Hongkong (Chan et al, 1984). Unlike Hongkong the males were slightly older than the females.

The ratio for upper limb to lower limb amputations was 1 : 3.86 (Table 8). Therefore, upper limb amputees were far less than either in India or Hongkong. Trauma was the leading cause of upper limb (87%) and multiple limb (59%) amputations. In the lower limb although trauma (47%) was the main cause of amputation disease (41%) was a close second (Table 12). Most traumatic amputations occurred in the 21–40 age group (50%); whereas "Disease" affected more in the 41–60 age group (42%) and to some extent in 21–40 age group (38%) (Table 13).

The high incidence of 353 domestic/farm/industrial accidents (28.68%) (Table 14) incurred by 185 amputee in the 21–40 age group (Table 13) need not be blamed on industrialization. In this accident group there were only 76 cultivators (22%) and 137 labourers (39%). Even the injuries sustained by these vocational groups were not entirely confined to their occupation, as some of them were injured by domestic activities undertaken during their free time. Therefore, it was evident that cultivators were more susceptible to gun-shot/explosion, labourers to road accident, students to railway accidents and dependents were prone to all types of accident (Table 14).

Disease was responsible for 723 amputations (32.45%), leading age groups affected were 41–60 (42%) and 21–40 (38%). Gangrene was the main cause of amputation in the 41–60 age group (27%). If the 21–40 and 41–60 age groups were considered together leprosy as well as vascular disease affected them with equal intensities (Table 13). Leprosy prevailed in the dependents but this could be misleading (Table 14), because the high incidence of lepromatous amputees in the 21–40 age group would suggest, that due to the chronicity of their condition, many were transformed to dependency from other vocations.

The majority of the causes of amputation are preventable and may be reduced by appropriate primary and secondary preventive measures. Therefore, it is extremely important to evolve procedures for early detection of leprosy and diabetes mellitus, to ensure adequate treatment coverage and health education in diet and care of anaesthetic hands and/or feet; instructions in first-aid for minor injuries and cuts, road, railway and domestic accidents; and to encourage early referral of congenital amputees. For these procedures to be effective, innovative community-based approaches should be employed as 80% of the population are rural inhabitants. For successful achievement inter-sectorial co-operation is also essential. In addition, research is needed to investigate the cause and prevalence of thrombo-angiitis obliterans in high starch consuming young males. Preventive measures for gun-shot/explosion accidents is beyond the scope of this discussion.

Until these interventions are timely and appropriately instituted drainage of manpower and demand for prosthetic service will continue. To make prosthetic service affordable there will be need for training and further development of simple, functional, durable and acceptable prosthetic components.

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Energy cost of walking with flat feet

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Abstract

A comparative study has been conducted to assess the effects of arch support on oxygen consumption in 20 subjects with flat feet who were generally complaining about fatigue, and also to explore whether their feeling of weariness was objective or not. The resting, walking and final recovery heart rates, blood pressures, and walking oxygen consumption values of the patients with flat feet were measured and calculated and compared to a control group using treadmill and oxygen consumption devices. In stage one the patients did not wear any arch support. Then suitable arch supports were prepared for each patient and in stage two they wore these arch supports. The results did not show any significant difference between the resting heart rates, blood pressure and oxygen consumptions. However, differences in walking heart rate, systolic blood pressure, final recovery heart rate, oxygen consumption, and energy cost values were found to be significant between stage one and two of the test in the patient group. The difference in walking diastolic blood pressure values without and with arch support were found to be insignificant. It may therefore be deduced that oxygen consumption during walking is decreased when a suitable arch support is applied to patients with flat feet.

Introduction

The term flat foot is commonly used to describe the foot in a pes valgoplanus position, in which the arched contour along the medial side of the foot is not evident. A typical feature of the condition is an outward rotation of the base of the calcaneus, called valgus because of the weight-bearing line of the leg. When a pronation deformity is present, the head of the talus, navicular, and first cuneiform bones are displaced downward and medially. An abducted forepart may be observed in the visible flat foot. The equilibrium of these structural components may change if the arches continue to deteriorate (Gray, 1969).

The mechanism of arch support in the foot remains controversial despite years of investigation. According to one theory, the arches are maintained by the contraction of muscles, according to a second, by the strength of passive tissues, and according to a third, by the combination of both muscles and passive structures (Basmajian and Stecko, 1963).

The energy cost of walking in disabled persons has received little attention except when assisted ambulation is considered. Waters and associates (1976) found that the energy cost of walking in amputee patients is increased compared with that of normal subjects, and McBeath et al (1974) and Pugh (1973) showed that in patients using different types of canes or crutches, 30 to 80 per cent more oxygen is consumed.

A survey of the recent literature has shown no comparative study on oxygen consumption of patients with flat feet before and after utilization of arch supports.

The purpose of the present work was to investigate the effects of arch support on oxygen consumption of 20 subjects (all female) with flat feet during treadmill walking.

Patients and methods

Oxygen consumption was measured in 20 patients who had flat feet and in 20 healthy people (all female) used as controls, during treadmill walking. The patients with flat feet were selected according to their X ray findings.

The subjects ranged in age from 18 to 38 (mean: 25.8 ± 1.31) in the patient group and

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from 20 to 35 (mean: 28.0 ± 1.22) in the control group. All of the subjects were evaluated clinically by means of physical examination and postural analysis, and radiographically and it was found that all were in good health.

For the diagnosis of flat feet lateral radiographs of the feet of all the subjects were taken. The angle of plantarflexed talus and the talocalcaneal angle were calculated and the values were found to be normal in the control group (Cavagna et al, 1963, Pugh, 1973). The mean values for the patient group was 40.6 (30-55) degress for angle of plantarflexed talus and 49.5 (38.5-59) degrees for talocalcaneal angle.

Footprints of the patients with flat feet were taken and the head of the first metatarsals, medial tubercle of calcaneus and sustentaculum tali were marked and the distance of these points from the heel were calculated to prepare a suitable medial longitudinal arch support made of polyethylene. The arch support was placed between insert and leather to avoid its displacement in the shoe.

Before the test each subject was evaluated electrocardiographically and no pathological change was observed.

Before the actual measurements were made, the subjects were trained to walk on the treadmill with a respiratory mask in place until they felt perfectly at ease with the apparatus. The measurements were made two hours after the patients had eaten a meal, at an ambient temperature of 18 to 20 degrees Celsius and a relative humidity of 40 to 60 per cent. The body weight and height of each patient was determined prior to each test.

The subjects were made comfortable in the sitting position and their resting oxygen consumption was measured by Versatronik Oxygen Consumption Computer Model 0-1000. Then their electrocardiographs were taken from CR_4 derivation in standing position and resting heart rates with the systolic and diastolic blood pressures were also measured.

In the first step of stage one the subjects walked steadily with the respiratory mask in place at a speed of 4.83 km. per hour on level ground for six minutes. In the second step of stage one they walked at a speed of 6.44 km. per hour on an incline of 10 per cent for six minutes. In the third step they walked at a speed of 8.05 km. per hour on an incline of 20 per cent for six minutes. Their blood pressures were measured, electrocardiographs taken, and heart rates and oxygen consumption were calculated for the walking results of stage one.

After the treadmill was stopped the recovery systolic and diastolic blood pressures of the patients were measured while sitting again and heart rates were calculated at the first, third and fifth minutes for the final recovery results of stage one.

The patients with flat feet were given their arch supports and were told to use it continuously for two weeks. In stage two the same measurements were made again for both of the groups and resting, walking and final recovery heart rates, blood pressures and oxygen consumptions were calculated.

All results were evaluated by computerized statistical methods to assess signifcance by means of Student t-test.

Results

The patients ranged in height from 1.55 to 1.69 metres (mean : 1.60 ± 0.00036) and the controls ranged in height from 1.60 to 1.71 metres (mean: 1.63 ± 0.00025). The patients ranged in weight from 43 to 63 kilograms (mean: 53.25 ± 1.18) and the controls ranged in weight from 45 to 62 kilograms (mean: 52.31 ± 2.01).

The resting heart rates, blood pressures and oxygen consumption values do not show a significant difference in stage one and two for both of the groups, so it can be considered as a criterion of the objectiveness of these tests ($p > 0.05$) (Table 1). The tests were planned to start in the same conditions.

Walking heart rates, systolic blood pressure, oxygen consumption, and energy cost values are given in Table 2, showing a significant decrease in stage two where the subjects wore arch supports ($p < 0.01$). No significant

Table 1. The mean resting values of the patients (n = 20).

	Stage 1	Stage 2	Difference	(Std. deviation)
Heart rates (per minutes)	91.25	89.35	0.75	(2.67)*
Systolic blood pressure (mm Hg)	113.50	111.75	1.75	(4.06)*
Oxygen consumption (ml/min)	241.25	238.50	2.75	(6.38)*

* $p > 0.05$

Table 2. The mean walking values of the patients (n = 20).

		Stage 1	Stage 2	Difference	(Std. deviation)
Heart rates (per minute)	First step	117.75	112.70	5.05	(4.79)*
	Second step	143.05	134.50	8.55	(8.66)*
	Third step	186.20	171.60	14.60	(12.34)*
Systolic blood pressure (mm Hg)	First step	118.75	116.50	2.25	(3.43)*
	Second step	128.75	124.00	4.25	(3.73)*
	Third step	138.50	131.75	6.75	(4.06)*
Oxygen consumption (ml/min)	First step	737.50	677.50	60.00	(30.78)*
	Second step	1115.50	1023.00	92.50	(90.69)*
	Third step	1618.50	1493.50	124.50	(59.25)*
Energy cost (ml/kg/min)	First step	13.90	12.76	1.14	(0.39)*
	Second step	21.07	19.30	1.76	(0.75)*
	Third step	30.79	28.28	2.51	(1.40)*

* $p < 0.01$

decrease was observed in stage two of the control group ($p > 0.05$).

Walking diastolic blood pressure values in stage one and two for both of the groups showed no significant difference ($p > 0.05$). During exercise diastolic blood pressure changes do not occur so in this test the values before and after the arch support in the patient group did not show a difference. Also the values of the control group in stage one and two did not show a difference.

The oxygen consumption values (millilitres per minute) increased during the exercise period but the increase is significantly less in stage two of the test where the subjects in the patients group wore arch supports ($p < 0.01$). No significant decrease was observed in the control group in stage two ($p > 0.05$).

The energy cost values (millilitres per kilograms per minute) were found to be significantly less in stage two ($p < 0.01$) of the patient group but no significant decrease was observed in stage two of the control group ($p > 0.05$).

Discussion

In 1938 Margaria analysed the energy cost of walking for normal subjects — uphill, downhill and on level ground at different speeds. He showed that the optimum speed (least energy cost per unit of distance) is higher the more gradual the incline, being about four to five kilometres per hour when the subject is walking on level ground. At this speed the oxygen consumed is about 100 millilitres per kilogram of body weight per kilometre. At higher or lower speeds the energy cost increases disproportionately.

According to Fisher and Gullickson (1978) normal and disabled persons naturally attempt to walk at a speed which is most efficient in terms of E_e/kcal/min. Disabled persons decrease their speed of walking, so that their E_e/kcal/min decreases toward the normal range. The more disabled a person, the more determinants of gait are lost, therefore the more E_e/unit distance is used in ambulating and the less efficient is the gait.

The energy cost of locomotion has also been analysed during treadmill walking (Falls and Humprey, 1976; Margaria, 1968; Passmore and Durnin, 1955; Bobbert, 1960). The treadmill allows control of the experimental conditions, particularly the speed of locomotion, and it has been clearly shown that treadmill walking gives substantially identical results to normal walking, the only difference being in air resistance, which is negligible at walking speeds.

When an individual is walking uphill, there is less lowering of the centre of gravity of the body (negative work) compared with the preceding lift because of the incline of the terrain, hence, there is less reutilization of the kinetic energy and a higher metabolic cost. Other aspects of the interchange of energy may also affect metabolic cost. For example, higher deceleration when the foot strikes the ground may require compensatory increase of positive work to maintain constant speed, and this higher energy cost will mean increased oxygen consumption (Veicsteinas et al. 1979).

Buskirk and Taylor (1957) reported that

maximum oxygen consumption with an incline of 10 per cent and a speed of 5-6 km per hour is 50.02 ml per kg per min in healthy people. These values are higher than in this series of tests. The results of Kasch et al (1966) were 48.25 ± 4.5 ml per kg per min maximal oxygen consumption for 12 healthy people, and Pandolf and Goldman (1975) reported 34.69 ± 2.25 ml per kg per min maximal oxygen consumption for eight healthy people. The authors' results are parallel to this.

Veicsteinas et al (1979) reported that only subjects with rigidity of the talocalcaneal joint showed increased oxygen consumption which reached 5 to 20 per cent above normal. They also showed an increased step frequency, probably as a compensatory mechanism to reduce the mechanical work performed during each step.

A control group was used in this study because it was possible that if the same patients were re-examined at two weeks without the arch support they might have improved their performance without, simply because they were now used to the test.

As a conclusion from the results of the tests it can be proposed that oxygen consumption can be decreased in patients with flat feet simply by applying a suitable arch support. This may be because flat feet require more muscular effort to accommodate the strain and avoid pain or because of abnormal forces due to the loss of the mid foot rocker.

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Modern above-knee fitting practice (A report on the ISPO workshop on above-knee fitting and alignment techniques May 15–19, 1987, Miami, USA*)

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Introduction

During the period of May 15-19, 1987, an International Workshop on Above-Knee Fitting and Alignment Techniques was held in Miami, Florida. Conceived and organized by A. Bennett Wilson, Jr. and Mel Stills, the workshop was supported and sponsored by the International Society for Prosthetics and Orthotics with the support of the Rehabilitation Research and Development Service of the Veteran's Administration. Hosting the workshop was the Prosthetics and Orthotics Education Programme of the School of Health Sciences, Florida International University, and more specifically, Dr. Reba Anderson, Dean of Health Sciences and Ron Spiers, Director of Prosthetic Orthotic Education. More than 50 physicians, prosthetists, engineers and educators from the United States, England, Scotland, Denmark, Sweden, Israel, the Netherlands and Germany participated.

The purpose of the workshop was an organized exchange of information and experiences relative to the management of above-knee amputees. Above-knee socket design variables, specifically the accepted and established quadrilateral design and the newer ischial-containment designs known by various acronyms, (CAT-CAM, NSNA, Narrow M-L), were discussed in detail in an effort to determine differences and similarities, advantages and disadvantages, indications and contraindications, in order to develop recommendations for future action. While many prosthetists and/or clinics may have considerable experience with the newer AK socket designs within the United States, it is true that there are still many questions and concerns on the part of consumers, clinicians, third party paying agencies, and educators in the U.S., as well as a great curiosity on the part of the international community.

The workshop was introduced by Dr. Anderson, Dean of Health Sciences at Florida International University; Professor John Hughes, President of ISPO; and Dr. Margaret Gianninni, Director of the Rehabilitation Research and Development Service of the Veteran's Administration.

History of above-knee fitting

The programme began with a presentation by Bennett Wilson, entitled "Recent Brief History of AK Fitting and Alignment Techniques." This paper identified the advent of the suction socket in the U.S. shortly after World War II and traced the development of the total-contact quadrilateral socket in the early 1960's. The audience was reminded that the total-contact quadrilateral socket, with or without suction suspension, was the socket design of choice from 1964 until very recently, when ischial-containment socket designs emerged. It was noted that, at present, the three senior prosthetic education programmes in the U.S.A., University of California, Los Angeles, Northwestern University, Chicago, and New York University, in addition to teaching the application of the standard total-contact quadrilateral socket, are offering special courses in what at first glance appear to be radical departures from the quadrilateral design. The technique at UCLA is known as CAT-CAM (Contoured Adducted Trochanteric-Controlled Alignment Method), based on work by John Sabolich and inspired by Ivan Long. The

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* The full Report of the meeting will be published by ISPO.

technique being presented at Northwestern University is said to be based more directly on the Ivan Long technique and is known as NSNA (Normal Shape-Normal Alignment). The technique taught at New York University is usually referred to as the Narrow ML (medio-lateral) socket design using a special jig designed by Daniel Shamp to facilitate casting. Mr. Wilson concluded his remarks by saying that "unfortunately, none of these techniques has been subjected to an evaluation programme independent of the development group, and a great deal of confusion exists among clinicians responsible for amputee care. I hope that this workshop can be helpful in clearing away some of the confusion, and point the way for action that will bring order to the present day practice of AK prosthetics."

