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Polypropylene prosthetic component for a knee-disarticulation prosthesis

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It is well known by prosthetic professionals in developing countries that adequate components for knee disarticulation prostheses, priced affordably and adaptable to the environment, are not currently available.

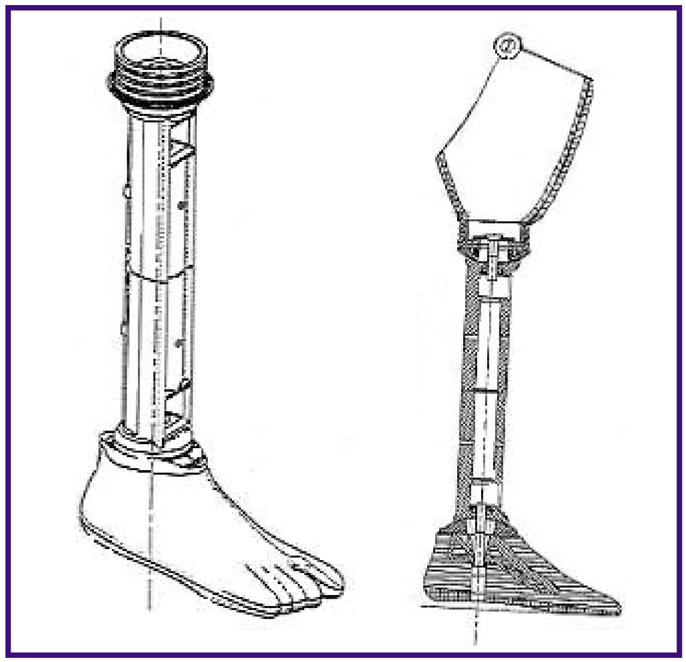
Patient walking with a knee disarticulation prosthesis

When the P&O practitioner is confronted with the design and production of a knee-disarticulation prosthesis, he or she has to select either a component for trans-femoral prostheses (such as conventional uprights for leather thigh corset, where the knee joint is integrated into the laminated shank), or high price modular components (available in industrialized countries).

The polypropylene prosthetic component system developed by the ICRC (International Committee of the Red Cross) takes into account the environment, price, and adaptability necessary for use in developing countries. This is a modular component system, with components available for trans-tibial and trans-femoral amputees. Until now, no components had been developed for knee-disarticulation prostheses. Therefore it became essential to develop a prosthetic component suitable to fit to a knee disarticulation prosthetic system widely used in the environment described above.

The objectives were:

- To design a new knee disarticulation component using polypropylene and metal uprights (both of which are readily available).
- To assemble knee disarticulation components that can be incorporated with the polypropylene trans-tibial componentry developed by the ICRC.



ICRC components on the left and then incorporated with the knee disarticulation component on the right

Six patients were identified and selected at random for this project. After measurements were taken, it was decided to develop two different sizes of knee components.

Fabrication of the component

As Figure 1 illustrates (next page), the distal or lower upright of the metal joint is bent according to the shape and contour desired. This must been done with the joints attached to an alignment (caliper) jig (Figure 2) to maintain proper alignment of the joints. One must also remember which side is being fabricated (left or right).

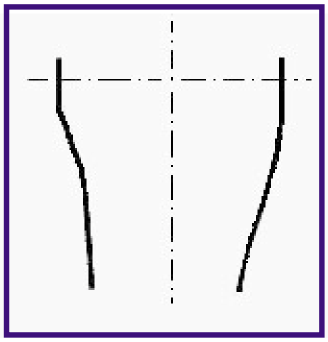


Fig. 1: joints bent to match contour of the compoenent

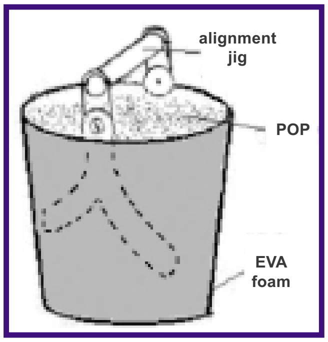


Fig. 2: caliper jig in plaster

A ten centimetre wide strip of EVA (foam) is rolled into a circle shape, to a diameter almost equal to that measured on the patient's contralateral side (I found two sizes generally fit most patients). The distal uprights are placed inside the roll of EVA, still attached to the caliper jig to maintain alignment as well as the medial-lateral measurement, (Figure 2).

Plaster of Paris (POP) is then poured inside the roll of EVA. Once the plaster has set, the EVA roll and joints are removed from the plaster mould.

The first molding of polypropylene is therefore done with the joints removed from the plaster, using 4mm polypropylene. This should be done with an inner layer of fine stockinette before molding on the positive cast. The stockinette will assist in the vacuum forming process, so that the plastic will follow the contour of the cast exactly (Figure 3).

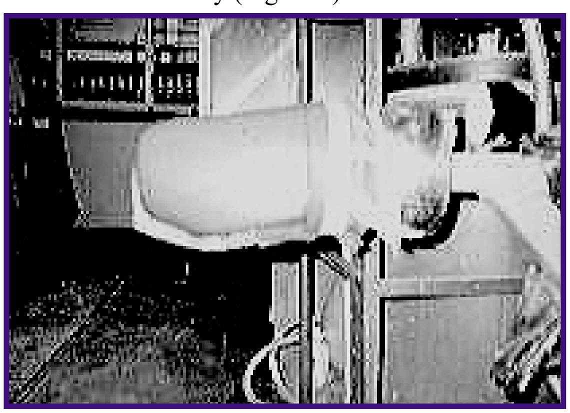


Fig. 3: first vacuum molding without the joints

Before molding the second layer, the joint stirrup is affixed on top of first layer (this does not require any space between the stirrup and the first layer). The uprights should be fixed, so as not to be displaced during molding, (Figure 4). Once molding is complete, the joints will be sandwiched between two layers of polypropylene. The proximal uprights of the metal joints are then bent to meet the socket.

Assembly of the knee disarticluation component

The objective was to create a knee disarticulation component, designed so that it could easily be incorporated with the polypropylene prosthetic components available from the ICRC. In fact, this component works best when incorporated with the

Fig. 4: second molding with joints in place

polypropylene components from the ICRC for trans-tibial prosthetics. The distal aspect of the knee component is fixed to a cylindrical cup, which can then be easily incorporated in the ICRC modular system.

Conclusion

This newly designed polyproyplene knee disarticulation joint with metal upright bars has been successful. This type of component can be used for amputations of any cause, regardless of surgical technique used for amputation.

It is easy to adjust a prosthesis made with these components in both static and dynamic alignment. The possible adjustments include anterior and posterior displacements, medial and lateral displacements, extension, and flexion, which can be done in the cup of the component.

The knee disarticulation component like other polypropylene components from the ICRC can be ready made in different sizes, which hastens the assembly process. Fabrication of the joint as described here consumes only 20 hours of labour.

Advantages of the new component:

- No additional time for correction of joint alignment after the component is mounted and aligned to the foot component as the joints of the polypropylene component are already aligned and parallel before the assembling process.
- The conventional prosthesis requires more time to ensure the joints are parallel during the process of assembling the joint and the shank.
- The weight of a conventional prosthesis is about 3.1kg to 3.3kg, while a prosthesis using the newly designed component is about 2.8kg to 2.9kg.

continued on the top of page 3

It should be a great help to many workshops in low-income countries if the ICRC would integrate this prosthetic knee component into component production. This could assure high quality of the material, design and function of the component.

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Technology and/or science for low-income countries?

Thomas Iwalla, Orthopaedic Technologist (ISPO category II), Kenya

Allow me to start by defining science and technology as follows:

- Science refers to knowledge about the structure and behavior of the natural and physical world based on facts that you can prove, for example, by experiments.
- Technology refers to scientific knowledge used in practical ways in industry, for example in designing new machines.

From these definitions given by the Oxford Advanced Learner's dictionary, one can see a thin line between the fields in question, though they are interrelated.

Science studies an already existing element, forms ideas and makes conclusions based on tested and proven deductions. Technology, on the other hand, is conceptual and practical! In technology, an idea is first conceived and then translated into a visual and realistic situation. However, technology is often misunderstood to mean science. Low-income countries are currently in need of huge investments in orthotics and prosthetics (O&P). Though a sophisticated prosthetic or orthotic device has a lot of science in it, a special emphasis must be placed on developing good orthopaedic technology.

We therefore need more awareness that O&P is technologically based. This reinforces the need for O&P professionals from the non-industrialized and industrialized worlds to form networks. The International Society for Prosthetics and Orthotics is an excellent example of this.

Disability has never been "inability" as far as the social and moral value of human life is concerned. In general, attitudes towards people with disabilities have changed, both in terms of the language used for reference and the societal prejudices that deprive the concerned individuals of career prospects.

Frustration due to lack of resources and education is the driving force for progress in O&P, as pointed out by colleagues in previous issues of ORTHOLETTER. This is seen, for example, in the misalignment of devices, or in devices manufactured in locations where there are no well-equipped rehabilitation centres. O&P professionals have a social and moral responsibility towards people with physical disabilities. The love and service for humanity, together with a sympathetic appreciation of human problems should be a great consolation for us. People with disabilities are always struggling with problems such as poverty, inequality, disadvantage and discrimination. Obstacles could prevent us from rendering quality service, as is expected of us after our basic training. Nevertheless, I pose a challenge to all of us in this rather noble profession to be armed with "D3C", which is:

DETERMINATION when we are undervalued,

DEDICATION to orthotics and prosthetics, even when we are not appreciated for our services,

DEVOTION in instances when we express our personal dissatisfaction with not having a voice on the rehabilitation team, and above all

COMMITMENT even when we work in an isolated and ill-equipped orthopaedic laboratory, where we have personal hardships and are not properly supervised, with few continuing education prospects. Even then let us aim to steer prosthetics and orthotics to greater heights of prosperity. The father of modern medicine, Hippocrates, and his French counterpart Ambroise Pare, the father of orthopaedics, never gave up during their days! Who are we to give up today amid advancements that have been seen throughout our profession worldwide.

In conclusion, the developing world is in great need of a well-blended mixture of science and technology with a greater emphasis on orthopaedic technology than there is now. To properly serve people with disabilities we must also further develop our profession through networking, awareness and dedication. Do not ever forget that our relentless efforts and contributions to O&P will one day be rewarded and will contribute greatly to the success of our profession. DOMINOS VOBISCUM prosthetics and orthotics.

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Meeting post-conflict needs:

Education and training in ICRC-assisted prosthetics & orthotics programs

Part I: context and problems faced

Theo Verhoeff, Physiotherapist, MPH; Claude Tardif, Orthotist-Prosthetist

This article is the first of a series dedicated to education and training in ICRC-assisted O & P programs.

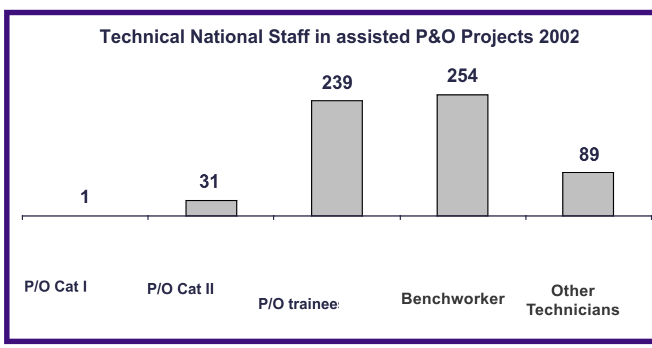
An amputee has a permanent disability and will need access to rehabilitation services for the rest of his or her life. Provision of these services is particularly problematic in countries with war or internal conflict, where large numbers of amputees and people with disabilities live. In these regions, most service provision systems and educational systems have collapsed. Assistance programs for new or existing centres often need to start from very basic levels. The International Committee for the Red Cross (ICRC) has an assistance approach which focuses on technical assistance for prosthetics/orthotics service delivery systems, introduction of low cost/good quality technology and prosthetics/orthotics teaching to national staff. This series of articles focuses on the teaching programs for national staff.