UCB quadrilateral socket-review

Professor Charles Radcliffe, Professor of Mechanical Engineering at the University of California, Berkeley (UCB) presented a paper entitled "Review of UCB Quadrilateral Socket and Alignment Theory". Having been a member of the Prosthetic Devices Research Project of UC Berkeley in the 50's and 60's, Professor Radcliffe is still a strong proponent of the quadrilateral socket. He presented a detailed review of the history and development of the quadrilateral socket and summarized this section of his presentation with the following comments: "The net result of all of this work in the 1950-1963 period was a better understanding of the complex interrelationships between the functional capability of the amputee, the rehabilitation goals, the prosthetic components required in the prescription, the gait of the amputee, the biomechanical forces generated, the socket shape, and the alignment. The socket was no longer described as a cross-section shape at the ischial level but rather a three-dimensional receptacle for the stump with contours at every level which could be justified on a sound biomechanical basis . . . . It should be emphasized again that the quadrilateral type of fitting is not just a socket, it is a complete system which includes the amputee as a most important component. The socket is the interface between stump and prosthesis, and its primary functions are to provide for weight-bearing in the stance phase, allow the use of the stump and hip musculature to control motion and posture of the upper body in the stance phase, and to provide for control of the prosthesis in the swing phase of walking."

The next section of Professor Radcliffe's paper focused on biomechanical and alignment principles of a prosthesis with a quadrilateral socket. Here he related his feelings that many of the claims made by proponents of the newer non-quadrilateral socket designs are equally attainable in the quadrilateral socket, if the original biomechanical principles are followed. "Regardless of the fitting method employed, the socket for any patient must provide the same overall functional characteristics including comfortable weight-bearing, a narrow base gait, and as normal a swing phase as possible consistent with the residual function available to the amputee after amputation. It is possible to provide this with a quadrilateral socket and it is being done routinely in many facilities." Professor Radcliffe went on to say: "In most of the recent articles that I have read, statements have been made which indicate clearly that the author is comparing very poorly fitted quadrilateral sockets to the results obtained using the new technique. They show diagrams of typical fittings and gait deviations which can only be described as a complete list of horror stories describing what not to do in fitting a quadrilateral socket. Any prosthesis with the problems listed in these articles should never have been delivered. If the average prosthetist in the United States is having the problems described by Long, Shamp, and Sabolich, then I must suggest that something is wrong with the methods being taught and used in daily practice. I am aware that the schools have made significant changes in the way that the principles are taught, with each school emphasizing different aspects of the problem. I suspect that there may have been a shift away from the fundamentals of teaching of overall objectives, including the interrelationships of amputee evaluation, components prescribed, biomechanics, and why sockets are fitted with particular contours."

UCLA CAT-CAM prosthesis

Following Professor Radcliffe was Tim Staats, Director of the UCLA Prosthetics Education Programme. Mr. Staats' presentation was on the "UCLA CAT-CAM" prosthesis. UCLA began teaching CAT-CAM AK prosthetics with

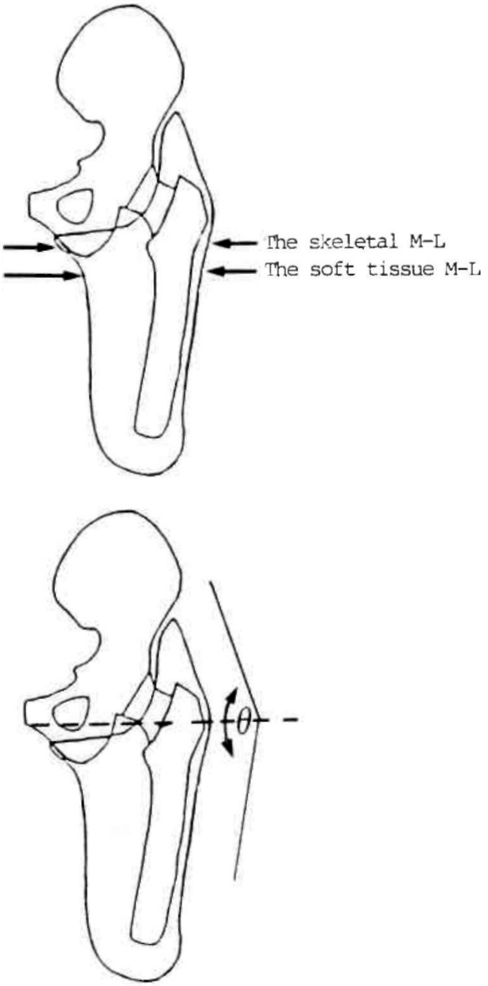


Fig. 1. UCLA CAT-CAM. Top, medial-lateral diameter measurements. Bottom, ilio-femoral angle.

a pilot course in March of 1985, which included both John Sabolich and Tom Guth as course instructors. Mr. Staats made it clear that the UCLA CAT-CAM philosophy of 1987 has departed from that of Sabolich, Guth, et al, and that the UCLA philosophy has now evolved to the point where a third edition of a teaching manual was published in March, 1987. To quote Mr. Staats as he spoke about this new manual: "The UCLA CAT-CAM above-knee socket is a variation of the CAT-CAM design developed by John Sabolich and Tom Guth, and the NSNA AK prosthesis of Ivan Long. Through countless hours of literature search, discussion and intensive training given in this and nine foreign countries, and through the results of over 200 students who have fabricated and fitted over 1000 sockets under the guidance of our staff, a new insight has been developed. Our staff has refined the techniques of measurement, casting, and model modification to the point where it is a clearly teachable and viable above-knee fitting method. It is with great respect that we continue to recognize the published contributions of John Sabolich, Tom Guth and Ivan Long, to the development and evolution of the UCLA technique. We would hope that this manual captures, blends, and enhances their philosophies. We recognize that our technique and CAT-CAM evolved from NSNA and we hope that these professionals can appreciate our efforts to refine and further evolve their clinical approach into a methodical step-by-step teaching manual."

Reviewing briefly the highlights of the UCLA CAT-CAM sequence, and beginning with patient evaluation and measurement and proceeding through modification and bench alignment it is suggested that reference should be made to the third edition of the UCLA manual.

The recommended evaluation/measurement protocol is very complete and detailed. Adduction and flexion analysis of the stump are emphasized. Some new measurements and/or evaluations are introduced and illustrated:

skeletal ML dimension, actually measured on patient (Fig. 1, top).

soft tissue ML dimension, taken from Ivan Long's chart of circumferences and related ML values (Fig. 1, top).

ilio-femoral angle, actually measured on the patient (Fig. 1, bottom)

pubic arch angle, evaluated by palpation and captured in the wrap cast (Fig. 2).

ischial inclination, evaluated by palpation and captured in the wrap cast (Fig. 3, top).

The wrap cast is taken with the patient in a standing position, and all shaping of the cast is accomplished by hand moulding. The goal is

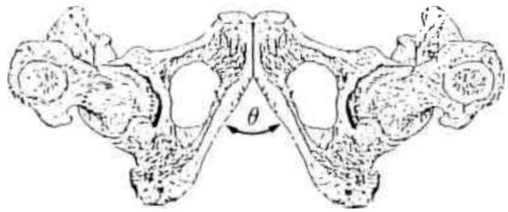


Fig. 2. UCLA CAT-CAM. The pubic arch angle

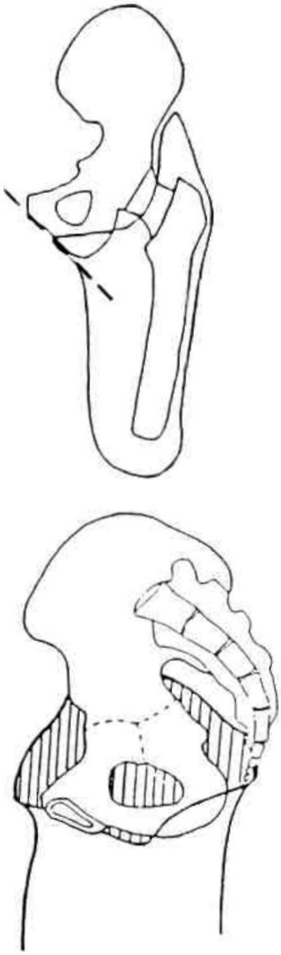


Fig. 3. UCLA CAT-CAM. Top, ischial inclination angle. Bottom, medial view of pelvis-socket relationship.

good definition and containment of the medial and posterior aspects of the ischial tuberosity and ischial ramus within the wrap cast and subsequent socket, as well as allowance for the pubic ramus to exit the socket near the midline of the medial wall (Fig. 3, bottom).

The initial trimlines for the resultant socket are as follows:

(a) Anteriorly, just proximal to the inguinal crease. The anterolateral brim must clear the superior iliac spine when the patient is sitting.

(b) Laterally, the brim extends approximately three inches above the trochanter. The final height of this wall is determined during fitting.

(c) Posteriorly, the trim line should begin at least one inch above the level of the inferior border of the ischial tuberosity. The curve that defines the posterior to lateral trim line normally begins at a point between the lateral third and the midline of the socket ML dimension at ischial level.

(d) The medial proximal brim will be "V" shaped, with the vortex of the "V" located at the point where the pubic ramus crosses the medial wall. This trim line projects upward from the vortex, posteriorly to encapsulate the medial aspect of the ischial ramus and tuberosity (Fig. 3, bottom). A circumference reduction chart is used to attain suction suspension. The values used in this chart are slightly less than those normally used in quadrilateral suction sockets.

For bench alignment, the following references are used:

(a) posteriorly, the socket is bisected at the level of the soft tissue ML; this reference line should fall as a plumb line to the centre of the heel

(b) laterally, the AP dimension of the socket is bisected at ischial level; this reference line should fall as a plumb line between zero and one inch anterior to the foot bolt

(c) socket is set in measured adduction and measured flexion plus five degrees

(d) the distal aspect of the medial wall should be on the line of progression

(e) the knee bolt is externally rotated five degrees

(f) the top of the foot, as well as the prosthetic shank, should lean medially four degrees; or the socket is hyper-adducted four degrees beyond measured adduction with the foot parallel to the floor and the shank perpendicular to the floor.

The UCLA CAT-CAM can be fabricated using rigid or flexible socket techniques. If a flexible socket or brim system is desired, the proximal medial trimline in the ischial area must be more aggressive during casting to allow for the linear shrinkage factor found in most thermoplastics.

A final comment — the manual reflects the accumulated experience of the UCLA staff and includes a section on solving the difficulties that might be experienced in fitting the CAT-CAM socket.

NSNA above-knee techniques

The next speaker was Gunther Gehl, Director of Prosthetic Education at Northwestern University in Chicago. Northwestern has been teaching the NSNA AK techniques of Ivan Long for several years now, and it was Mr. Gehl's task to report to the workshop on NSNA and Long's Line. He said that he and his staff taught NSNA as presented by Ivan Long with no changes. Long has been fitting Long's Line, now known as NSNA, for more than 12 years, and his approach has been consistent, with few changes. Perhaps changing the name from Long's Line to NSNA in July 1985 is the most significant change. Mr. Long has published three technical papers describing his technique: *Allowing Normal Adduction of the Femur in Above-Knee Amputees,* ('Orthotics and Prosthetics' December 1975); *Fabricating the Long's Line Above-Knee Prosthesis,* (1981); and as a reprint of the Long's Line article with new title, *Normal Shape-Normal Alignment (NSNA) Above-Knee Prosthesis,* ('Clinical Prosthetics and Orthotics' Fall of 1985). These articles were the basis for Gunther Gehl's presentation to the International Workshop.

The following is a review of the NSNA philosophy . Again, this is an overview within the limitations of this report. The details are available within Long's publications.

NSNA is less detailed regarding evaluation and measurements, placing great emphasis on the wrap cast, subsequent model modification, and alignment, all based on Long's Line, which is defined as a straight line, starting approximately at the centre of a narrow socket, passing through the distal femur down to the centre of the heel (Fig. 4). Long's Line shifts constantly when the amputee goes from a standing position to a walking position.

The wrap cast is taken with the patient in a standing position. The important points about the wrap cast procedure are identification of the ischium and proper alignment. The hand will be positioned to indicate the medial and posterior surface of the ischium, but not forward of the ischium. The amputee then adducts his stump as tightly as possible and extends his hip to tighten the hamstrings. At this point a lateral reference line is established.

The resultant cast model is oversized and requires considerable modification. Practically all modification takes place on the lateral wall.

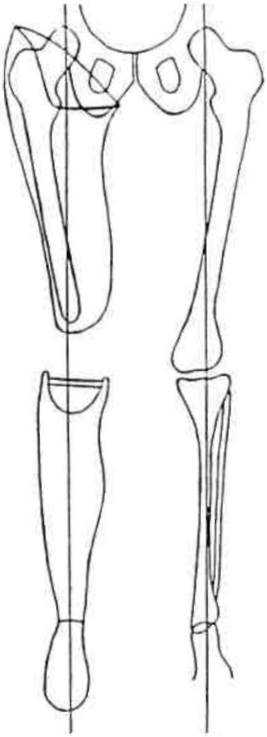


Fig. 4. Long's line.

The following is a brief description of modification goals and resultant trimlines, taken from Gehl's presentation and from Long's publications:

(1) The lateral wall is to be shaped to give support over a wide area, and particularly the lateral-posterior aspect of the socket.
(2) The medial wall will be lower than seat level, and the wrap cast will be the guideline as to level.
(3) Depth of the socket will be the same as the measured length of the thigh.
(4) The seat will be at a right angle to Long's Line.
(5) Long's Line is drawn from the centre of the seat level ML dimension to the centre of the distal femur. (The distal femur will be very close to the lateral surface, probably covered only by skin).
(6) The top one inch of the medial wall will flare outward 45 degrees.
(7) The lateral wall extends above the trochanter.
(8) The ischium will bear on the flare of the socket, both medially and posteriorly.

Table 1. M-L values determined from circumference just below ischium

Circumference just below ischium	Goal M-L
9″	− 2.5
10″	− 2.7
11″	− 2.9
12″	− 3.1
13″	− 3.3
14″	− 3.5
15″	− 3.7
16″	− 3.9
17″	− 4.1
18″	− 4.3
19″	− 4.5
20″	− 4.7
21″	− 4.9
22″	− 5.1
23″	− 5.3
24″	− 5.5
25″	− 5.7

(9) Plaster will be removed in the ML section as though the trochanter did not exist. To achieve the desired ML dimension, many casts will have to be reduced by two inches or more. The desired ML dimension is taken from Long's chart of ML values related to the thigh circumference just below the ischium (Table 1). Circumference reductions for suction suspension begin at one inch of tension proximally, reducing to ¾ inch, then ½ inch, with the remaining tensions at ¼ inch.

Long does not advocate the use of an alignment device. Bench alignment is critical and is based on Long's Line. The centre of the lateral wall is marked at seat level for TKA and the vertical reference line established during casting should be parallel to the TKA line. Long's Line is marked on the posterior of the socket. For the male, the socket is mounted with the inner aspect of the medial wall (which follows the pubic ramus angle) in 30 degrees internal rotation to the line of progression (the outer edge of the medial trimline is on the line of progression), and with the knee bolt axis four degrees higher on the lateral side. This is the same as adding four degrees of additional adduction to Long's Line. For the female, the socket is mounted with the inner aspect of the medial wall in 40-45 degrees internal rotation to the line of progression (again, the outer edge of the medial trimline is on the line of progression), and with the knee bolt axis seven degrees higher on the lateral side. Long emphasizes, that it is not necessary to change the alignment. When the amputee is allowed time to adjust to the new prosthesis, it will be found that alignment changes will not be necessary.

The Shamp brim for narrow ML socket

Daniel Shamp, then presented "The Shamp Brim, for the Narrow ML Above-Knee Prosthetic Socket." Shamp's system of brim casting and evaluation is currently the content of a special short course offered by New York University's Prosthetic and Orthotic Education Programme.

Long and Sabolich, as well as UCLA, advocate that the hand casting technique is the most successful in their experience with the narrow ML, wide AP, or ischial-containment socket for above-knee amputees. In response Shamp stated: "Experience with the Shamp Brim system has proven to make the procedure more uniformly successful and more easily learned and applied by the practitioner who has spent years working with the brim method for quadrilateral socket casting and modification." Shamp went on to present a detailed biomechanical rationale for the narrow ML socket. Biomechanical descriptions such as bony lock on the ischium, ischial containment within the socket, retention of normal adduction, etc. are consistently relevant to Shamp's socket system as well as all of the latest ischial-containment socket designs. Two noticeably different aspects of Shamp's technique are:

(1) the brim forming system itself, which allows for evaluation of brim design under weight-bearing conditions before proceeding with the wrap cast, and
(2) what Shamp refers to as, "centralization of the femur".

To accomplish centralization of the femur, during the casting procedure, the prosthetist pulls the distal medial tissue of the stump in a lateral direction while stabilizing the femur with the other hand by means of a 45 degree force against the lateral shaft of the femur (Fig. 5, left). Shamp stated that this centralization procedure is essential to prevent a large medial-distal bulge with resultant cosmetic problems when the femur is maintained in a position of maximum adduction in the AK prosthesis.