Poverty, insecurity and lack of career prospects

Collapse of service provision systems

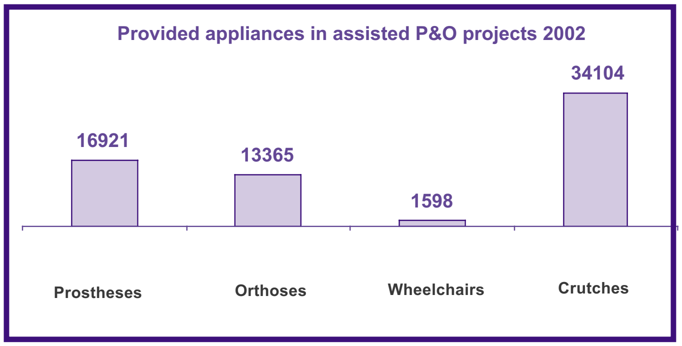
The context in which programs are carried out is important in understanding their main constraints. First, one must consider the poor economic and security situations of the countries in which the ICRC usually operates. Poverty, hunger, uncertainty, insecurity and lack of career prospects do not offer a positive climate to motivate national staff for training and prosthetic/orthotic service delivery. Though prosthetic/orthotic centres are not usually located on the front-line, the security situation may suddenly change and affect the centre. For instance, during the year 2000, the prosthetics/orthotics center in Jaffna, Sri Lanka was forced to change location 3 times because of urban warfare. In 1990, two members of the ICRC were kidnapped in Lebanon. Another important consideration is that the prosthetics/orthotics needs of war victims must be addressed within a reasonable lapse of time. New action is usually a result of an influx of recently war-wounded patients. The fitting of these patients cannot await the completion of a conventional training course for national staff. Thus, an important part of the resources and energy is spent on setting up and improving the patient service system and making services accessible to patients. A further problem is the insufficient basic and/or mid-level education of the national staff to be trained due to collapse of the country's educational system and /or the emigration of educated personnel. Training and upgrading possibilities of already employed staff can be limited due to their insufficient basic education. Furthermore, it can be difficult to recruit additional employees with sufficient background.

Currently there are several hundred national technical staff following continued training in the assisted centres every year. According to the circumstances, three types of in-house training can be distinguished.



On-the-job training is given in all programs and is the backbone of each program. The maximum number of apprentices per qualified prosthetist/orthotist is 6 students. The training is flexible, depending on the situation, progressing from demonstrations to close supervision by the prosthetist/orthotist, and is generally combined with limited theory. During the year 2002, 271 technicians involved in prosthetics/orthotics fitting and 243 other technical employees including bench workers received on-the-job training.

In 1993, the ICRC decided to offer the possibility of more advanced training in certain programs, leading to a Certificate of Professional Competence (CPC), issued jointly by the ICRC and the local authorities. Requirements are at least 3 years apprenticeship under supervision of a qualified prosthetist/orthotist and the successful completion of an examination in the presence of external examiners. This certificate meets the need for recognition of acquired competencies in countries where the normal education system is interrupted. So far, 59 technicians in 6 countries (Chad, Lebanon, Syria, Sudan, Georgia, and Azerbaijan) have successfully passed the exam. Forty technicians passed similar exams before 1993 in Nicaragua (12) and Ethiopia (28).



In some countries training is conducted up to the ISPO Category II standard, in close consultation with the International Society for Prosthetics and Orthotics (ISPO). This is organized in unique, modular, one-off work-study courses. Thirty-five students passed this exam in Mozambique (23), Georgia (5) and Azerbaijan (7). During the year 2002, 32 national orthopaedic technologists were employed in 49 assisted projects.

ISPO Category II final examination in the Caucacus

In addition to these three training programs, the ICRC's Special Fund for the Disabled in Addis Ababa, Ethiopia, offers month long refreshment courses in the manufacture of prostheses using polypropylene technology. This course, free of charge, is aimed at national staff of assisted projects and first mission ICRC prosthetists/orthotists, but is also open to non-ICRC candidates.

Refresher course in the ICRC polypropylene technology

Since 1995, this course was attended by 203 national staff and some 35 ICRC first mission prosthetists.

Parallel to the in-house training courses, the ICRC sponsors national staff to attend nationally or regionally established prosthetic/orthotic schools for training or upgrading. More than 20 students from assisted programs have been or are presently under training in four schools (Cambodia, Vietnam, Tanzania, El Salvador).

Training has contributed to improving the quantity and quality of fittings and increased the prospects of creating self-sustainable projects.

Since 1979, patients in 73 assisted projects were fitted with 194,772 prostheses and 87,458 orthoses during the period of assistance. The real number of beneficiaries is higher however, when one takes into account the patients who were fitted in the projects from which the ICRC has since withdrawn (full-time) assistance, for example Chad, Colombia, Lebanon, Mozambique, Rwanda, Syria, Uganda and Zimbabwe.

On the other hand, the combination of unsatisfactory economic circumstances with a higher degree of training, risks migration of qualified staff to better paid employment opportunities elsewhere. In Sudan and Nicaragua, more than half of the trainees left the assisted centres within 3 years after completion of the course. The level of training is directly related to the quality of prosthetic/orthotic fit for the patient and also to the prospects of sustainability of the project. It is important that conditions are created to provide adequate employment after training so that these individuals stay in areas of need.

Training is essential in addressing quality, quantity and sustainability, but major constraints do exist. The training goal for the ICRC is therefore to first identify and address the most essential needs in each project. Due to the limited existing health infrastructure, the priorities most easily addressed are often lower limb amputees, followed later by patients in need of orthoses and upper limb amputees.

In consultation with the ISPO and others, efforts are ongoing to standardize a methodology for the implementation of a basic training course with corresponding teaching packages. The course should offer prospects for upgrading to an internationally recognized level, if and when conditions allow. Part II of this series of articles will provide more information on this topic.

Sources:
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Opening of a new teaching wing at TATCOT

Sepp Heim

On November 9th, 2002, the new wing of the TATCOT school in Moshi, Tanzania, was officially inaugurated by his Excellency Benjamin Mkapa, President of the United Republic of Tanzania.

The new site consists of two levels. On the ground floor is located the TATCOT Wheelchair Technologist Training program. On the first floor there are varied classroom facilities for multiple purposes, and a study centre consisting of a library complete with electronic equipment and web access.

Professor Shangali, a visiting Bishop and his Excellency Benjamin W. Mkapa at the inauguration of the new wing

TATCOT staff members explain wheelchair production to the President of Tanzania and his entourage

The opening ceremony was assisted by a number of important international and national personalities and experts, underlining the importance of rehabilitation services in Tanzania and Africa. The involvement of these important people emphasises as well the important role that TATCOT plays by offering different training levels in prosthetics and orthotics and related rehabilitation services.

Dignitaries and representatives of various supporting organizations to the TATCOT project

First graduates of the degree program in Tanzania

Sepp Heim

On the 9th of November, 2002, the Kilimanjaro Christian Medical College (KCMC) celebrated its first graduates of the Bachelor of Science in Prosthetics and Orthotics program. Five candidates received degrees.

The B.Sc. training program at TUMAINI University in Tanzania is the first at this level in low-income countries, and sets a milestone for the future of the profession and its development in Africa. This training is the logical progression after Orthopaedic Technologist (ISPO Category II) training, and provides a perfect opportunity to train future teachers, researchers, and clinical team members in a unique environment.

2nd annual national P & O congress held in Cambodia

John Zeffer, CP, American Red Cross-Cambodia,
Delegation Kompong Speu Rehabilitation Center, Kingdom of Cambodia

On the 26th and 27th of December 2002, the 2nd Prosthetic and Orthotic National Congress of the Kingdom of Cambodia was held. Of special note was official acknowledgement from the Royal Government and the election of officers for a new association of prosthetists and orthotists, now recognized as the Cambodian Association of Prosthetists and Orthotists (KhAPO). In attendance were representatives from all 14 Physical Rehabilitation Centres that provide services to people with physical disabilities in Cambodia, as well as the Ministry of Social Affairs, Labor, Vocational Training, and Youth Rehabilitation (MoSALVY). Attendees also included representation from the Disability Action Committee (DAC), the Cambodian School of Prosthetics and Orthotics (CSPO), the Phnom Penh Component Factory, and the Physical Rehabilitation Committee that is comprised of non-governmental organizations and other agencies that are responsible for the centres: The American Red Cross, Cambodia Trust, Handicapped International (Belgium and France), The International Committee of the Red Cross, and Veterans International.

Participants of the 2nd Prosthetic and Orthotic National Congress of the Kingdom of Cambodia

Cambodia has only recently begun to recover from the social, economic, and spiritual destruction caused by over thirty years of civil war and violence. The national infrastructure has been shattered, and the people of Cambodia are among the poorest and most vulnerable in the world. The GDP per capita in Cambodia is $257 USD and life expectancy for the combined population is 56.8 years.[1] As difficult as life in Cambodia is, it is even more so for persons with disabilities. Cambodia currently has one of the highest proportions of landmine disabled in the world, at an estimated one in every 384 people.[2] These existing victims and their families will require a lifetime of assistance to overcome their disabilities. In addition to the high number of landmine disabled, there are thousands more who suffer from disabilities caused by diseases such as poliomyelitis and measles, as well as inadequate pre and post-natal care and inadequate or inappropriate medical care for illness and accidents, all due to the total disruption and destruction of basic services.

In response to this tremendous need, the above-mentioned organisations, through the Cambodian School for Prosthetics and Orthotics , have placed 55 ISPO recognized Category II Orthopedic Technologists in the country. "More P&Os are needed" states Mr. Bo Kim Song, an instructor at the CSPO and newly elected KhAPO Secretary for Continuing Education. There are 24 provinces in Cambodia and the 14 rehabilitation centres are only able to target service to 19 provinces. This leaves an untold number of persons with physical disabilities without attention. Approximately 6000 prosthetic limbs and 5500 orthotic devices are produced yearly at this time.

Business, as well as continuing education topics and needs, was presented during the congress. Currently, funding for continuing education programs is obtained from the stakeholders of the Physical Rehabilitation Committee, as was funding for the recent ISPO Polio Conference held in Phnom Penh.

Mr. Ma Channat, elected president of KhAPO, stated that the mission of the new association is "to preserve professional ethics, share experience and build a network of communication to expand and continue educational development for P&O in Cambodia." Mr. Kim Song added, "We need to continue to improve the quality of treatment in Cambodia. We also need to connect to other national associations so we can reach international standards."

Future directions for KhAPO include leadership of P&O development on a regional scale (South East Asia), and eventual achievement of ISPO Category I recognition for national prosthetists and orthotists to enable participation in worldwide P&O development. Fifty one graduates of CSPO have now enrolled for membership to KhAPO.

The topics of professional development presented at this congress included treatment of cerebral palsy, serial casting, orthotic design, and prescription. As not everyone can attend all conferences and seminars, especially those working in the remote provinces, the sharing of information in evidence at this gathering signified a level of professional growth for Cambodian Orthopedic Technologists. Category II individual case situations and treatment planning were largely represented in the presentations. A review of the recent ISPO Polio Conference identified strong and weak points of the 2-week seminar, and was significant in that Cambodian nationals, without international assistance, gave the analysis.