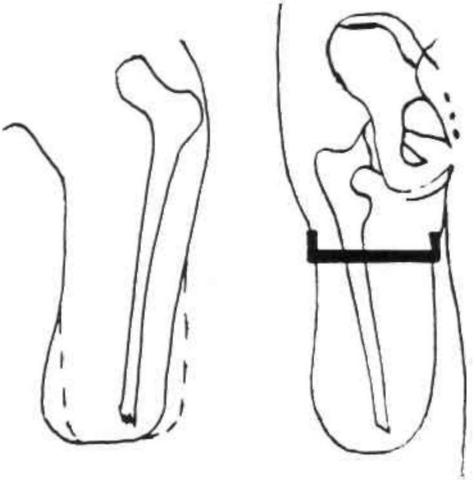


Fig. 5. Narrow ML socket. Left, centralization of the femur. Right, distal ischial tuberosity (DIT) medial-lateral diameter measurement.

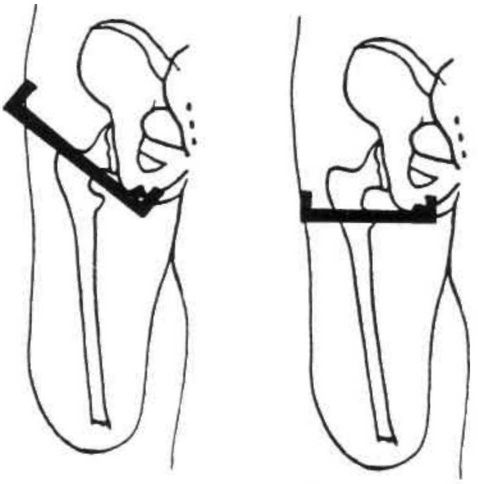


Fig. 6. Narrow ML socket. Left, oblique (OB) medial-lateral diameter measurement. Right, ischial tuberosity (IT) medial-lateral diameter measurement.

An overview of the Shamp Narrow ML technique follows, summarizing from Shamp's presentation and from the "Manual for Use of The Shamp Brim", which was provided for the workshop attendees. This manual was produced by Prosthetic Consultants Incorporated of Akron, Ohio in cooperation with the Department of Prosthetics and Orthotics, New York University Post-Graduate Medical School, and is published by the Ohio Willowwood Co.

The measurement and evaluation procedure includes a careful observation and recording of the characteristics, lengths, and circumferences identified on the Narrow ML AK Information Chart. Review of this information chart will show the practitioner familiar with the technique for the quadrilateral socket that only a small number of measurements are different for the Narrow ML socket. It is important to note that three ML measurements must be taken precisely as follows:

(1) Distal Ischial Tuberosity (DIT): firm ML measurement of the stump taken one or two inches distal to the ischial tuberosity (Fig. 5, right).
(2) Oblique ML (OB): firm ML measurement taken from the medial side of the ramus of the tuberosity to a point just superior to the greater trochanter of the femur (Fig. 6, left).
(3) Ischial Tuberosity ML (IT): firm ML measurement taken from the medial border of the ramus of the ischial tuberosity to the subtrochanteric area of the femur (Fig. 6, right).

The Shamp Brim, which is compatible with the Berkeley brim stand, is now set up and adjusted to the patient's measurements. As stated earlier, the brim allows for weight-bearing evaluation of the patient with regard to socket design before the actual wrap cast is taken.

As with all of the ischial-containment socket designs discussed at the Workshop, the location of the ischial tuberosity in the socket is essential to both a comfortable fit and a stable femur in maximum adduction. For the Shamp technique the ideal location is ½ inch inside the medial-proximal wall of the prosthesis and indicates the area referred to as the IT ML measurement. The medial wall has a 45-degree angle that assists the wedge effect in stabilizing the femur, therefore the location of the tuberosity on this slope is important. The trimlines are similar to both NSNA and the UCLA CAT-CAM, including the low anterior wall with clearance for the ASIS, the relatively horizontal posterior wall, and the high lateral wall, which is extended generously above the trochanter. Although, not as exaggerated as in the UCLA CAT-CAM, the medial wall is lowered as it approaches the anterior wall, allowing for the pubic ramus to pass from within the socket.

Alignment follows generally accepted quadrilateral alignment principles for TKA and knee bolt external rotation. For alignment in the frontal plane (posterior view, ML plane), Shamp advocates the principles of Long's Line.

Design criteria for geriatric above-knee sockets

Dr. Hans Lehneis of the Rusk Institute of Rehabilitation Medicine was the next speaker and his presentation covered work done at the Rusk Institute and the New York V.A. Medical Centre. Dr. Lehneis and associates are investigating anatomical, physiological, and biomechanical characteristics of geriatric above-knee amputees in an attempt to develop a set of design criteria for geriatric above-knee sockets. This project is still in the developmental stages.

Flexible sockets

Ossur Kristinsson of Iceland, the developer of the flexible socket-rigid frame system made the next presentation. Kristinsson reported that he was continuing development of flexible sockets, including walls and brims. He is conducting an extensive materials search in hopes of finding those materials that will make possible the ultimate flexible socket design. He went on to say that we need some simple definition of flexible socket characteristics: "To label a socket as flexible I would say that you should be able to deform it by your hands, and the material should not be elastic enough to stretch under the loads it will be subjected to." Concerning flexible socket design, Kristinsson stated: "When designing a flexible socket system the most critical aspect for the comfort of the wearer is how the frame is designed. It has to be capable of supporting the flexible socket, preventing permanent deformation, and the socket-frame combination has to be structurally strong and stable enough to counteract the reaction forces." A final, important point made by Kristinsson was that "There may be doubt among professionals and users about the value of the flexible wall. I am, however, totally convinced that the flexible socket is here to stay. If anything, I think it will get more flexible as we gain access to more suitable materials than we are using today, and some obstacles on the way to proper understanding of the socket-stump interaction are overcome."

Continuing the flexible socket presentations was Norman Berger of New York University's Prosthetic Orthotic Programme. Berger's presentation was of the ISNY (Icelandic-Swedish - New York) flexible socket design as published and taught by NYU. Berger described the socket and frame fabrication technique used in the ISNY design. Three interesting points are worthy of mention:

(1) the flexible socket is fabricated with polyethylene, which has a known shrinkage factor
(2) the desired wall thickness of the flexible socket is 0.06 inch
(3) lateral distal support for the femur is not provided by the frame.

The final presentation on the topic of flexible sockets was made by Charles Pritham of Durr Fillauer. A co-author and co-developer of Durr-Fillauer's flexible socket technique, Pritham described the biomechanical function of the flexible walled ischial-gluteal bearing quadrilateral socket as follows:

(1) ischial/gluteal weight-bearing
(2) stabilization of the distal femur laterally
(3) total contact
(4) flexible walls

Note the mention of stabilization of the distal femur laterally; this is provided by the frame design of the Scandinavian Flexible Socket. Pritham went on to say: "It will be appreciated that the design is actually not fundamentally different, flexible walls aside, from a similarly designed socket in the rigid walls. Indeed one of the factors that undoubtedly hastened its acceptance was the fact that previously learned methods of casting and fitting quadrilateral sockets were fully acceptable when fitting a flexible walled socket. While the advantages cited are formulated with the quadrilateral socket in mind, there is no reason to suspect that they are significantly different from non-quadrilateral AK sockets. Indeed, flexibility is often considered by the designers of one another of the various designs as an integral factor in their success."

Pritham listed advantages of flexible walled sockets as follows:

(1) flexible walls
(2) improved proprioception
(3) conventional fitting techniques
(4) minor volume changes readily accommodated
(5) temperature reduction
(6) enhanced suspension.

Indications for use of the flexible wall socket are:

(1) mature stumps (where frequent socket changes are not anticipated)
(2) medium-to-long stump (where a significant portion of the wall will be left exposed and flexible)
(3) suspension is not a factor.

While the use of flexible wall sockets has been well accepted, Pritham pointed out that questions have arisen in at least three areas.

A. Material

Both Surlyn and low density polyethylene (in a variety of types and name brands) have been used successfully and each has its advocate. Pritham and colleagues at Durr Fillauer prefer Surlyn for three reasons: clarity, no shrinkage and ease of rolling the edge.

B. Thickness

Originally socket walls .030 inch thick were specified, but walls this thin lacked durability. Subsequently, thickness in the neighbourhood of .080-.090 inch were specified and are preferred. (Note, NYU prefers .060 inch.)

C. Frame configuration

At least three different configurations have been described for quadrilateral sockets. The differences centre on the lateral wall and the amount of support considered necessary for the femur.

A variety of designs have been put forth in order to achieve specific features in non-quadrilateral sockets, including the total flexible brim.

Pritham concluded his presentation by saying: "The crucial point would seem to be that flexibility is independent of socket shape and can be modified to provide specific design features in a socket-frame system. The specific configuration depends upon the prosthetist's experience and fitting philosophy and the needs of the individual patient."

Total surface bearing sockets

Rounding out the first day of presentations was Dr. Robin Redhead, Chief Limb Fitting Surgeon at Roehampton Limb Fitting Centre in London. Redhead's paper was entitled "Experience With Total Surface Bearing Sockets." This presentation centred more on pressure distribution and biomechanics than on socket design or shapes. Dr. Redhead and associates maintain that regardless of socket shape or design, well distributed weight-bearing can eliminate the need for single point, bony weight-bearing, such as ischial weight-bearing. This system of well distributed weight-bearing was referred to as a total-surface-bearing socket. It infers a hydrostatic type of socket fit utilizing the incompressibility of the fluids in an AK stump.

This presentation brought a reaction from Professor Radcliffe, who does not agree with the hydrostatic concept of weight-bearing in prosthetics. He stated that "You need a closed system for hydrostatics and the AK stump is not a closed fluid system. With an open fluid system, the fluids are pushed out."

There was considerable discussion on this topic, both pro and con, and it was not satisfactorily resolved.

Sabolich/Guth CAT-CAM socket

On the second day, John Sabolich, from Oklahoma City, and Glenn Hutnick, from New York, presented another view of CAT-CAM. As stated earlier, Staats had reported that the UCLA CAT-CAM is evolving independently of the CAT-CAM technique of the original developers.

Sabolich and Hutnick reported that the original CAT-CAM was continuing to evolve and develop. Sabolich stated that: "It took five to six years to develop the current medial wall design, which has become increasingly more aggressive in enclosing and capturing the ischial ramus." They advocated use of the total flexible brim. "The key is the flexible brim system — it is totally flexible in the proximal area, where most patients complain." Aside from 100 per cent use of the total flexible brim, the Sabolich/Guth CAT-CAM differs from NSNA and the UCLA CAT-CAM by not advocating the four to seven degrees medial lean of the foot, pylon, and knee bolt in bench alignment as proposed by Long and UCLA. Sabolich went on to say "this additional adduction or tilting of the knee bolt is a coverup for lost stability due to inadequate ischial containment." Long's response was that this was incorrect. Probably the most noticeable aspect of design that separates the Sabolich/Guth CAT-CAM apart from the other recent ischial-containment designs is the aggressive capture of the ischial tuberosity and ramus mentioned above. Sabolich claimed that they are enclosing more and more of the ischial ramus, as much as possible and still allow comfort in the pubic ramus area. This ramus enclosure provides two biomechanical functions: (1) a medial bony stop for ML stability and (2) rotational control, especially on soft fleshy stumps. Other than these departures, the Sabolich/Guth CAT-CAM differs very little from the UCLA CAT-CAM, especially in terms of brim shape, trimlines, and biomechanics. Sabolich, unlike Long, does advocate the use of dynamic alignment devices.

At this point in the Workshop, Professor Radcliffe returned to the podium in an attempt to present and clarify the comparative biomechanical principles of both quadrilateral and ischial-containment sockets. The following biomechanical analyses are taken from Professor Radcliffe's discussion and from the paper he later submitted reviewing his presentations.

"It has been demonstrated that pressure against the medial aspect of the pubic ramus can be used to supplement the weight-bearing on the tuberosity of the ischium and contribute to medial stabilization in the upper one-third of the above-knee socket. In taking advantage of the weight-bearing potential on the medial aspect of the ramus, the prosthetist is creating a situation much like weight-bearing on the seat of a racing bicycle. To prevent the ramus from sliding laterally and downward into the socket, the prosthetist must exaggerate the counterpressure from the lateral side. This has been done by a reduction in the M-L dimension particularly in the area just distal to the head of the trochanter. The soft tissue must be accommodated, and therefore, the A-P dimension is correspondingly increased compared to the quadrilateral socket. Compared to the quadrilateral fitting the height of the anterior brim is typically lowered and flared and the gluteal area is filled in and fitted higher as a result of the ischium being encased deeper into the socket.

"The medial brim of the socket must slope forward and downward to the point where the pubic ramus crosses the medial brim and emerges from the socket. The ischial ramus clearly is capable of providing medial counterpressure which supplements the medial pressure on the adductor musculature. Since the socket slopes downward and inward along the entire medial brim, this contour is faired into the medial wall of the socket, which gives the impression of exaggeration of the medial counterpressure in the upper one-third of the socket.

"The adduction of the socket and the use of lateral stabilization should not differ from that achieved by a properly fitted quadrilateral socket. There is an apparent exaggeration of the modification of the lateral wall, but this is primarily limited to the area just below the trochanter where the M-L dimension has been reduced to ensure that the encased pubic ramus and ischium are maintained in the desired position on the medial brim. The exaggeration of the medial flare and reduction of the M-L dimension in the upper third of the socket leads to the impression of a greater angle of femur adduction, but the actual angle of the femur should be similar in both types of fittings if the quadrilateral socket is properly fitted and aligned.

"Long's Line as proposed by Ivan Long is the *anatomical axis of the lower extremity* as described in anatomy textbooks. Placing the femoral stump in an advantageous position for normal use of the hip musculature by adduction and flexion of the socket has been a part of good prosthetic practice for at least forty years in the United States and perhaps longer in certain European centres. Mr. Long's line appears to be most useful in the cast taking procedure and subsequent modifications of the model rather than have any fundamental bearing on the alignment of the prosthesis. It appears to offer no new concepts useful in the bench or dynamic alignment of the prosthesis."

Professor Radcliffe told the Workshop that the use of "catchy names" should be avoided, and he therefore proposed the terminology of ISCHIAL-RAMAL weight-bearing socket as well as ISCHIAL-GLUTEAL weight-bearing socket.

Professor Radcliffe continued his biomechanical analysis by saying "The biomechanics of the ischial-ramal weight-bearing socket are similar to the ischial-gluteal weight-bearing quadrilateral socket. The major differences are in the manner in which the ischium is maintained in position within or on the brim of the socket. In each case there must be vertical support with a combination of lateral and anterior counterpressure to maintain the ischium in position . . . Some of the socket shape diagrams I have seen published are so crude and inaccurate as to be almost meaningless. The level of the cross-section shown is often not indicated and a section at ischial level is sometimes compared to a section which is obviously higher or lower." Professor Radcliffe then illustrated what he believed to be a more accurate comparison with emphasis on the three-dimensional shape both above and below the level of the tuberosity of the ischium. In each case he showed a cross-section of the socket at:

(1) ischial level with the medial wall projected upward to this level
(2) the outline of the highest points on the brim (Fig. 7).

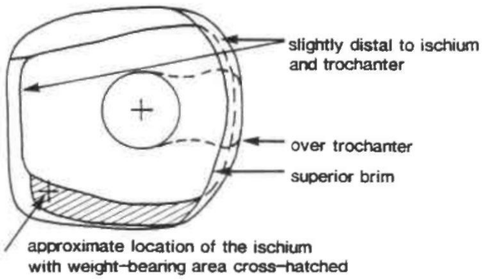
This concluded all presentations of current fitting techniques.

Evaluation techniques

The remaining presentations were concerned with evaluation techniques. Bo Klasson of LIC, Sweden presented "Socket Fit With Reference to Soft Tissue Force Transmission." Briefly, Klasson's approach is that sockets should be designed with physical characteristics that match the physical characteristics of the stump. Where the tissues of the stump are firm, so should be the matching area of the socket material; where the tissues are soft and flexible, so should the socket be. Klasson referred to this as "surface matching", and concluded by urging the development of some means of determining the degree of quality of socket fit."

The next speaker was Professor George Murdoch of Dundee, Scotland, presenting "A Method For the Description of the Amputation Stump." Murdoch's paper was based on the premise that there is a need for an international classification system for amputation stumps to be developed in order to compare data in one publication with another, one patient with another, one fitting technique with another.

The final presentation was made by A. Bennett Wilson on "Physiological Monitoring Equipment in Evaluation of Lower limb Prosthetic Components and Techniques." He reported on a system of physiological monitoring originally proposed by MacGregor of the University of Strathclyde in the 1970's. Recently modified for use by the University of Virginia Division of Prosthetics and Orthotics, this system consists of a compact tape recording component worn on a waist belt that records



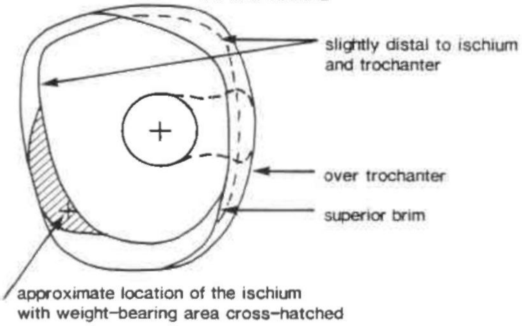


Fig. 7. Top, socket contours for an Ischial-Gluteal weight-bearing socket using the UC Berkeley brims. Bottom, socket contours for an Ischial-Ramal weight-bearing socket of the NSNA type provided by Ivan Long.

electronically, step count, walking velocity, standing vs. sitting, and heart rate, plotted against time up to 24 hours. The tapes are then analyzed by a special micro-computer program, which subsequently prints the information in digital and graphic format.

Under some circumstances the heart rate data can be useful in providing an energy index, but probably more importantly, the step count, standing vs. sitting, and velocity data provide specific information about the activity of the subject. Wilson and colleagues have recently developed a solid state device which is less costly and more reliable. The new system has 17 information gathering channels. Wilson concluded by saying: "At this point we do not have sufficient experience to know how many subjects have to be monitored and how much data are needed to show significant differences, but it certainly appears that at last we have a breakthrough in instrumentation for evaluation of prosthetic devices and other treatments involving the function of the musculoskeletal system."

Panel reports

With all presentations complete, the plenary group was divided into six panels of 6-9 members with the following charge:

1. Determine similarities
2. Determine differences
3. What is the role of flexible walls?
4. Indications and contraindications
5. Recommendations for future action:
   (a) Evaluation
   (b) Education
   (c) Application

A synopsis of these reports is presented in concluding this report.

New panels were then formed to restudy the rationale for and possibly develop protocol for evaluation. The reports from this second group of panels were discussed in plenary session.

What follows is a synopsis of the conclusions and recommendations of the panel reports.

I. Similarities & Differences

A. Biomechanics

1. Ischial Containment:
   similarities: all non-quads advocate and utilize varying degrees of ischial containment
   differences: quads do not utilize ischial containment; non-quads, amount of ischial containment
2. Weight Bearing Distribution:
   similarities: nonquads, combination of ischial tuberosity and ramus, and peripheral (soft tissue)
   differences: quads, ischial-gluteal weight bearing
3. ML Stability — maintenance of adduction
   similarities: goal of all AK socket systems; greater success and maintenance in non-quad sockets due to ischium acting as bony stop or lock
   differences: quad, soft tissue lock only, no bony lock less successful maintenance of adduction, thus less ML stability
4. Socket Shape — ischial level cross section
   similarities: non-quads, narrow ML, wider AP, concave post-trochanteric shape
   differences: quad, wider ML, narrower AP
5. Trimlines:
   similarities: non-quads, generally; especially anterior, posterior, and lateral wall trimlines
   differences: quads, especially anterior, posterior, and lateral wall trimlines; medial wall of CAT-CAM
6. Suspension:
   similarities: all compatible with suction
   differences: non-quads, unclear about auxillary suspension
7. Alignment:
   similarities: all but NSNA utilize alignment devices; non-quads, medial wall not on line of progression; NSNA & UCLA CAT-CAM, tilting of knee bolt in bench alignment; Shamp Narrow ML & NSNA, use of Long's Line; non-quads, TKA bench alignment, socket midline
   differences: NSNA does not use dynamic alignment device; quad medial wall on LOP; not all tilt knee bolt; NSNA, varying degrees of knee bolt tilt, 7 degrees, female, 4 degrees, male; quad, bench alignment, more stable TKA, T reference point is located at posterior ⅓ of socket
8. Rotational Control:
   similarities: non-quads, bony lock of ishium and post-trochanteric concavity
   differences: quad, muscular-soft tissue cross-section

B. Method of Obtaining Cast:

similarities: quad and Shamp Narrow ML — brim; UCLA CAT-CAM & Sabolich/Guth CAT-CAM, hand moulding technique; NSNA & UCLA CAT-CAM, standing

differences: CAT-CAM & NSNA, hand moulding technique;

Sabolich/Guth CAT-CAM, sometimes cast lying down

C. Anatomical Considerations:
UCLA CAT-CAM: detail about pelvic differences
ischial inclination
pubic arch angle
ilio-femoral angle
NSNA: male, female alignment differences:
bolt tilt

II. Role of Flexible Walls

* not linked to any ONE philosophy of designing an AK socket
* vital to the success of the Sabolich/Guth CAT-CAM
* improved sitting comfort
* improved proprioception
* better heat dissipation
* improved muscle activity
* reduced weight
* ease of socket change within frame, no loss of alignment
* enhanced suspension, if suction suspension

Note: * ALL PARTICIPANTS AGREED THAT THERE IS A GREAT NEED FOR IMPROVED FLEXIBLE MATERIALS.

III. Indications & Contraindications

— there were no specific contraindications noted for any socket design
— some advocated not changing successful quad wearers
— quads are most successful on long, firm stumps with firm adductor musculature
— nonquads are more successful than quads on short, fleshy stumps
— non-quads are the better recommendation for high activity/sports participation/running
— lack of agreement on best recommendation for bilateral AK

IV. Recommendations

The panels conclusions and recommendations were remarkably consistent. Most consistent was the recommendation for improved terminology, grouping. What have been referred to as "non-quads" into a single, workable term. Suggestions ranged from "Narrow ML" to Ischial/Ramus Containment (IRC) and Non-Ischial Containment (Non-IRC). Due to time constraints, arguments about this recommendation were never resolved. It is hoped that all recommendations can be addressed in a future workshop or through some other form of action.

A. Evaluation

There was unanimous agreement for formal evaluation of the newer AK techniques (NSNA, CAT-CAM, Shamp Narrow ML) as well as evaluation of implications of the inferiority of the quadrilateral technique.

1. A programme for scientific/laboratory evaluation should be set up at a centre or multiple centres, depending upon resources. This study might include: cinematography, force plate, motion analysis, gait mat and other "gait lab" studies as well as radiographic data on alignment and containment, physiological data, residual limb/ socket force analysis, and/or any other relevant laboratory studies.
2. A programme of clinical evaluation, based on previous fittings and continuing fittings in clinics already utilizing new fitting techniques. This would be a more subjective study, and would require a greater effort for co-ordination and pooling of data.
3. Complete manuals should be developed for each individual technique, unless the developers can find it mutually agreeable to work together and blend the new techniques. The panels found this option to be desirable.
4. Evaluation should be independent of the developers.
5. Any evaluation needs to be coordinated by an authoritative group. ISPO and/or the U.S. V.A. were recommended. The American Academy of Orthotists and Prosthetists should also be involved.
6. Possible funding sources within the USA include the V.A. and the National Institute for Handicapped Research (NIHR).

B. Education

The post-graduate, specialized courses for experienced practitioners appear to be most appropriate for teaching these newer techniques at this time. Incorporation into entry level education programmes should follow as well written, experience-based manuals are developed. Any teaching course should include "hands-on", patient contact, fitting and management as part of the curriculum.

C. Application

The application of these new techniques, while certainly not as widespread and accepted as the quadrilateral technique, or even the flexible socket technique, is occurring at this time. Growing acceptance and application will most certainly follow. It is hoped that this workshop as well as future workshops will aid in safe and proper application of these and future advances and developments in prosthetics.

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The effectiveness of shock-absorbing insoles during normal walking

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Abstract

This paper describes a study of the effectiveness of commercially available shock absorbing insoles when used in four different pairs of shoes during normal walking. The measurement method was based on the use of the Fourier Transform of the axial acceleration of the leg measured by an accelerometer mounted at the ankle. The magnitude of shock was measured by the "Shock Factor" which has been defined as the rms acceleration between 50 Hz and 150 Hz expressed as a proportion of that between 10 Hz and 150 Hz. Nine insoles were tested in each pair of shoes and the Shock factor for each combination was compared with the value obtained for the shoes alone. Statistically significant reductions of Shock Factor were noted in 58% of cases; the largest improvement (30% reduction in Shock Factor) was achieved by lightweight Sorbothane. The experimental technique has now been further developed to allow the measurement of Shock Factor by a portable Shock Meter.

Introduction

The existence of transient accelerations and the associated skeletal stress waves at heelstrike in normal gait was demonstrated by Light et al (1980) and a possible association between degenerative joint disease and impact loads has been proposed by Radin and colleagues (1973). This background knowledge together with the increased popularity of jogging and running has led to the current interest in the measurement of skeletal shock and the development of footwear to reduce it. This paper will describe a method for assessing such footwear and present results from a number of proprietary shock absorbing inserts.

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Work has been carried out previously at a number of centres (Perkins, 1983). Wilson (1985) at the Shoe and Allied Trades Research Association has performed both drop tests and walking experiments to evaluate shock absorption and his results suggested that sports shoes can be particularly effective in reducing acceleration peaks. Pratt and colleagues (1986) carried out similar assessments and showed that peak acceleration could be reduced by up to 30% with a Poron insole. This paper describes a study to measure the acceleration of the tibia during walking and presents a novel method of signal analysis which allows the rapid comparison of different footwear.

Experimental equipment and method

The accuracy of acceleration measurements is entirely dependent upon the use of a suitable method of mounting the accelerometer. Since direct bone mounting by a pin was regarded as unacceptable the accelerometer was attached to a moulded polypropylene splint, manufactured from an accurate plaster cast, fitting around the malleoli. This arrangement has the advantage that the skin is loaded predominantly in compression leading to a stiffer mounting; the natural frequency of the assembly has been kept as high as possible by the use of a lightweight accelerometer (Kistler model 8620). The initial testing and development of this mounting has been described elsewhere (Johnson 1986).

The experimental arrangement consisted of the accelerometer connected, via a signal conditioning unit carried in the trouser pocket, to a spectral analyser (Nicolet Model 660B) by a trailing cable. The accelerometer was fitted to the left leg and identical footwear was worn on each foot. All of the tests were carried out in a laboratory with a wooden block floor laid over concrete. The analyser, controlled from a host microcomputer, was configured to sample the acceleration signal in the range 0 to 200 Hz over a period of 16s, equivalent to approximately 20 steps. It was programmed to allow a time delay between the start of the test walk and sampling of the data to eliminate spurious data during the first few steps. Similarly a bleep was sounded after sampling had finished to tell the subject to stop. At the end of a test walk the rms spectrum was stored on the microcomputer; for any given footwear configuration the experiment was performed 5 times and the mean spectrum calculated. It was this mean spectrum which was used to compare footwear. Experiments were carried out by the author wearing 4 types of footwear with and without each of the following shock absorbing inserts:

1. Sorbothane[1] heel insert
2. Viscolas insole
3. Sorbothane[1] walking insole
4. Sorbolite insole
5. Red Sorbothane[1] insole
6. Nonshock insole
7. Soft blue Sorbothane[1] insole
8. Hard blue Sorbothane[1] insole
9. Lightweight Sorbothane[1] insole

The types of shoe used for the study were as follows:

1. Trainer with Velcro fastening
2. Leather casual with leather sole and heel
3. Similar to (2) but a rather looser fit
4. Lace up shoe with soft rubber sole and heel

Signal analysis

The severity of a skeletal stress wave is determined by both the amplitude and the frequency content of tibial acceleration. The effectiveness of a shock absorbing shoe could, therefore, be judged by its ability to reduce both the high frequency content and the amplitude of the acceleration. In addition, it must be taken into account that much of the low frequency acceleration is associated with the swing phase of gait and is, therefore, unlikely to be influenced by footwear. For these reasons it was decided to measure two aspects of the rms spectrum. The first measurement was that of the rms acceleration over the frequency range 10 Hz to 150 Hz. The upper limit had been

1. Sorbothane is a trade name of BTR plc.

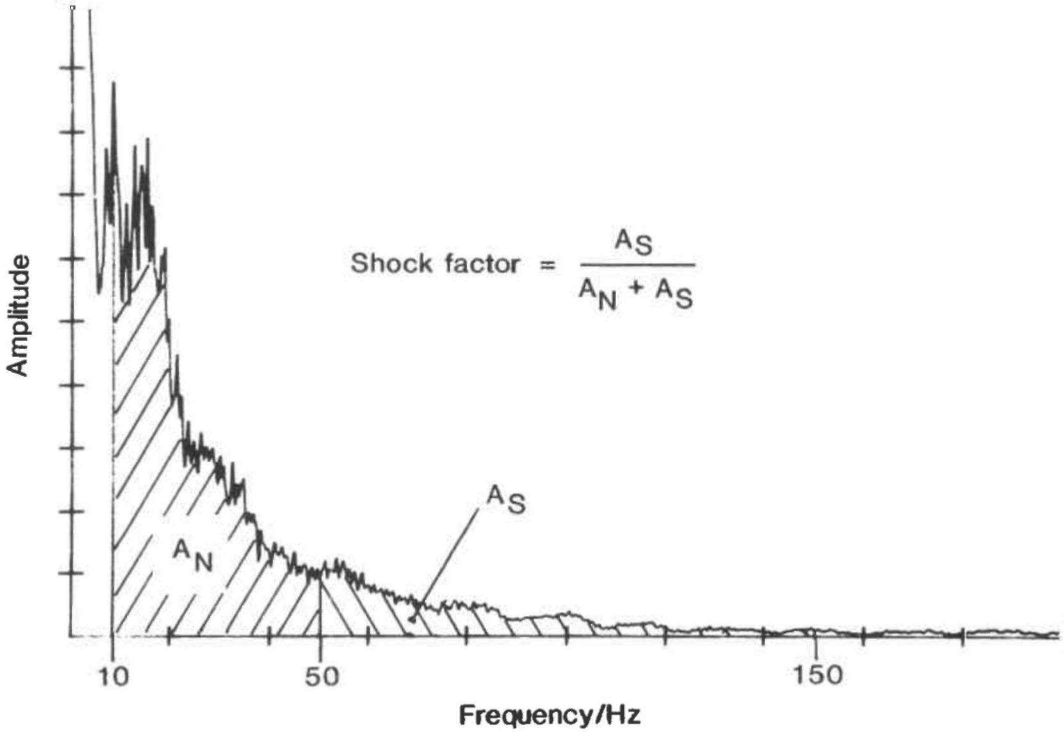

Fig. 1. Definition of Shock Factor

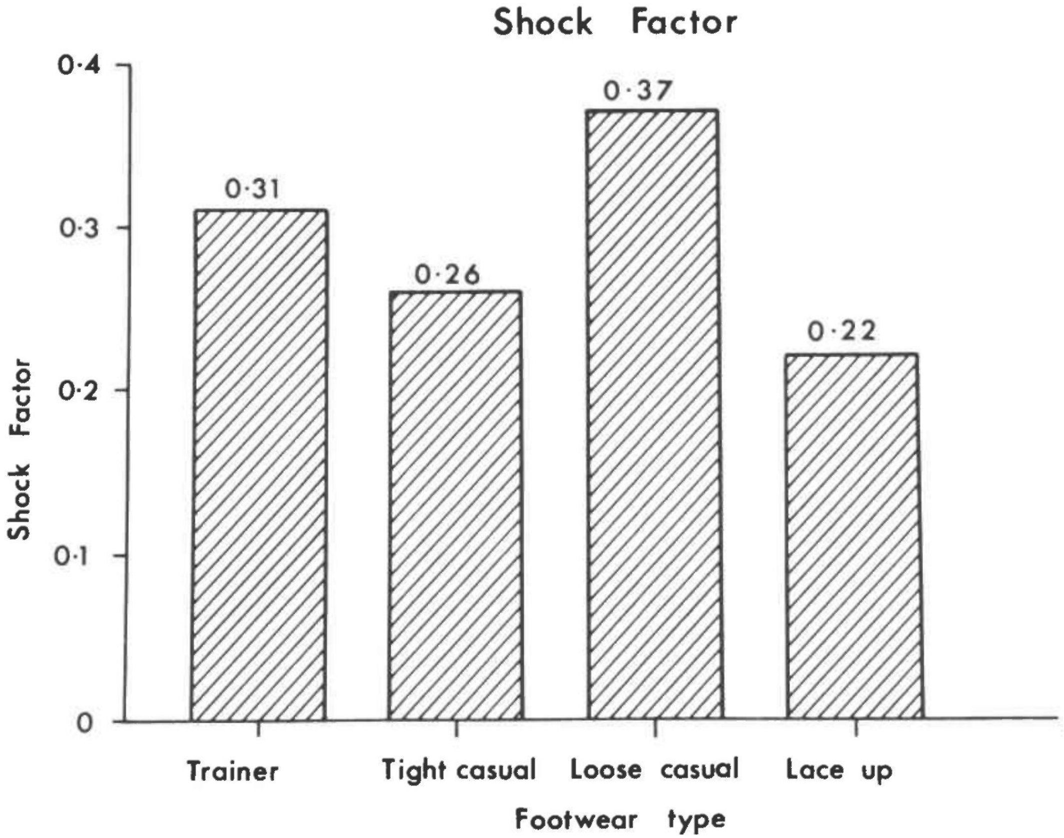

Fig. 2. Variation of Shock Factor for different shoes without insoles.

chosen after inspection of the data had shown the signal to be small at higher frequencies. The second measurement was concerned with the proportion of the signal which could be considered to represent shock loading making it necessary to determine a cut off frequency distinguishing between "normal movement" and "shock"; when studying the frequency content of the ground reaction force in normal gait Simon and colleagues (1981) found the highest frequency to be 50 Hz and so this has been chosen as the cut-off frequency for this particular study. In addition, data at less than 10 Hz has been ignored because of the poor response of piezoelectric accelerometers at low frequencies. The rms values of the "normal" and "shock" signals may be calculated as the integrals represented by the areas An and As shown in Figure 1. A shock factor S may then be defined as:

$$S = As/(An + As)$$

This factor, which can vary between 0 and 1, can be used to compare the effectiveness of an insert used in different types of footwear by different users whose acceleration spectra may have personal distinctions. The relevant integrations were carried out on the mean spectrum using Simpson's rule.