Increasing sustainability of a professional level of prosthetic and orthotic services was in evidence at this Congress. "This association must be encouraged and supported for continuance of quality care for persons with physical disabilities," stated Jean François Gallay, chairman of the Physical Rehabilitation

continued on page 10

Lower limb orthosis with polypropylene articulation

This article is a modification of a report from Handicap International and the Hô Chi Minh Ville Rehabilitation Centre for Disabled Children contributed by Jean Claude Vesan, Orthotist-Prosthetist

Handicapped International, like many non-governmental organizations involved in orthopaedic devices, used to focus on prostheses supply, the first priority in post-conflict times. Our actions in low-income countries (often in the framework of community-based programs), where poliomyelitis or cerebral palsy are the major causes of disabilities, has now led us to develop our expertise in the field of orthotics, destined for a more varied and numerous target population.

Traditionally, the most commonly used technology in developing countries has been the metal orthosis (aluminium, steel, etc.), which simply requires basic equipment. On the other hand, this kind of device is heavy and unaesthetic and also obliges one to wear a closed or half-closed shoe, which is hardly supported by children in tropical climates. In addition, the identification and purchasing of good quality sidebars and joints is often a problem.

Thanks to socio-economical progress in some of these countries, a new type of orthosis could be fabricated by different agencies: the "mixed" orthosis. This orthosis uses thermoplastics, which are more comfortable and more precise, and which do not require any special footwear. The purchasing of sidebars and joints for this orthosis, however, is still a problem. This "transitory" technology was already an important step for our beneficiaries. However, in Vietnam, the motivation and the technical level reached by Handicap International's partners allowed us to progress further. In the Hô Chi Minh Ville Rehabilitation Center for Disabled Children, the polypropylene knee joint for lower-limb orthoses was created, showing new properties:

- Fabricated solely of polypropylene, with the exception of the articulating screws, the straps, and the locks[1]
- Weight: For a 50 kg user, for example, the knee-ankle-foot orthosis is only 550 g. This is an improvement of approximately 30% in comparison to a mixed orthosis, and a 40% improvement compared to an aluminium orthosis
- Independence from steel joint and sidebar supply
- Improved function of the device, due to the improved stiffness of the knee, maintaining both joints in the proper alignment
- Easy repairs of the lock and the joints
- Wider distribution of the posterior knee pressures, allowing more comfort, particularly in case of genu (knee) recurvatum
- Cost of the device, decrease for the joints and sidebars
- No particular knowledge or material needed

Fabrication

This technical description will only be related to the specific process, not the general principles of any orthotic device. In addition to the basic material used for mixed orthoses, a polypropylene joint requires:

- One alignment guide, composed of a threaded rod with an 8 mm diameter, and two aluminium cylindrical pieces of 35 mm diameter
- One 6 mm drill, to be used for rounding off the joints' heads
- One hinge, used for the making extension stop
- One circular saw with a 100 mm blade, to be adapted on a drill for the manufacturing of the extension block stops

Required materials

Casting & measurements

The patient is standing in a corrected position, the hip joint in 6^{o} of external rotation, knee straight, and ankle at 90^{o}. Particular attention must be paid to the following measurements:

- Diameter above the condyles
- Knee joint axis diameter
- Ankle malleolus diameter

Positive mold

Positive mold plaster correction

Taking these measurements into account, rectifications are performed on the anterior of the leg cast in order to make the donning of the orthosis easier.

Joints guide positioning

Thanks to a round "surform" file, the positive mould is carved to make room for the alignment guide. To increase the security of the lock, the alignment guide should be placed in a more posterior position than the normally placed. A minimum distance of 1cm behind the joint's physiological axis is appropriate. The alignment guide protrudes on each side (medially and laterally) of the positive mold, by 3 mm.

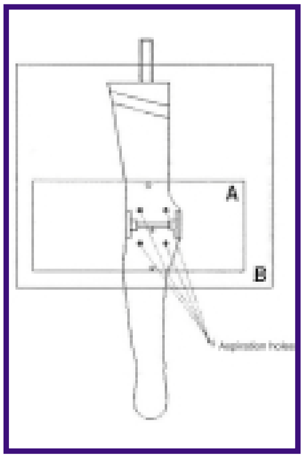


Figure 1

Thermal molding and cutting of the femoral segment

2 polypropylene sheets are cut according to the schematic in Figure 1:

- Small sheet (A) (5mm thick) for the lower part and joint
- Big sheet (B) (4mm thick), for the whole segment.

A sock, or tubular jersey, is put on the positive mold before the molding to draw the air away during the process. If needed, microcellular moss is placed on the joints and on the sidebars of the device in order to make it more rigid. Both sheets are thermally molded, one on top of the other, the small one first, than the larger, as shown below.

Both sheets must be carefully molded together to reduce any air bubbles. During the vacuum molding process, pull both ends of the two sheets on the plaster mold to ensure a better connection of the two pieces

Note : *The rigidity that results from the increased thickness of both polypropylene sheets will assist the wearers by providing improved knee stability once the straps are fastened.*

The femoral section is cut off the cast and will be trimmed around the joint area as explained in the next sections of the article.

Thermal molding and cutting of the lower leg segment

Two polypropylene washers, as thick as the 2 superimposed sheets of the femoral segment, are placed over each side of the joint alignment guide with the flat side of the washer at the back (shown in Figure 2). The purpose of this is to replace the joint heads of the femoral section, so the joint heads of the lower leg section will be at the proper diameter.

For the lower leg segment, 2 polypropylene sheets, of 5 mm each, are cut according to the schematic in Figure 2:

- Small sheet (C), for the upper part of the joint
- Big sheet (D), for the whole leg and foot segment

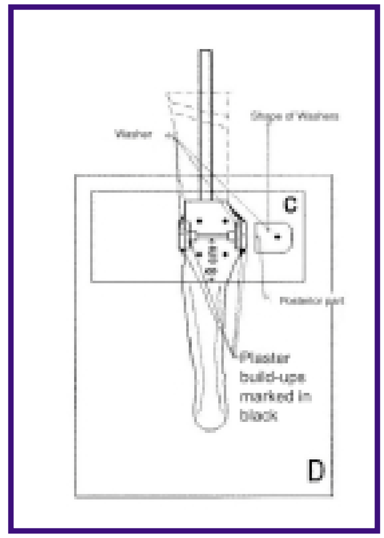


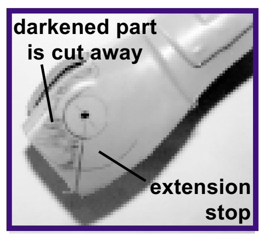
Figure 2

The thermal molding process is the same (take the same precautions) as for the femoral segment, starting with the small sheet, around the knee.

Design of the extension stops

The 4 anterior stops are designed in the sagittal plane with a 45° angle. The stops protrude anteriorly and make contact with each other when the user goes into full extension. The diagrams below show the preparation of these stops (also see Figure 3 - pg. 10).

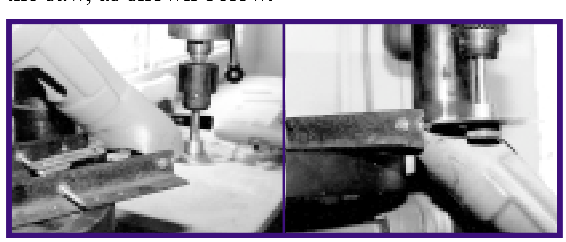
Joint heads and extension stops cut



Joint heads, on each side of the lower part of the femoral segment and of the upper part of the leg segment, are marked as shown to prepare for the cutting of the joint heads and extension stops.

An 8 mm hole is made in the orthosis axis (in the centre of joint heads), and the circumference of the heads (35 mm diameter) is cut with a 5 mm drill as shown on the right.

The extension stops are then cut according to the marked plastic by using the saw, as shown below.



Trimlines of the orthosis
The way to cut or trim an orthosis is the same for a mixed orthosis, and can be done according to the technician's normal procedures. In the Rehabilitation Centre for Disabled Children, the orthoses have no ankle joints, because they tend to wear away too quickly. This is compensated for by a more posterior cut of the forefoot, which makes walking easier.

Joint assembly
The axis of the orthosis is made of two M6 nuts, with an external diameter of 8 mm, placed on the inside of the joints and two countersunk M6 screws placed on the outside (Figure 3).

Lock fitting
The lock (posterior) is made of a hinge (e.g. the metal hinge of a cupboard) and of an elastic return strap (inner tube). The ends of the elastic return strap are fixed on each side of the leg segment and go back and round the leg to control the lock (See Figure 3).

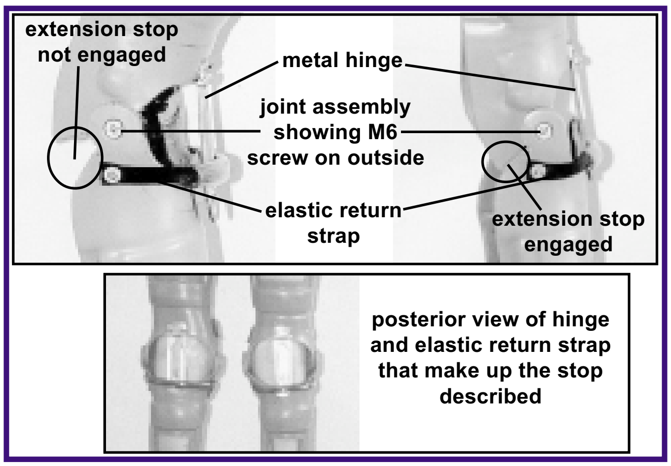


Figure 3

In Vietnam, a special mold has been set-up and built for this use, recycled polypropylene is used to make this lock component.

Straps assembly, fitting and delivery
This phase is the same for any kind of orthosis. In Vietnam, the location for the straps are directly cut in polypropylene, which makes buckles unnecssary. The nylon, velcro and moss straps are removable and can easily be washed or replaced.

The completed orthosis

Follow-up at home
The systematic at home follow-up of the devices is also an important part of the process. It is the only way to be sure that the technology used meets the demands of the living conditions and the environment of the user. In Vietnam, this follow-up was implemented when it was noticed that a major proportion of devices were not being used. The most important reasons are:

- The stay in the rehabilitation centre was too short to try the device and to practice walking again.
- Delivery of devices through mobile teams was performed without trying it on.
- Impossibility for the user to transport themselves to the rehabilitation centre to adapt the device or simply to replace the damaged straps.
- Devices that have become too small due to the growth of the user.

Now, this at home follow-up guarantees that more than 90% of the devices (prostheses and orthoses) are actually being used. It also accounts for an important part of the training of new users.

[1] *The joint screw mechanism is now being made out polypropylene since this article was written.*

HANDICAP INTERNATIONAL
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continued from page 7

Committee and ICRC Head of Project. Indeed, the seeds of this effort to bring assistance to persons with disabilities in Cambodia are taking root and should be nourished.

[1]*United Nation Development Program*
[2]*Ministry of Planning with UNDP; Cambodia Poverty Assessment, 1999*

Contributions and inquiries can be made to:
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ISPO Ad Hoc Committee for Non-Industrial Countries

In the past year ISPO has formed an Ad Hoc Committee with a focus on non-industrial countries. The Chair of this committee is Heinz Trebbin who currently is the Director of the GTZ Project in El Salvador and current member of the ISPO Education and Publications Committees. The committee brings together a number of individuals from around the world who have varying experiences in non-industrial countries and who also bring unique and important resources to the committee.

A mission statement for the committee was drafted to give the committee some guidelines to develop the initial activities that the committee will try to initiate. The mission statement and initial activities are described below:

MISSION STATEMENT
The Ad Hoc Committee aims to assist at improving the quality, availability and sustainability of P and O services in non-industrial countries through the exchange of information and the development of tools in service provision, project guidelines, technology update and training.

ACTIVITIES
The activities of this committee will take into account the conclusions and recommendations of the various ISPO consensus conferences. This committee will be responsible to harmonize the activities of the existing technical working groups and make recommendations to the ISPO board for approval.