Results

Figure 2. shows the average shock factor measured while walking in the four types of footwear without shock absorbing insoles. Figure 3. shows results for various insoles in which the improvement was statistically significant ($p<0.05$) using the student t-test. Shock improvement has been defined as the percentage reduction in Shock Factor resulting from the use of an insole. The most impressive shock reduction has been achieved by the Lightweight Sorbothane and the Soft Blue Sorbothane each of which reduce shock by over

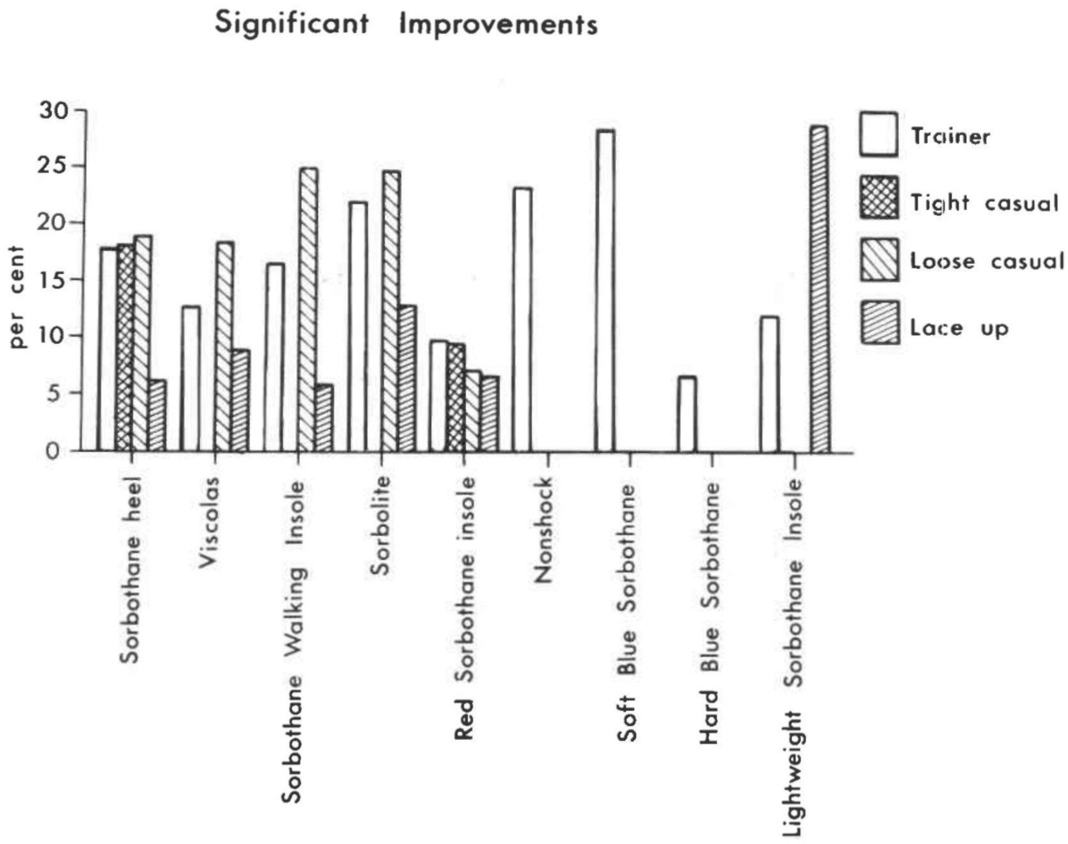

Fig. 3. Statistically significant shock improvement afforded by different insoles.

30%. These are followed by Sorbolite, Nonshock and the Sorbothane walking insole all achieving better than 20% shock reduction. The results can be summarized as follows: On average, across footwear and insoles, a Shock Improvement of 8% was achieved with a maximum of 29% (Soft Blue+type 1, Lightweight Sorbothane+type 3). The overall best performer was Sorbolite (average 15.5%). In only three cases was a significant deterioration observed although some deterioration occurred in eight (22%) of the tests. In 21 cases (58%) a significant improvement was observed.

Discussion and conclusions

With the exception of the work of Pratt and colleagues (1986) this is the only comparative study of a range of insoles. Whereas their work was based on the measurement of peak acceleration, the present study uses the Shock Factor which it is suggested is a more representative measure of shock. This work has shown that statistically significant shock reductions can be achieved by insoles and that their effectiveness is greatly influenced by the footwear in which they are used. Indeed, it is interesting to note the large variations between the different shoes when used without insoles particularly since the two pairs of casual shoes were very similar except that one pair was a rather tighter fit than the other. This suggests that the fit between the shoe and foot can have a major influence over shock transmission.

This study has not been concerned with measurement of the mechanical properties of insoles; this must be a priority if they are to be designed in a scientific manner. However, the author has suggested in an earlier paper (Johnson, 1986) that shock reduction may be largely a function of compressive stiffness. This idea is borne out by the results from the Hard and Soft Blue Sorbothane which are of identical geometry; the softer insole affords greater shock reduction. Other studies by the author confirm this impression.

The method described here suffers from two major limitations—it requires expensive (non-portable) spectral analysis equipment and this must be connected to the subject by a trailing cable. However, these problems have now been overcome by the development of the Shock Meter[2] consisting of two major components—a universally fitting ankle cuff with accelerometer and a meter unit which is worn on a waist belt. This unit analyses the acceleration over a period of one minute and displays the Shock Factor on a digital readout. Being completely portable, the meter is ideally suited to the measurement of shock in both running and walking. A repeatability study has shown that the meter is repeatable to within 10% for a single 1 minute test and this may be further improved by averaging several tests. Now that this instrument is available more exhaustive testing of different insoles and footwear during both running and walking becomes possible. The author has already commenced such work.

Acknowledgements

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The choice of prosthetic and orthotic technique for less developed countries: analysis and perspectives in Colombia

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Abstract

In their efforts to set up orthopaedic technical services, less developed countries such as Colombia have often relied on so called "turn key" technology transfers depending on the know-how and the infrastructures in industrial countries. The sophisticated industrial product stands thus in sharp contrast to the "single item" product which relies on traditional crafts and local materials.

Both extreme forms of technology are currently employed in most less developed countries including Colombia.

While the high-technology product is costly and requires a specialized base to produce and to service it, the "single item" product lacks generally the minimum requirements in terms of uniform quality, biomechanical function and cosmetic acceptability. Although the remarkably high standard of industrial products explain their worldwide demand and distribution, it should not be concluded that countries such as Colombia have no other choice than to adopt these technologies.

In search of an intermediate alternative, the potential of a yet undervalued, appropriate technology is explored and an accurate account of its advantages is given.

Developing strategy

The first and foremost consideration in establishing orthopaedic technical services is the variety of extremely different conditions that exist in each region of Latin America which inhibit the application of any uniform scheme. Consequently one scheme is never readily transferable from one distinct region to another without its careful adaptation.

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The second aspect explores the necessity to shift attention from the usually highly developed central services toward sub-regional and community-based levels. Established institutions must play an active role in functioning as resource and reference centres. The third point demands the unconditional, consequent exploration of local resources. The drive for more centralization, more sophistication, and more foreign dependency must be curtailed in favour of a more appropriate technology.

The situation in Colombia

The determining factors for establishing a national orthopaedic technical structure are the legislative provision by the government authorities, the formal training of prosthetists and orthotists, the restriction of services to qualified practitioners and the enforcement of quality and price control.

Viewing the situation in Colombia, no constructive steps have been undertaken to develop a national policy. Consequently, any law or regulations which are necessary to control any para-medical profession, are virtually non-existent.

However, when examining other allied professions, it can be seen that there is a large number of orthopaedic surgeons and a number of well established schools with a regular output of occupational and physiotherapists. The orthopaedic-orientated manpower resources have led to steady growth and a countrywide spread of medical rehabilitation services.

To the detriment of a multi-disciplinary approach to the treatment of the physically disabled, prosthetics and orthotics have been denied recognition and been unable to develop into an organized structure. In the absence of any noteworthy initiative from the government side, the prospects of raising the educational and technical standard in Colombia, must be regarded as remote. Instead of taking the lead as one of the most resourceful countries in the continent, Colombia shares the sad state of backwardness evident in other less developed countries.

On the basis of the foregoing assessment, it is no wonder, that most existing orthopaedic-technical facilities are grossly inadequate to meet the demands and to keep pace with contemporary standards.

What has become a matter of concern to the professional, is to observe how the shortcomings are increasingly met by the activities of semi-or pseudo-professionals, who know little about the psycho-medico-social nature of the profession. This profiteering at the expense of innocent, traumatized human beings, can be considered to be the biggest threat the profession is confronted with.

It is necessary, to distinguish between three different levels of services available in Colombia, namely:

The government controlled workshop
The workshop supported by non-government organizations
The private workshop

The government controlled workshop

Although these utilities can take the credit for having pioneered prosthetics and orthotics in the country and integrated this entity into the mainstream of medical rehabilitation activities, their share of public services remains a fraction of those generated by the private sector.

The usual problems of limited budgets, lack of trained personnel, logistic insufficiencies and bureaucratic obstructions have caused a stagnant situation, hampering the service to a large number of patients.

The workshop supported by non-governmental organizations

Taking into account the limited capacity of state controlled services, the private foundations have gradually taken over the leading role in providing services. They can be truly regarded as the pacesetters in advocating a balanced pattern of treatment. In spite of unfavourable conditions, these Foundations have succeeded in organizing training programmes which will lead to the first cadre of orthopaedic technicians in the country.

Another important aspect to mention is their committment to develop more appropriate technologies, which should be affordable to patients from all walks of life.

These projects aim to countermeasure the continual exploitation of the patient by the commercial sector.

The private workshop

This sector is dominated by some individuals whose drive for quick profiteering seems to ignore all ethical considerations. Fabrication of orthopaedic appliances is usually done in a garage-type workshop using basic manufacturing facilities with the aid of semi-skilled technicians or on-the-job trained artisans.

Needless to say, this "mechanical approach" is the least likely environment to serve a patient appropriately and has little possibility of enhancing the reputation of a distinct paramedical profession.

The multi-faceted picture of Colombia's orthopaedic technical services resembles a disorganized structure, which seems to be typical for other countries in Latin America. Foreign aid, assistance and influence has seldom led to uniformity. Instead they have had their impact on further diversification, concerning developing philosophies and technologies.

The example of Colombia gives evidence of that unfavourable situation, where a primitive technology stands in sharp contrast to the high-technology transfer.

High-technology

It is a generally accepted fact, that science and high-technology are not neutral; they do not benefit everybody equally. What has been widely unnoticed however, is that persistent propagation of high-technology products has caused a decline of stimulating new ideas, in creating indigenous designs, and in developing appropriate manufacturing techniques.

It is erroneous to believe that prosthetic and orthotic standards existing in industrial countries can serve as a pattern for less developed countries. Such a belief has a deep and detrimental impact on the local orthopaedic technical scene which is difficult to reverse.

An appropriate prosthetic and orthotic supply system must be based on a careful analysis and bring into balance the different technical, medical and socio-economical components.

In this context, the adoption of high-technology with its extremely high cost-benefit effect would ignore the distinct socio-economical conditions represented by the majority of the disabled population.

Any system that is developed must be designed to benefit the community at large. It should be oriented on a target group which is made up by the large poor sector of the population and not by a small group of affluent individuals.

The continual use of high-technology in a country like Colombia is thus tainted with social injustice, that one person benefits at the expense of many others.

The introduction of imported components has led to extremely high pricing, making the orthopaedic appliance a novelty item available only for those who can afford it.

It can also be said that exploitation of patients, who are desperately in need but can ill-afford to pay for high-technology bills, has become a common practice. On the basis of this assessment it must be stressed again, that a prosthesis or orthosis should not cost more than the common people and the community can afford.

Artisan and primitive technology

In the past, the artisan had a pioneering role in orthopaedic technology. The individual, innovative achievements created by skilled, experienced craftsmanship cannot be questioned. Without the constant exploration and application of the artisan's knowledge and skills the extraordinary performances of orthopaedic practitioners today, would be unthinkable.

With the advent of scientific research and industrial technologies however, the artisan's performance lost its competitiveness in terms of labour-cost effectiveness and because of its inconsistent quality (Table 1).

However what is going to bring the artisan's technology into discredit is neither the craftsmanship approach nor its lack of competitiveness, but rather the primitive approach by pseudo-professionals.

Table 1. Technology overview

Criteria	High Technology ⇩ mass scale industrial production ⇩	Appropriate Technology ⇩ small/ medium scale serial production ⇩	Primitive Technology ⇩ single item production ⇩
Manufacturing rationality	Positive		Negative
Quality/ durability	Positive		Negative**
Standardization inter-changeability	Positive		Negative
Cost benefit effectiveness	Negative		Positive
Utilization of local materials	Negative		Positive
Application of local technology	Negative*		Positive
Service/ spare parts	Negative*		Positive
Cosmetic appearance/ weight	Positive		Negative**

*no network **inconsistent

The "inappropriateness" of such an approach can be seen in the widespread anachronism which allows a considerable number of self-proclaimed or short-term trained technicians to practice a highly specialized profession.

The "inappropriateness" becomes manifest in the poor quality of orthopaedic appliances produced, which falls short of contemporary standards with regard to comfort, alignment, cosmesis and workmanship (Fig. 1).

These malpractices, which obviously violate the professional code of conduct of preventing physical and psychological damage to the patient, are the cause and target of growing criticism. Returning to the days of primitive trial and error practices cannot be regarded as an appropriate answer to the challenges in less developed countries.

Whatever technology is introduced to a country like Colombia, its standards must meet the minimum requirements in terms of professional proficiency, biomechanical functional and cosmetic acceptability.