The activities that have been initially identified by the committee are listed in the next column along with the committees initial thoughts on what kind of content should go along with each activity.

ACTIVITY 1 - Service Provision
- provide checklists to evaluate the quality of P and O devices.
- identify self help and user groups.
- to help develop a strategy to promote public awareness of the availability of prosthetic and orthotic services.
- to give access to patient registration and follow-up systems.

ACTIVITY 2 - Project Guidelines
- to advise and promote the use of the existing protocols and update them over time.
- these documents could include the following areas:
  - assessment and planning
  - project monitoring and evaluation
  - cost calculation.

ACTIVITY 3 - Technology Update
- this activity will make information available on the following:
  - technical guidelines and standards.
  - appropriate technology.
  - advancements of technology.
  - research and evaluation.

ACTIVITY 4 - Training
- this activity will promote the existing WHO/ISPO guidelines for training, provide information on existing curriculums of training institutes and publish information on the development in teaching needs, methods and materials.

ACTIVITY 5 - Exchange of Information
- develop a website making the information the committee produces or gathers, easily available and accessible.

For those of you who would like further information on the committee's activities or would be interested in helping with the committee's work, please contact Heinz Trebbin by way of the following e-mail address - isrigtz@es.com.sv

Course & Conference Listing

ISPO Polio course
Week of 20 July 2003
Lome, Togo
John Fisk (e-mail: jfisk@siumed.edu)

ISPO Consensus conference Orthotics in Stroke Management
21-26 September 2003
Ellecom, The Netherlands
Juan Martina (e-mail: j.martina@grootklimmendaal.nl)

ISPO - Cerebral Palsy course (to be confirmed)
September 2003
Santiago, Chile
David Condie (e-mail: condie@benassynt.freeserve.co.uk)

ISPO Canada 2003 Symposium: Innovations in Prosthetic and Orthotic Gait
17-18 October 2003
Toronto, Ontario, Canada
Edward Lemaire(e-mail: elemaire@ottawahospital.on.ca)

IV Latin American ISPO Congress,
20-23 Oct 2003
Buenos Aires, Argentina
Carolina Shiappacasse (e-mail: schiap@intramed.net.ar)

Orthotics & Prosthetics Society of India (OPSI) National Conference 2004
23-25 January 2004
Bhubaneswar, Orissa, India
A.N. Nanda (e-mail: nirtar@ori.nic.in)

ISPO - Cerebral Palsy course
3-10 December 2003
Hanoi, Vietnam
David Condie (e-mail: condie@benassynt.freeserve.co.uk)

8th European Congress of Research in Rehabilitation
13-17 June 2004
Ljublana, Slovenia
Crt Marincek (crt.marincek@mail.ir-rs.si)

ISPO 11th World Congress: "Innovations for Quality Living"
1-6 August 2004
Hong Kong, China
Congress Organizing Committee (e-mail: ispo@pctourshk.com)

Trans-tibial alignment

Normal bench alignment

Noelle Lannon, Canada

This article is the first in a series on prosthetic alignment

“Alignment” refers to the spatial relationship between the prosthetic socket and foot. The main purpose of alignment is to position the prosthetic socket with respect to the foot so that undesirable patterns of force applied to the residual limb are avoided. A second purpose is to produce a normal pattern of gait.

Concept of moments

A **moment** is defined as “the tendency of a force to create rotation about a certain point”. In prosthetic alignment it may be assumed that this point is located roughly in the geometric center of the prosthetic socket (“center of socket”). The socket may be considered to have a tendency to rotate about this point, and this rotation is resisted by the force applied by the residual limb (stump).

The prosthesis is subject to downward forces applied by the residuum from above, and by the reaction from the ground reaction below. If the downward force applied by the stump, and upward acting ground reaction force (GRF) are acting in the same line (collinear), there is no tendency for the socket to change its angular relationship with respect to the residual limb (rotate about the theoretical center of socket). If they are not collinear, there will be a tendency for the socket to change its relationship with respect to the stump (rotate). This tendency is best resisted with a good fitting total contact socket, and is influenced by the alignment of the prosthesis.

This described tendency of the socket to rotate about the limb in turn creates forces that act on the stump. Forces acting on the stump can be controlled so that relatively higher forces (pressure) will be applied to the areas where they are best accommodated and are most effective. These forces may also be reduced in pressure sensitive areas.

Bench alignment

Taking the time to properly bench align a prosthesis contributes to a smooth, energy efficient gait pattern. This includes controlled knee flexion after heel strike, smooth rollover with limited recurvatum (hyperextension), and heel off prior to initial contact on the normal (other) foot.

In the **sagittal plane**, proper anteroposterior (AP) positioning of the socket with regard to the foot will result in even weight distribution between the heel and toe portion of the foot statically. For a trans-tibial prosthesis, a plumb line (gravitational line 90° to the ground) should fall through the center of socket (it may be easier to mark this with a erasable marker), slightly anterior to where the ankle joint axis would be, and through the weight bearing area of the foot between the middle of the weight bearing surface of the heel, and the metatarsal heads (shown in Figures 1 and 2). When this is done make sure the appropriate heel height is approximated using a wood block or other device to lift the foot. Although some texts differ, generally five degrees of socket flexion is incorporated into an initial bench set-up (Figure 2). If the patient has a knee flexion contracture, this five degrees should be added to the degree of contracture present. For example, if the patient has a contracture of 10 degrees, the socket should initially be set in 15 degrees of flexion. This initial flexion, or socket tilt, will help assist better loading in the socket and helps create a smoother gait pattern. This flexion in the socket positions the limb in a natural midstance position and helps reduce hyperextension tendencies during gait.