Appropriate technology

After analysing high-technology and artisan-related technology it is easy to conclude that

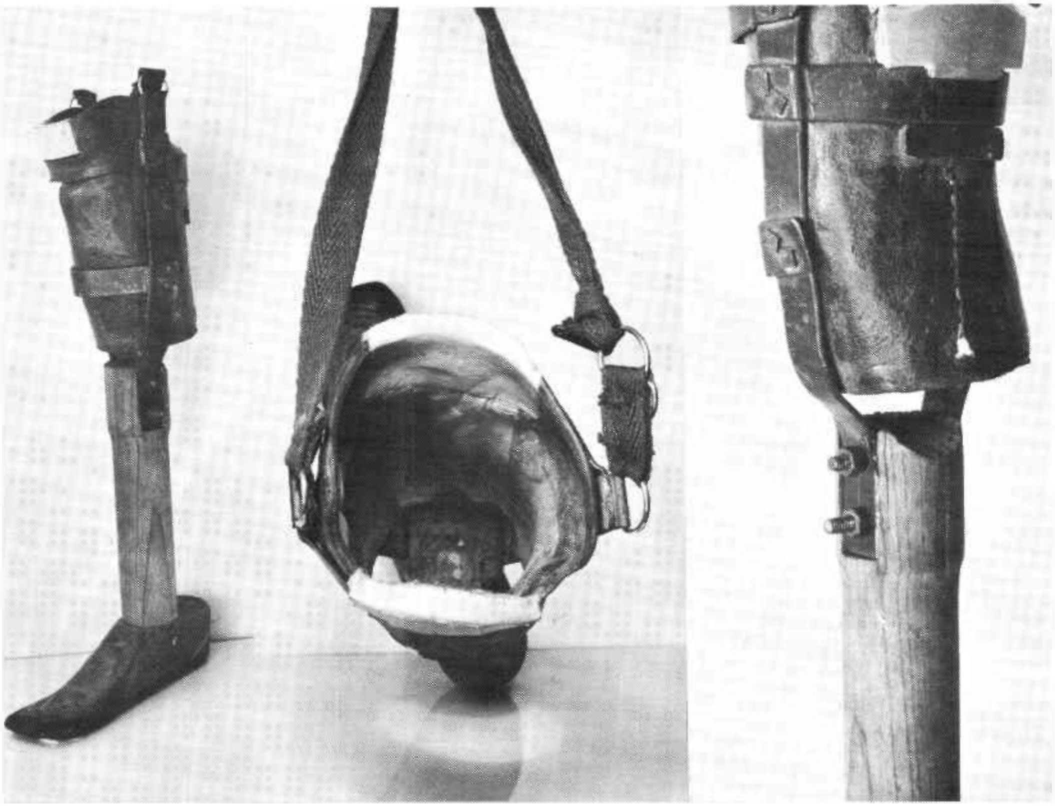

Fig. 1. Examples of primitive technology.

both forms are inappropriate to cope with the demand now and in the future. The concept of appropriate technology with its simplified low-cost approach has drawn considerable attention during the last years. However in spite of this attention, its definition and the scope of application has never been pointed precisely. Up to now the potential benefit of appropriate technology is undervalued, occasionally misinterpreted or even misused.

Essentially, it is a technology which ranges on an intermediate level between a stagnant, inconsistent, labour-intensive technology and an imported, capital-intensive industrial mass-scale technology.

The wide range of application implies that the product itself might provide little information because it can make use of any manual, semi-industrial, and even industrial manufacturing process and any kind of material.

What appropriate technology really means is the maximum exploration of local expertise, labour and materials to generate an important multiplier effect on the local economy.

It focuses on an appropriate technical solution to a specific socio-economic situation. This requires a simple but scientifically sound basis which can be set by blending contemporary technologies with the traditional ones.

By no means does it employ the pseudo-artisan, primitive and ineffective techniques, which cannot meet the basic qualitative and quantitative requirements.

Consequently, the "single item" production of prosthetics and orthotics, which is propagated by some organizations as appropriate technology, does not comply with the criteria set for an intermediate technology (Table 1).

To develop a complete, efficient network of orthopaedic technical services on a national basis, a centralized small/medium serial production represents the only appropriate solution to counter the very acute shortage of components and ready-made appliances in countries such as Colombia.

Conclusion

The recognition of the discrepancy which exists between "appropriate" and "inappropriate" technologies must be regarded as a conflicting situation in Colombia and elsewhere, which needs clarification.

Viewing the scene in Latin America it is seen that most countries lack the manufacturing facilities to meet the orthotic and prosthetic requirements on an appropriate scale.

In the absence of any local appropriate technology, orthopaedic technical services will continue for the most part to be a privilege for a limited number of wealthy patients who can afford to buy foreign technology.

The attempt by some organizations to introduce a primitive, low-cost technology must be regarded as an evolutionary set-back.

The professional community and national authorities in lesser developed countries must realize that incompetence and ignorance of basic technical, biomechanical, psychological and cosmetic principles can only lead to malpractice, risking further damage to the patient.

To redirect the course of development the following policy guidelines should be taken into consideration:

- formulate new ideas and examine approaches, methods and techniques in the field of prosthetics and orthotics, which could best be applied in a distinct environment
- create a new type of orthopaedic technician who is able to initiate ideas for indigenous designs and detail their construction criteria to the production engineer
- replace a technology, which is characterized by high costs and over-sophistication by one which is acceptable in terms of cost-benefit effectiveness, technical appropriateness and environmental adaptability.
- exchange the feasibility studies and research in the area of appropriate technology to intensify communication and cooperation among the concerned institutions.

It is only after these principles have been adopted that the basis for implementation of appropriate solutions can be envisaged. This would permit orthopaedic technical services in uniform quality, in sufficient quantity and at reasonable cost to be brought to a larger number of patients in need.

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Technical note

Multiaxial orthotic hip joint for squatting and cross-legged sitting with hip-knee-ankle-foot-orthosis

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Abstract

In view of the importance of squatting and cross-legged sitting in the activities of daily living in Asian and African countries, a multiaxial orthotic hip joint has been developed which when fitted to a Hip-Knee-Ankle-Foot-Orthosis (HKAFO) can permit the user to squat and sit cross-legged. The design consists of a modified ball and socket joint.

Introduction

The majority of the activities of daily living in India and in a number of countries in Asia and Africa are performed in squatting or cross-legged sitting positions, e.g. eating, preparing food, home making, working in the farms, sitting in meetings or religious gatherings, attending school etc. It is so much merged in the routine life style that wearing a caliper with a hip joint of the presently available designs, means a total change in life style from floor level to chair level living. This applies more so to rural schools in India, where children have to sit on the floor mat, cross-legged. Those wearing calipers can not wear them in school, thereby increasing the rate of rejection.

With the presently available designs of orthotic hip joint squatting is not possible due to the constraints on the range of motions available. Orthotic knee joints, which allow full flexion as with the human knee are available commercially, but the orthotic hip joint having movements in the various planes that are required for squatting and cross-legged sitting, is not available.

The movement of squatting in man requires about 130° flexion, 15° abduction and 5° external rotation at the hip besides full flexion at the knee and dorsiflexion at the ankle joint.

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During cross-legged sitting the hip moves about 90° in flexion, 45° in abduction and 60° in external rotation. The range of movements varies to some extent with the individual.

The requirements of an orthotic hip joint, which when fitted to a HKAFO allows squatting and cross-legged sitting, are as follows.

(a) It should allow movements only of flexion and extension during walking as with other orthotic hip joints.

(b) There should be no abduction-adduction or rotation during standing or walking, but these movements should come into play when one squats or sits cross-legged.

Design

As in the human hip joint, a ball and socket orthotic joint has been developed. The ball socket is connected to the pelvic band. Figure 1 shows the schematic diagram of this joint. The socket is made in two halves, secured together with rivets, to allow the ball to be contained in the socket firmly. The permitted movements of the ball in the socket are controlled by channels cut in the socket. The lower part of the socket is split to form a channel to allow the bar connected to the ball to move in the antero-posterior plane only. For this excursion of the joint, the socket is reinforced by having thicker walls at the lower part, as shown in Figure 1. The lateral half of the socket is cut open in such a way that on flexion beyond 40° the bar connected to the ball is released to let the ball move in further flexion up to 130°, abduction up to 45° and external rotation up to any angle desired.

Functionally this joint works as a simple hinge joint (uniaxial) for standing and walking and as a ball and socket joint (multiaxial) for squatting and cross legged sitting.

A vertical rod, within the socket locks the ball by slotting into a hole cut in the upper part

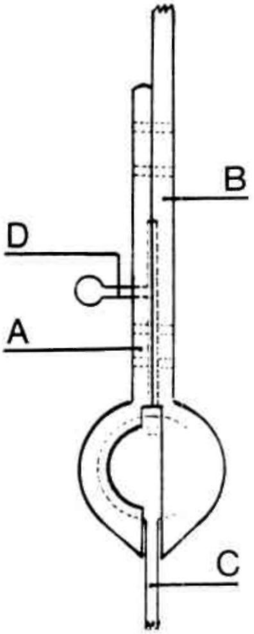

Fig. 1. Diagram of the multiaxial orthotic hip joint. A—lateral half of socket. B—medial half of socket. C—bar connecting the ball. D—lock.

of the ball. The lock is manipulated by a lever projecting through the lateral bar which comprises half the socket. If desired, a spring loaded lock can also be incorporated to facilitate locking. The mechanism locks the joint in the neutral position, when the lever is pushed down (Fig. 2).

Other modifications required in a caliper to permit squatting and cross-legged sitting are:

(i) The knee joint should allow flexion up to 165°. Such joints are commercially available.

(ii) When squatting for a long time, the knee cap may be subject to undue pressure in a few patients. This can be avoided by loosening the knee band a little on squatting, and retightening before standing again.

(iii) The ankle joint should allow dorsiflexion. A 90° posterior stop at the ankle is adequate. In those cases where this movement at the ankle is not permitted during standing or walking, an additional lock can be provided at the ankle joint, that can be opened when required. For patients finding difficulty in operating the ankle lock, its operation can be controlled by a small cable with its control lever attached to the lateral thigh bar.

Fig. 2. Patient wearing the HKAFO fitted with the multiaxial hip joint. Top—squatting. Centre—close up of the hip joint in squatting position. Bottom—cross-legged sitting.

Conclusions:

The design presented here is a concept in design. Further work for finalizing the right materials and dimensions continues. Preliminary results following clinical trial fittings were satisfactory in regard to acceptability, utility in activities of daily living, comfort of wearing and ease of operation.

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Technical note

A new in-built device for one-point stepless prosthetic alignment

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Abstract
The authors have developed a new in-built device for alignment of below-knee prostheses. The device allows one-point, stepless adjustment of angle and slide, independently of each other and also after completed prosthetic manufacture. Principally, the device consists of a half-sphere for angle adjustment and a plate for both slide adjustment and socket application. If the socket has to be exchanged, the whole device can be re-used, apart from the plate, which forms part of the socket bottom. The device is light, compact, cosmetically easy to cover and cheap. The design incorporates a combination of the most important facilities for alignment as well as for exchange of socket, and by its simplicity seems to offer major advantages over other designs.

Introduction

Correct alignment of the below knee prosthesis is of decisive importance for the amputee's walking ability (Radcliffe, 1954, 1962; Holmgren, 1980), Commonly, the prosthetist has to make numerous adjustments until satisfactory function is achieved. Once the prosthesis has been manufactured and used for a couple of months, adjustment of alignment is sometimes needed to improve walking ability and, occasionally, to postpone prosthetic exchange. This, however, can only be accomplished if the prosthesis is equipped with an in-built device for alignment. As to the need for prosthetic exchange, the most common cause is probably socket failure. Under this circumstance, it would be advantageous if the prosthesis with the in-built alignment device (Staros, 1963) could be re-used after exchange of the socket only.

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This technical note describes a new in-built device for simple alignment of the below-knee prosthesis, permitting one-point, continuous (stepless) adjustment of angle and slide, independently of each other, even after the completion of prosthetic manufacture

The BOA device

The BOA (In-Built One-point Alignment) device (Fig. 1) is made mainly of aluminium and weighs 97g. It is 35mm high and has a maximum diameter of 73mm. Adjustments of angle and slide can be made steplessly and independently of each other, at one point even after completed prosthetic manufacturing. For angle adjustment, the device is equipped with a half-sphere (A) with a radius of 11mm. The angle can be changed up to ± 12 degrees by four steel screws (B). A 6mm screw bolt (C) through the half-sphere holds the plate (D), which, cast

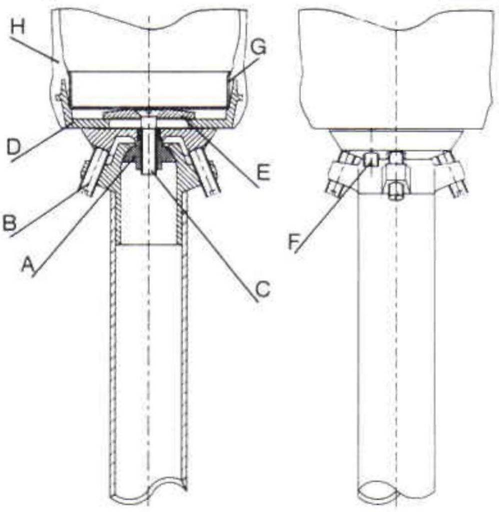

Fig. 1. The device in neutral position. Annotations in text.

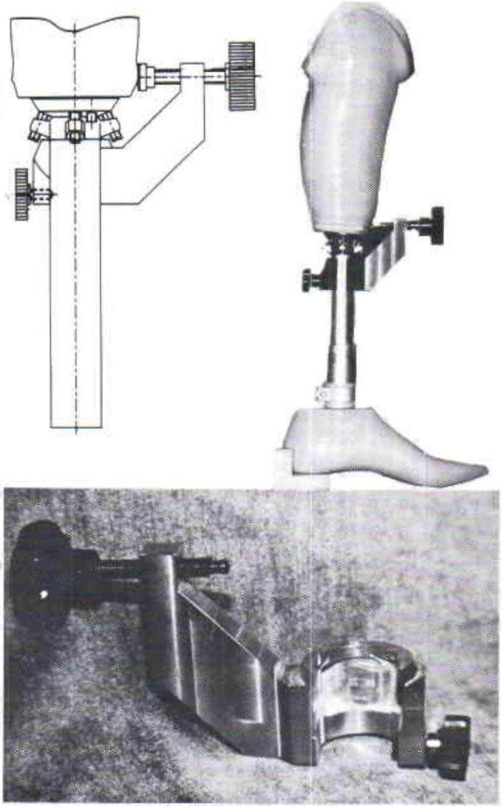

Fig. 2. Tool for slide adjustment—see text.

in plastic, forms the socket bottom. There is a 31mm hole in the plate, covered by a 36mm washer (E). The 6mm screw bolt can be moved horizontally in the hole of the plate, permitting up to ± 12.5mm slide. These adjustments are made with a special tool, which is temporarily mounted on the tube (Fig. 2). The tool can be rotated around the tube thereby allowing accurate stepless slide movements of the socket (H) in any direction (Fig. 2, bottom). The plate position is locked by two screws (F) and by the 6mm screw bolt, easily reached within the socket. A cover (G) fits the socket to the plate.

When the prosthesis is being fitted and aligned on the patient's below-knee stump the tube is kept vertically in the frontal plane during stance phase, which facilitates correct alignment. In the sagittal plane, the prosthesis is adjusted in the same manner as in the frontal plane.

Compared to other widely used prosthetic types the design seems to combine the most advantageous features of the others (Table 1).

Table 1. Features of alignment devices

	Alignment device		
	BOA	Otto Bock	Hosmer
In-built	yes	yes	no
Socket exchange only	yes	yes	no
Independent change of angle and slide	yes	no	yes
Vertical tube during stance phase	yes	no	yes
Weight (g)	97	440	820

Fifteen young below-knee amputees have used prostheses with the in-built device for 9 months without any single technical failure. So far socket exchange has only been necessary in one case because of decreased stump volume. Exchange of the socket and realignment of the prosthesis were easily achieved in one procedure. Another 50 prostheses with the in-built device have been used for six months without any need for additional adjustments.

REFERENCES

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RADCLIFFE, C. W. (1954) Mechanical aids for alignment of lower-extremity prostheses. *Art. Limbs*, **1**, 23.

RADCLIFFE, C. W. (1962) Biomechanics of below-knee prostheses in normal level, bipedal walking. *Art. Limbs*, **6(2)**, 16-24.

STAROS, A. (1963) Dynamic alignment of artificial legs with an adjustable coupling. *Art. Limbs*, **7(1)**, 31-43.

Prosthetics and Orthotics International, 1988, 12, 105–106

Case note

Bilateral below-knee amputee 107 years old and still wearing artificial limbs

E. S. M. SAADAH

Artificial Limb and Appliance Centre, Brighton

Abstract

It is not often that a person over 100 years old is able to walk on artificial limbs and maintain their mobility and independence after going through bilateral below-knee amputation.

This case note is about a 107 year old lady with bilateral below-knee amputation, who is perhaps the oldest surviving bilateral below-knee amputee in the British Isles, if not in the World.

There does not appear to be any reference in the literature to a bilateral below-knee amputee of 100 years old plus, who is still alive and wearing his or her artificial limbs. The nearest is of a 91 year old lady with bilateral below-knee amputation and wearing artificial limbs, reported by Gerhardt et al, 1986.