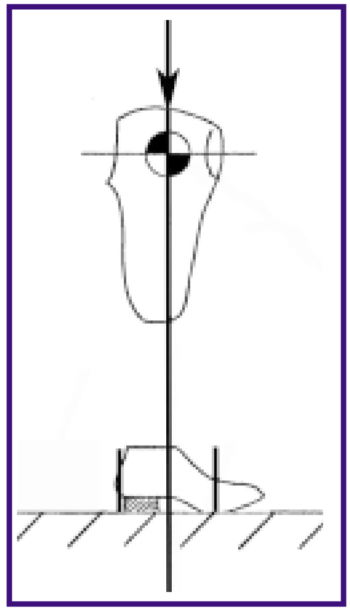

Fig. 1: standard anterior-posterior alignment in the sagittal plane

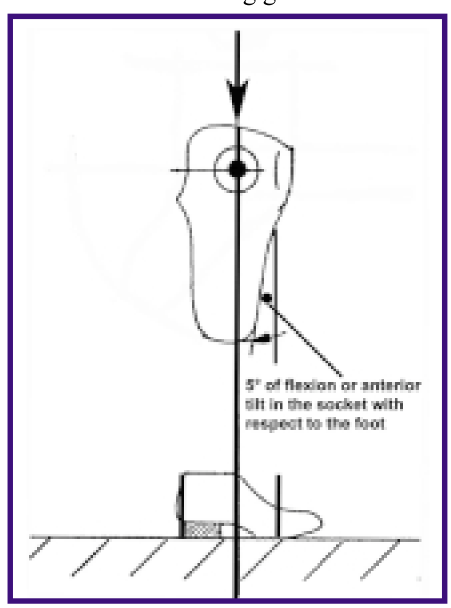

Fig. 2: standard flexion angle of the socket in the sagittal plane

Proper alignment in the **frontal plane** should result in a more narrow base of gait, and decreased energy spent in walking. The goal is to duplicate the normal knee position (normally varus) at mistance, and ensure appropriate loading of the medial flare of the tibia (a force tolerant area). If cosmetic finishing of the prosthesis is a problem, the foot can be out-set (lateral) minimally to improve the cosmetic shaping of the prosthesis.

Imagining the "center of socket" in the frontal plane, a plumb line should fall roughly through the center of the posterior shelf of the prosthetic socket (this shelf would normally be horizontal, reflecting the frontal plane shape of the limb - not tilted one way or the other). The plumb line should then fall through the center of socket, and bisect the middle of the heel of the foot when looking from behind (Figure 3).

Looking down on the trans-tibial socket from above (**transverse plane**), it should be possible to draw an imaginary line that will go from the middle of the posterior shelf, through the PTB (patellar tendon bar), bisecting the second toe of the prosthetic foot. In the transverse plane the angle of toe out of the foot should be set to five to seven degrees. This angle can be determined with most prosthetic feet by placing the medial border of foot parallel to line of progression of the way the amputee walks. This may need to be altered during static and dynamic alignment to match the toe-out angle of the normal foot.

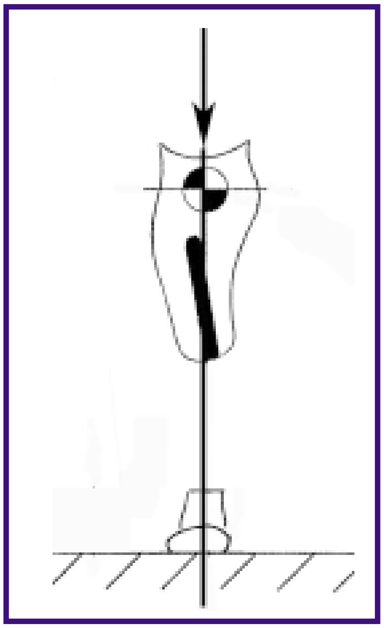

Fig. 3: standard medial-lateral alignment in the frontal plane

The importance of proper bench alignment cannot be stressed enough. While it is of course possible to alter the alignment of a prothesis once it has already been assembled, aligning the prothesis to a proper, standard "bench alignment" provides an excellent place from which to start. Aligning every prosthetic device to a set standard bench alignment provides an ideal "starting point" for a prosthetic fitting, without the orthopaedic technologist having to guess at how the prosthesis is aligned. Only minimal adjustments may be required during dynamic alignment, if the prosthesis is aligned properly during the bench set-up (this is especially ideal if working with such materials as wood). If adjustments are necessary, all modular couplings used will be at their maximum range of adjustability.

References:

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FIGURES are courtesy of Markus Thonius

The next article in the series on prosthetic alignment will focus on normal static and dynamic alignment of a trans-tibial prosthesis, and will appear in the next issue of OrthoLetter.

Questions and Answers

REMINDER!! Everyone is welcome to pose questions either from past articles or from the field in general. These questions need not be specific to any particular topics, but can cover a wide variety of subject matter. Those who have questions or inquiries are encouraged to submit them for posting. It is hoped that the readership will respond to the questions posted through a related article or a short response.

Contact information is on the back page of the newsletter.

Message from the Editor

Requests for hardcopies of ORTHOLETTER continue to come to us from those in industrialized countries via e-mail. I should remind everyone that ORTHOLETTER is only mailed as a hardcopy to those working or residing in low-income countries. For those who reside in industrialized countries, the policy of ISPO is that those individuals can download the PDF version available from our website or view it via their web browser directly from the internet. As there is no advertising in ORTHOLETTER, the costs have to be completely covered by the organization and therefore postal costs must be kept within budgetary constraints. Again our website address is – home.ica.net/~cocinc/Ortholet.html.

Our website has seen a reasonable amount of activity since we started keeping statistics on how often our home page was viewed. We have had over 1000 hits to our homepage since March 1st and about 300 hits to our page showing pictures and video of the plastic reinforcing techniques explained in the article on Plastic Architecture in the December 2002 issue. I hope the website will continue to develop and complement the printed issues. For this issue we will show more details of the fabrication procedure for the knee disarticulation prosthesis article on page 1.

Please continue to submit articles, comments, and feedback. We need your support!

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For a free subscription or to make submissions to ORTHOLETTER, please contact the Editor at the address below:

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