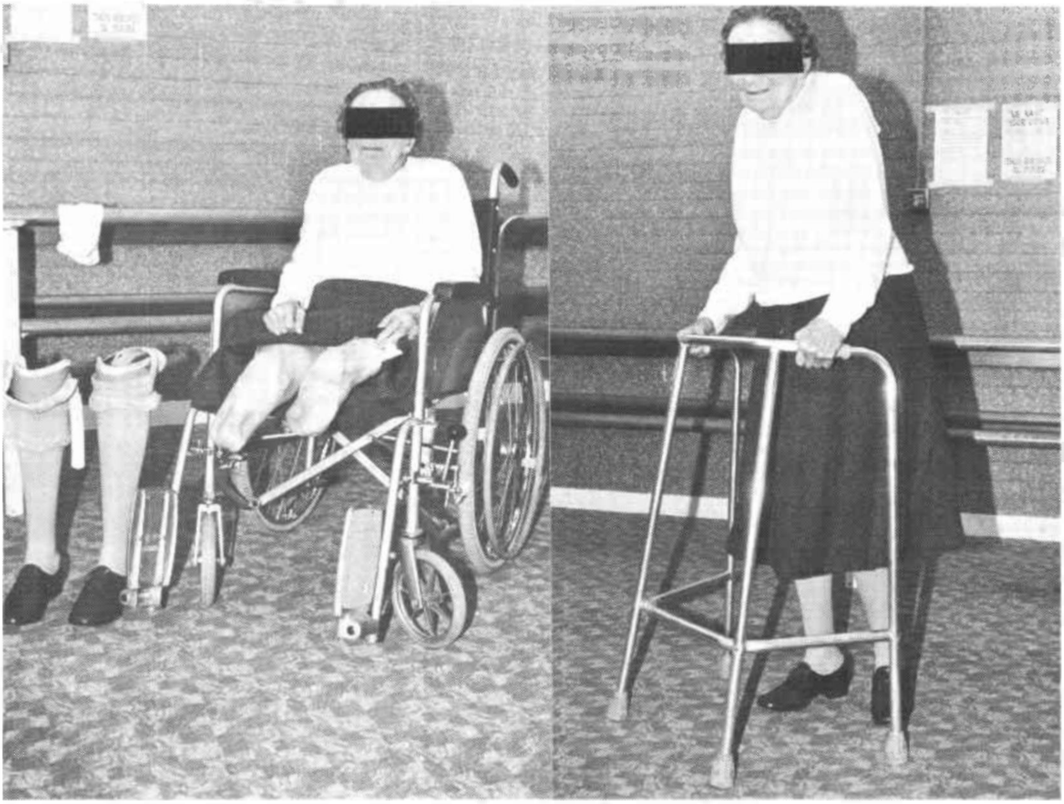


Fig. 1. The patient with her prostheses and in the walking frame.

The patient

Mrs J. S. who was born in 1881, lived her early life actively until 1976 when she fell and fractured her left femur and sustained a degloving injury to the skin of her left leg. The fractured femur healed, but the skin of her left leg failed to heal despite various skin grafts, which failed to take, and a deep ulcer developed which warranted left below-knee amputation. Mrs J. S. was just 95-years old then. Peripheral vascular disease was diagnosed and she was rehabilitated on a patellar-tendon-bearing (PTB) prosthesis with limited success. Two years later in 1978 she developed an ischaemic ulcer on her right foot, which failed to respond to conservative treatment and right below-knee amputation was carried out.

She was given bilateral PTB pylons, followed by Modular PTB prostheses. Mrs J. S. was nearly 98-years old and was able to maintain her mobility on a pair of modular PTB prostheses.

After her 106th birthday, she complained about the weight of her artificial limbs, which she was still wearing all the time. A pair of carbon fibre PTB prostheses with polypropylene sockets and Pelite liners were provided and from the day she took delivery of this pair of carbon fibre prostheses, she has never looked back—she is able to walk, aided with a walking frame, and she wears her artificial limbs all day and every day (Fig. 1).

Rehabilitation

Mrs J. S. is a slim lady—48 kg in weight, 1.57m in height with good hearing and good eyesight—apart from very mild arthritic deformities in her hands she is in good health and has full range of movement in both hips and knees and good balance.

However, early rehabilitation with one prosthesis met with limited success due to the pain in her other leg, but after her second amputation, she was able to walk, with the help of a walking frame, from the start. She was very motivated and willing to walk.

At present she is still independent and walks with a walking frame indoors.

All correspondence to be addressed to Dr. E. S. M. Saadah, Artificial Limb and Appliance Centre, Elm Grove, Brighton BN2 3EX, United Kingdom.

REFERENCE

Gerhardt, J. J., King, P. S., Zettl, J. H. (1986). Immediate and early prosthetic management: rehabilitation aspects. Toronto: Hans Hunber Publishers. pp 156–157.

Prosthetics and Orthotics International, 1988, 12, 107–108

International Newsletter Summer 1988

Diversified activity characterizes ISPO National Member Societies. Worldwide reports of seminars with international speakers, panel discussions, specialized workshops, and comprehensive courses indicate the breadth of interests of our members and the service the societies render to their constituents. David Condie, Co-Editor for European Member Societies, Dundee Limb Fitting Centre, 133 Queen Street, Broughty Ferry, Dundee DD5 1AG, Scotland, and Joan Edelstein, Co-Editor for African, American, Asian and Oceanian Member Societies, New York University, 317 34th Street, New York, NY 10016, United States welcome announcements of meetings and news of activities of individual ISPO members.

Canadian National Society was co-sponsor with the Canadian Association of Prosthetists and Orthotists of a broad ranging seminar in June in Montreal. Local speakers included Hugh Walter Barclay, CO from Kingston and Steven Hale, Prosthetics-Orthotics Supervisor at Calgary General Hospital. International guests were Professor—Doctor of Medicine Georg Neff, Department of Technical Orthopaedics, Tubingen University Hospital, Germany, and Dr. H. R. Lehneis, CPO, New York University. The programme emphasized prosthetic and orthotic developments in Europe, focusing on new surgical procedures; seating; orthotic and prosthetic resolutions of common problems; the elements of research; status and future of prosthetics and orthotics in the Third World. At the ISPO seminar on traumatic amputations in Herzliya, Israel, Dr. Gordon Hunter presented three papers, "Vascular Injuries Leading to Revascularization and/or Amputation of the Lower Limb(s) in Polytrauma;" "Syme's Amputation: Long Term Review;" and "Electronically Powered Prostheses for the Adult with an Upper-Limb Amputation." Sandra Millstein, BPT, MCPA spoke on "Long-Term Review of Traumatic Partial Foot Amputations in Adults," "Long-Term Review of Stump and Phantom Limb Pain following Traumatic Amputation in Adults," and "Prosthetic Use in Adult Upper-Limb Amputees." At the Annual Assembly of the American Orthotic and Prosthetic Association in San Francisco, California, Karl Ruder represented Canada with his paper, "Pelvic Stabilization Socket." He also presented Gertrude Mensch's invited paper, "Prosthetic Gait Training: Stump Motions and Their Relationship to Gait Functions." Mrs Mensch and Patti Ellis were honoured by the American Medical Writers Association for their book, "Physiotherapy Management of Lower Extremity Amputations." Their book was one of the nine prize winners from a field of 137 entries.

India's ISPO National Chapter conducted a workshop in January at the Artificial Limbs Manufacturing Corporation, Kanpur, on making splints with low temperature thermoplastics. ORFIT plastic was used for the programme because of its valuable properties of being easily moulded directly on the body, as well as its elasticity and memory. In June the National Chapter conducted a panel discussion on "Developments of Handicap Aids for the Orthopaedically Disabled," in Kanpur. Next January, the Chapter has scheduled a continuing education and teaching programme at the National Institute of Rehabilitation and Training at Bhubneshwar, which will be conducted in association with the annual conference of the Indian Association of Physical Medicine and Rehabilitation.

ISPO with the assistance of the **United States** National Member Society, and in association with the American Academy of Orthotists and Prosthetists and the Veterans Administration organized an international workshop on CAD CAM (Computer Aided Design and Computer Aided Manufacture) in Prosthetics and Orthotics in Seattle, Washington in June. The initiative for the meeting came from ISPO. Panelists addressed priorities in applications of the principles and achievements to date and recommended priorities for future research, development and education. Topics were discussed from medical, prosthetic, and engineering perspectives and from national, international, and Third World geopolitical vantage points. Invitations were extended to experts from the United States, Netherlands, England, Canada, Germany, Scotland, Iceland, Sweden, Denmark, Japan, and Belgium.

Korea has founded the Korea National Member Society-ISPO in May with officers including President: Professor Dr. Yong-Pal Ahn; Vice-President: Professor Dr. Jung-Soon Shin; Secretary: Professor Dr. Myung-Sang Moon; and Council Members Jung-Hee Oh, MD. Kwang-Mok Lee, MD; Jin-Ho Kim, MD; and Ee-Keun Lee. Professor Dr. Se-Yoon Kang is an auditor. The leadership has been drawn from Catholic University, Yonsei University, Korea University, Han-Yang University, and Seoul National University, all in Seoul.

Australian National Member Society announced a very busy schedule of professional events. In May the Society, in association with the Central Development Unit of the Commonwealth Department of Veterans' Affairs conducted a three-day "Course on Upper-Limb Prosthetics and Orthotics" for medical practitioners and therapists, in Melbourne. The course consisted of lectures, demonstrations, and seminars on anatomy, kinesiology, and pathomechanics of the upper limb; medical and surgical considerations; prosthetic and orthotic components; principles and practice of prescription and check-out procedures; and pediatric problems. The programme was highlighted by presentation of selected patients and videotapes and slides of clinical cases. Valma Angliss and other members of the Society were invited to Queensland to lecture on "CDU Experience with Flexible Sockets" at the Scientific Meeting of the Australian College of Rehabilitation Medicine; lecture to prescribers, prosthetists, and therapists in Brisbane on flexible sockets; consult on limb deficiences in Brisbane and Townsville; lecture on management of brachial plexus injuries; discuss occupational therapy management of the limb-deficient child with therapists from throughout North Queensland, some of whom travelled several hundred miles for the opportunity to meet with Mrs. Angliss and her colleagues. In September the Society's Annual Scientific Meeting in Perth will feature A. Bennett Wilson, Jr. as principal guest speaker. The programme will be preceded by a workshop on above-knee sockets. At the meeting, topics will include rehabilitation of the vascular amputee; limb salvage; problems of the ageing amputee; pain in the amputation stump; rehabilitation engineering; and upper-extremity loss.

Joan Edelstein
Co-editor

Prosthetics and Orthotics International, 1988, 12, 109–114

Calendar of events

National Centre for Training and Education in Prosthetics and Orthotics
Short Term Courses 1988–89

Courses for Physicians, Surgeons and Therapists

NC503 Introductory Biomehanics; 17th-21st October, 1988.
NC504 Lower Limb Orthotics; 7th–11th November, 1988.
NC508 Orthopaedic Footwear; 29th–30th November, 1988.
NC511 Clinical Gait Analysis; 18th–20th January, 1989.
NC505 Lower Limb Prosthetics; 23rd–27th January, 1989.
NC502 Upper Limb Prosthetics and Orthotics; 30th January–3rd February, 1989.
NC506 Fracture Bracing; 3rd–7th April, 1989. (Also suitable for orthotists and plaster technicians).
NC510 Wheelchairs; 18th–20th April, 1989.

Courses for Prosthetists

NC218 The Ischial Containment Above-Knee Socket; 5th–9th December, 1988.
NC219 Below-Knee Modular Systems (Revision Course); 20th–24th February, 1989.
NC209 Below-Knee Modular Systems; 6th–17th March, 1989.
NC220 Above-Knee Modular Systems (Revision Course); 24th–28th April, 1989.
NC210 Above-Knee Modular Systems; 15th–26th May, 1989.

Course for Orthotists

NC221 Reciprocating Gait Orthotics; 1st–12th May, 1989.

Course for Orthotists and Therapists

NC217 Ankle-Foot-Orthoses for the Management of the Cerebral Palsy Child; 27th February–2nd March, 1989.

Course for Prosthetics Technicians

NC606 Above-Knee and Below-Knee Modular Systems; 6th–10th February, 1989.

Further information may be obtained by contacting Prof. J. Hughes, Director, National Centre for Training and Education in Prosthetics and Orthotics, University of Strathclyde, Curran Building, 131 St. James' Road, Glasgow G4 0LS, Scotland. Tel: 041-552 4400 ext. 3298.

5–9 September, 1988
16th World Congress of Rehabilitation International, Tokyo, Japan.
Information: Secretary General, 16th World Congress of Rehabilitation International, Japanese Society for Rehabilitation of the Disabled, 3–13–15, Higashi, Ikebukuro, Toshima-ku, Tokyo 170, Japan.

6–9 September, 1988
International Congress of Orthopaedics, Prague, Czechoslovakia.
Information: J. E. Purkynē, Czechoslovak Medical Society, International Congress of Orthopaedics, Vitēzného Ūnora 31, 12026 Praha 2, Czechoslovakia.

7–9 September, 1988
Biological Engineering Society Annual Scientific Meeting, Salford, England.
Information: Ms. J. Upton, BES, The Royal College of Surgeons, Lincoln's Inn Fields, London WC2A 3PN, England.

11–14 September, 1988
European Society of Biomechanics Meeting, Bristol, England.
Information: Dr. A. E. Goodship, School of Veterinary Science, Park Row, Bristol BS1 5LS, England.

11–16 September, 1988
East and West Combined Orthopaedic Meeting, Belgrade, Yugoslavia.
Information: Sava Centre, Milentija Popovica 9, Y-11070 Novi Beograd, Yugoslavia.

12–16 September, 1988
ISPO International Conference on Wheelchairs and Special Seating, Dundee, Scotland.
Information: The Secretariat, Dundee '88, Dundee Limb Fitting Centre, 133 Queen St., Broughty Ferry, Dundee DD5 1AG, Scotland.

15–19 September, 1988
7th International Symposium on Biomedical Engineering, Tianjin, China.
Information: Foreign Affairs Office, Tianjin Municipal Bureau of Health, Nanjing Rd., Tianjin, China.

17–19 September, 1988
11th Annual Meeting of the American Society of Hand Therapists, Baltimore, U.S.A.
Information: Georgiann Laseter, OTR, FAOTA, Hand Rehabilitation Services, 3707 Gaston Avenue, Suite 520, Dallas, TX 75246, U.S.A.

20–22 September, 1988
Progress in Bioengineering, "25 years of Bioengineering at Strathclyde", Glasgow, Scotland.
Information: Prof. J. P. Paul, Univ. of Strathclyde, Bioengineering Unit, Wolfson Centre, 106 Rottenrow, Glasgow G4 0NW, Scotland.

20–23 September, 1988
Scoliosis Research Society, Baltimore, U.S.A.
Information: Vern Tolo, SRS, 222 South Prospect, Park Ridge, IL 60068, U.S.A.

22–23 September, 1988
2nd Biomechanics and Orthotic Management of the Foot Meeting, Newcastle, England.
Information: Dr. D. J. Pratt, Orthotics and Disability Research Centre, Derbyshire Royal Infirmary, London Rd., Derby DE1 2QY, England.

22-23 September, 1988
5th National Orthopaedic Conference of the Pakistan Orthopaedic Association, Islamabad, Pakistan.
Information: Prof. M. A. Piracha, Chairman, Organising Committee, Fifth National Orthopaedic Conference, Pakistan Institute of Medical Sciences, G–8/3, Islamabad, Pakistan.

23-24 September, 1988
AOPA Continuing Education Conference 4–88, "Spinal Orthotics and Seating", Kansas City, U.S.A.
Information: AOPA, 717 Pendleton St., Alexandria, VA22314, U.S.A.

23–24 September 1988
ISPO Australian National Member Society Annual Scientific Meeting, Repatriation General Hospital, Hollywood, W.A. Information: The Honorary Secretary ISPO, C.D.U., PO Box 211, Kew, Vic. 3101. Tel: (03) 862 2944.

23-27 September, 1988
Annual Meeting of the Canadian Association of Physical Medicine and Rehabilitation, Ottawa, Canada.
Information: Canadian Association of Physical Medicine and Rehabilitation, c/o University Hospital, 338 Windemere Rd., London N6A 5A5, Canada.

26–28 September, 1988
3rd European Congress of Occupational Therapy, Lisbon, Portugal.
Information: Ana Palma, Associacáo Portuguesa de Terapia Ocupacional, A Joao Crisostoma 65, 1000 Lisboa, Portugal.

28–30 September, 1988
British Orthopaedic Association Scientific Meeting, Oxford, England.
Information: BOA, 35-43 Lincoln's Inn Fields, London WC2A 3PN, England.

28–30 September, 1988
12th Annual Meeting of the American Society of Biomechanics, Illinois, U.S.A.
Information: Keri Blackwelder, Conferences and Institutes, University of Illinois at Urbana-Champaign, Suite 202, 302 E. John St., Champaign, IL 61820, U.S.A.

7 October, 1988
Basic Splintmaking, Derby, England.
Information: Mrs A. M. Lees, Course Secretary, National Demonstration Centre in Rehabilitation, Dept. Rheumatology and Rehabilitation, Derbyshire Royal Infirmary, London Road, Derby DE1 2QY, England.

12–16 October, 1988
Eastern Orthopaedic Association, Puerto Rico.
Information: EOA, 301 8th St., Suite 3F, Philadelphia, PA 19106, U.S.A.

15–21 October, 1988
Western Orthopaedic Association, Hawaii.
Information: WOA, 2975 Treat Blvd, –E5, Concord, CA 94518, U.S.A.

25–30 October, 1988
American Academy of Orthotists and Prosthetists Annual National Assembly, Washington, DC.
Information: American Academy of Orthotists and Prosthetists, 717 Pendleton St., Alexandria, VA 22314, U.S.A.

26th October, 1988
Conference on Preventing Pressure Sores, Oxford, England.
Information: Administrative Assistant, Demonstration Centre, Mary Marlborough Lodge, Nuffield Orthopaedic Centre, Headington, Oxford OX3 7LD, England.

26–29 October, 1988
American Academy of Cerebal Palsy and Development Medicine Annual Meeting, Toronto, Canada.
Information: AACPDM, PO Box 11083, Richmond, VA 23230, U.S.A.

27–28 October, 1988
Functional Foot Orthoses, Derby, England.
Information: Mrs A. M. Lees, Course Secretary, National Demonstration Centre in Rehabilitation, Dept. Rheumatology and Rehabilitation, Derbyshire Royal Infirmary, London Road, Derby DE1 2QY, England.

27–28 October, 1988
Seventh Southern Biomedical Engineering Conference, South Carolina, U.S.A.
Information: David D. Moyle, Conference Chairman, Dept. of Bioengineering, Clemson University, Clemson, South Carolina 29634-0905, U.S.A.

30 October–4 November, 1988
Annual Meeting of the American Academy of Physical Medicine and Rehabilitation, Seattle, U.S.A.
Information: American Academy of Physical Medicine and Rehabilitation, 30 North Michigan Ave., Chicago, IL 60602, U.S.A.

November, 1988
Joint Conference on Biomedical Engineering, Hangzhou, China.
Information: Yi-ping Li, Secretary CIE/BMES, Shanghai Institute of Physiology, Chinese Academy of Sciences, 320 Yue Yang Road, Shanghai, China.

1–3 November, 1988
Rehabilitation Engineering and Therapy Unit 25th Anniversary, Professionals' Open Days and Seminars, Sussex, England.
Information: Mrs. D. Blake, Rehabilitation Engineering Unit, Chailey Heritage, North Chailey, Lewes, East Sussex, BN8 4EF, England.

2–4 November, 1988
Fourth Annual International Conference of "Computer Technology/Special Education/ Rehabilitation", California, U.S.A.
Information: Dr. Harry J. Murphy, CSUN Office of Disabled Student Services, 18111 Nordhoff St., Northridge, California 91330, U.S.A.

3–7 November, 1988
10th Annual Conference on IEEE Engineering in Medicine and Biology, New Orleans, U.S.A.
Information: Cedric F. Walker, Dept. of Biomedical Engineering, Tulane University, New Orleans, LA 70118, U.S.A.

5–8 November, 1988
International Conference on Severe and Multiple Disabilities, Melbourne, Australia.
Information: Public Relations Dept., Spastic Society of Victoria, PO Box 381, St. Kilda, Victoria 3182, Australia.

9–12 November, 1988
Children's Orthopaedics, Washington, U.S.A.
Information: Raymond Morrissy, AAOS, 222 South Prospect, Park Ridge, IL 60068, U.S.A.

3 December, 1988
Shriners Hospital Pediatric Orthopaedic Seminar, Philadelphia, U.S.A.
Information: Randal Betz, Shriners Hospital, 8400 Roosevelt Blvd, Philadelphia, PA 19152, U.S.A.

3–6 December, 1988
Innovative and Controversial Strategies in Rehabilitation, Miami, U.S.A.
Information: Division of CME D23-3, University of Miami, School of Medicine, PO Box 016960, Miami, FL 33101, U.S.A.

9–10 December, 1988
5th International Conference on Medical Engineering, Singapore.
Information: The Secretary, 5th BIOMED, c/o Dept. of Orthopaedics, National University Hospital, 5 Lower Kent Ridge Rd., Singapore 0511, Republic of Singapore.

1989

9–14 January, 1989
American Academy of Orthopaedic Surgeons Annual Meeting, Las Vegas, U.S.A.
Information: AAOS, 222 South Prospect, Park Ridge, IL 60068, U.S.A.

19–20 January, 1989
Meeting on Electrical Stimulation of Muscle, Hexham, England.
Information: Dr. R. J. Minns, Regional Medical Physics Dept., Durham Unit, Dryburn Hospital, Durham, U.K.

31 January–5 February, 1989
American Orthotic and Prosthetic Association Annual Meeting and Scientific Symposium, Orlando, U.S.A.
Information: AOPA, 717 Pendleton St., Alexandria, VA 22314, U.S.A.

9–11 March, 1989
9th Annual Scientific Meeting of the Australia College of Rehabilitation Medicine, Sydney, Australia.
Information: Anne Worden, 55 Charles St., Ryde, New South Wales, Australia 2112.

14–15 April, 1989
Conference on The Changing role of Engineering In Orthopaedics – Call For Papers. London, England.
Information: Andree Johnson, Conference Department C384, The Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, London SW1H 9JJ, England.

16–19 April, 1989
69th Annual Conference of the American Occupational Therapy Association, Baltimore, U.S.A.
Information: AOTA, 1383 Picard Dr., PO Box 1725, Rockville, Maryland, U.S.A.

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

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

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.

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.

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.

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.

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

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.

Prosthetics and Orthotics International, 1988, 12, 115–118

Sixth World Congress

12–17 November, 1989, Kobe, Japan

Time and place

The Sixth World Congress of the International Society for Prosthetics and Orthotics will be held in the Kobe Convention Center, Kobe, Japan from 12th to 17th November 1989. The Kobe Convention Center includes the International Conference Center, Kobe and the Kobe International Exhibition Hall, closely located to each other.

Kobe is located some 30km west of Osaka, with a population of 1,408,000, and serves as the capital of Hyogo Prefecture. It is situated about halfway along the Japanese archipelago facing the Inland Sea, with the scenic backdrop of the Rokko mountains. The city has thrived as an international trade centre since the Meiji Period, and still retains the exotic atmosphere of an international port city. Kobe has a different face from Osaka, Kyoto or Tokyo. The appearance of the city—sophisticated shopping streets, foreign-style architecture preserved from the Maiji Period and the romantic natural setting—accentuates Kobe's unique atmosphere.

Kobe is accessed by the airport limousine bus in about 40 minutes from the Osaka International Airport.

Kobe is actively promoting its new role as a centre of cultural exchange. The city offers a number of well-appointed convention halls and high standard accommodations as well as economy class so called "business hotels" and inexpensive lodging centres for youth.

Congress Structure

Instructional Course Lectures
Main Topic Sessions
Panel Sessions
Free Paper Sessions
Audiovisual Presentations
Poster Presentations
Manufacturers' Presentations and Demonstrations
Scientific Exhibition
Commercial Exhibition
World Assembly
Social Programme

Languages

The working languages of the Congress will be English and Japanese. Simultaneous interpreting between the two languages will be provided in the major rooms.

Instructional Course Lectures

The aim of this lecture series is to present well-prepared, highly informative material representing the state-of-the-art technology in the field of prosthetics and orthotics.

The topics of the courses will be:
- Lower Limb Prosthetics
- Lower Limb Orthotics
- Fracture Orthoses
- Upper Limb Orthotics
- Scoliotic Orthotics
- Management of Stroke Patients
- Amputee Gait Training
- Upper Limb Prosthetics
- Clinical Gait Analysis
- Wheelchairs and Seating for the Severely Disabled
- Neuropathic Foot

Main Topic Sessions

These sessions will feature current trends and recent developments in the undermentioned subject groups, presented by prominent international speakers.
- Environmental Engineering for the Severely Disabled
- Low Back Pain: Surgery and Orthotic Treatment
- Amputation Surgery (Including Traumatic Amputation)
- Sports Injuries and Orthotics
- Upper Limb Orthotics
- Upper Limb Prosthetics
- Neuropathic Foot
- Prosthetics and Orthotics in Developing Countries
- Scoliosis and its Treatment
- Lower Limb Prosthetics: Stump and Socket Interface

Panel Sessions

These sessions will contain lead papers, by experts in the field, combined with appropriate submitted papers. It is anticipated that these sessions will provide ample scope for group discussion.

The topics will include:
- Team Approach in Prosthetics and Orthotics
- Orthotic Treatment for Stroke Patients
- Surgical and Orthotic Treatment for Osteoarthritis and Rheumatoid Arthritis
- Spina Bifida
- Cerebral Palsy
- Historical, Geographical, Climatic and Cultural Considerations in Prosthetic Design
- Management of Spinal Cord Injury
- Functional Electrical Stimulation (FES)
- Communication Aids
- Limb Deficiencies Present at Birth
- Education in Prosthetics and Orthotics
- CAD/CAM in Prosthetics and Orthotics
- Wheelchair and Seating Problems
- Orthotic Treatment in Poliomyelitis

Free Paper Sessions

These sessions will give participants the opportunity of presenting the results of their research work and/or clinical and technological experience, to benefit those who are interested and engaged in a similar field of activity.

Audiovisual Presentations

Great emphasis will be placed on audiovisual presentations, incorporating films, videotapes and tape/slides.

Poster Presentations

There will be ample facilities for the display and discussion of poster presentations.

Scientific Exhibition

Space will be available for scientific exhibits from non-commercial institutions and organizations. As a special feature, we are hoping to arrange worldwide exhibits of traditional prostheses and orthoses using local or modern materials, particularly from Asian countries.

Manufacturers' Presentations and Demonstrations

Time will be available within the Scientific Programme for those taking part in the commercial exhibition to present and demonstrate new products and developments.

Commercial Exhibition

The Commercial Exhibition will be held concurrently with the congress at the Kobe International Exhibition Hall. Participants luncheon area, coffee shop, bar, exhibitors demonstration area and the scientific exhibition will all be accommodated in the same hall with a capacity of 3,000m^2 along with the commercial exhibition.

Other attractions are also being planned for the hall.

Social Programme

To entertain Congress participants and their accompanying persons, particularly those from abroad, a variety of interesting and informative programmes are being planned for the duration of the Congress as indicated below.

Sunday, November 12
Opening Ceremony, Knud Jansen Lecture

Monday, November 13
Japan Night

Tuesday, November 14
Dance Evening

Wednesday, November 15
Kobe Sightseeing, Reception by Mayor of Kobe

Thursday, November 16
Congress Dinner

Friday, November 17
Closing Ceremony

Accompanying Persons Programme

An interesting variety of free or modestly-priced events is now being planned by the Organizing Committee. The Committee will make the utmost effort to entertain accompanying persons with an attractive programme while congress participants are in sessions.

Further announcement and call for papers, exhibits and films

Papers, exhibits and films on prosthetics, orthotics, technical aids, surgery, rehabilitation engineering, rehabilitation management and related subject areas are invited. Please fill out the form, detach and mail promptly.

For further information contact:
Secretariat
VI ISPO World Congress
c/o International Conference Organizers, Inc. (ICO)
Crescent Plaza 1F, 2–4–6, Minami-Aoyama, Minato-ku, Tokyo 107 Japan.

Please complete and return this form as soon as possible to ensure your receipt of the Complete Announcement, which is scheduled to be published in November 1988.

(Please use a typewriter)

November 12–17, 1989, Kobe, Japan

REPLY FORM

(Male/Female)

Name: ______ (First) (Middle) (Last) (Degree)

Affiliation: ______ Professional title (position): ______

Mailing Address: ______

(Please check appropriate boxes and fill in the blanks.)

I will attend the Congress.

I will be accompanied by ______ family member(s).

I would like to offer:

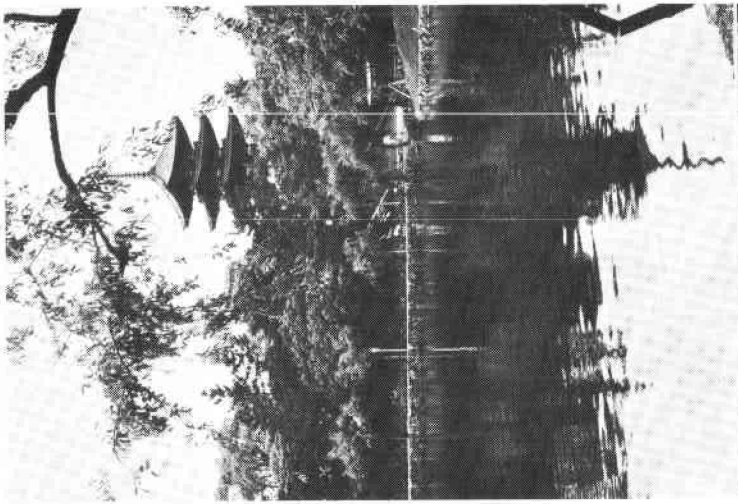
- □ a paper
- □ an audiovisual presentation
- □ a scientific exhibit

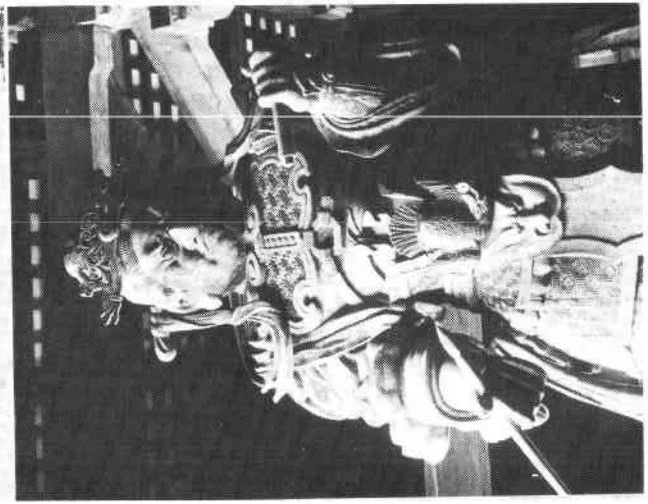
on ______

Note: Closing date for submission of abstract: February 1, 1989
(Abstract forms will be contained in the complete announcement.)

Please send me a copy of the 1st Announcement.

Date: ______





Secretariat
VI ISPO World Congress
c/o International Conference Organizers, Inc.
(ICO)
Crescent Plaza 1F, 2-4-6, Minami-Aoyama,
Minato-ku, Tokyo 107 Japan.

The Brian Blatchford Prize

The Brian Blatchford Prize has been established by the Blatchford family to honour the memory of Brian Blatchford. It will be awarded every three years at the World Congress of the International Society for Prosthetics and Orthotics.

The first Brian Blatchford Prize will be awarded at the Sixth World Congress of ISPO to be held in Kobe, Japan from November 12th–17th 1989. On this occasion the Prize will be £2,000 and will be awarded for the most outstanding innovation in prosthetics and/or orthotics practice over the previous three year period. The innovation should be related to a piece of prosthetic and/or orthotic hardware, or a scientifically based new technique which results in a better prosthesis or orthosis. The innovation should have reached a sufficiently advanced stage to ensure that it can be used successfully on patients.

The applicant or nominator should initially present evidence detailing the innovation, together with a sample of the device if appropriate, and send it to reach the President of ISPO by 31st December 1988 at the following address:

Professor J. Hughes,
National Centre for Training and Education
in Prosthetics and Orthotics,
Curran Building,
131 St. James Road,
Glasgow G4 0LS
Scotland

The innovation shall be presented at the Sixth World Congress and duly published in 'Prosthetics and Orthotics International'.

The President and Executive Board of the International Society for Prosthetics and Orthotics and the Blatchford family reserve the right to withhold the Prize should no suitable application be submitted.

The Forchheimer Prize

The Forchheimer Prize has been established by the Forchheimer family to honour the memory of Alfred Forchheimer. It will be awarded every three years at the World Congress of the International Society for Prosthetics and Orthotics.

The first Forchheimer Prize will be awarded at the Sixth World Congress of ISPO to be held in Kobe, Japan from November 12th–17th, 1989. On this occasion the Prize will be 4000 SEK and will be awarded for the most outstanding paper on 'Objective Clinical Assessment', 'Clinical Evaluation', or 'Clinical Measurement' published in 'Prosthetics and Orthotics International' during the three years prior to the Congress.

The President and Executive Board of the International Society for Prosthetics and Orthotics and the Forchheimer family reserve the right to withhold the Prize should no suitable paper be published.