

Best foot forward

The invention of the Jaipur foot and the Jaipur limb prosthetics has been a boon to amputees the world over.

Neena Bhandari reports.



Sethi. "International aid agencies, which often implement their own ideas and prejudices while helping developing countries, are completely unmindful of the actual problems faced by amputees when fitted with inappropriate designs vis-a-vis their life-style," he adds.

The Jaipur Foot is definitely hard to distinguish from a normal foot. Women even paint and adorn their prosthetic with jewellery. Amputees fitted with the Jaipur Limb can squat, sit cross-legged for hours, walk on rugged terrain, wade through water, climb trees, pull rickshaws, draw water from the well and perform almost all normal activities.

"Patients can continue to stay in their villages with their own family and friends. This, for me, is true rehabilitation," smiles the doctor.

Critics grumble that the foot piece is

too broad to fit inside a closed shoe. Many also find it too heavy. People also tend to think that the Jaipur Foot and the Jaipur Limb come as a package deal, but, as the inventor says, "One can use the foot piece with any existing superstructure for the leg and thigh."

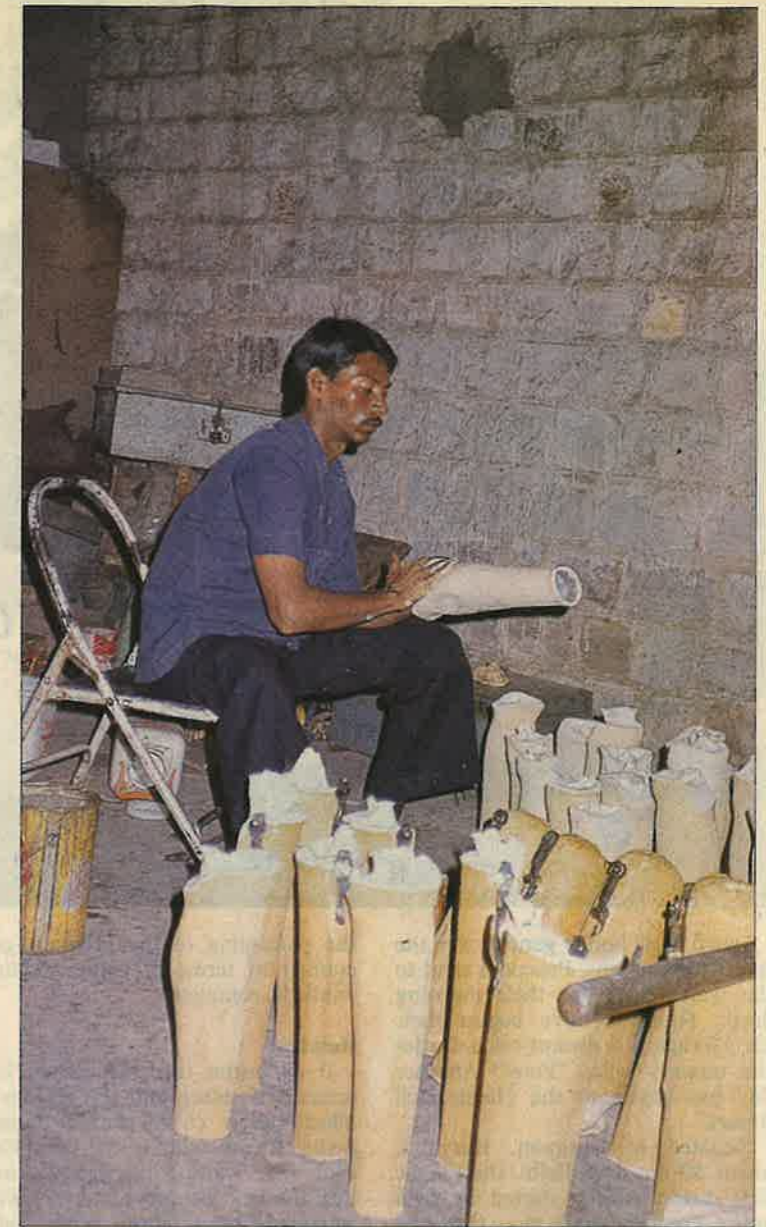
Most surgeons perform amputations as a life-saving measure and do not realise the importance of the stump as an organ of locomotion and its relation to the ability of the amputee to obtain maximum use of the prosthesis.

Dr. Sethi feels that surgeons should take the lead in encouraging and devising models of prosthetics. "We must realise that designing prosthetic and orthotic aids is a complex issue because we are dealing with live human beings with their varied lifestyles and cultures which have evolved through centuries of adaptation. Our technological solutions must

respect these traditions and permit the users to integrate into their environment," remarks Dr. Sethi.

And just as trends in athletic and non-athletic footwear spur competition in the million-dollar shoe industry, prosthetic foot piece manufacturers also vie with each other to incorporate a kind of energy release mechanism in the foot piece that would provide a kick at the time the heel leaves the ground. But the veteran doctor warns, "I would vote for superior adaptability over a spectacular kick-off. And if one considers the cost of the device (\$5 for a Jaipur foot to \$500 for an athletic foot piece), the debate for developing countries is closed. A product has to be within the reach of the amputees."

Dr. Sethi feels that in any country, it is better to work with locally available material, as imported material pushes



The lightweight experiment

Inspired by the success of the Jaipur foot, in 1992, defence laboratories set out to fabricate a lightweight device that could help polio patients move more easily. With the help of Dr. P.K. Sethi, the inventor of the Jaipur foot and Prof. S.C. Lakkad of the Indian Institute of Technology, Mumbai, a Floor Reaction Orthosis (FRO) was developed in the next couple of years.

The FRO is a low-cost, orthotic appliance that can remedy the situation for a polio patient. It is a lightweight alternative to heavy polio boots and supports the affected leg of the polio patient.

The key material used in the FRO is composites, which is a combination of materials bonded together yet retaining their identities and properties. They are light, tough and can withstand high temperatures. A typical example is the fibre reinforced polypropylene.

Due to this special feature, composites are finding wide applications in the defence. From the nose tip of the Agni missile to the launch tube, airframe, wings and fins of Nag, India's anti-tank missile and Hansa, the country's first all-composite two-seater aircraft, the utility of this material is on the increase.

The Defence Ministry set up a Composite Production Centre (ComProc), under the Defence Research and Development Organisation (DRDO) in Hyderabad exclusively to cater to the demands of the Integrated Guided Missile Programme (IGMDP). A spin-off of this Centre is the production of FROs.

ComProc collaborated with the Nizam's Institute of Medical Sciences (NIMS) in Hyderabad to fit the FROs to several polio patients during the last few years. Based on the feedback, a continuous updating has also been under-



taken. In addition, synthetic foot and socket mechanisms and prosthetic appliances are being fabricated at the Centre. Interestingly, during organised polio camps conducted in Andhra Pradesh, the doctors from NIMS and researchers from the National Institute of Rural Development (NIRD), Hyderabad, undertook an exercise to measure the foot lengths in a bid to arrive at possible averages similar to shoe sizes of normal people.

Polio typically affects the legs and hands of a patient. The muscles do not develop to the normal level, thus affecting their motor functions. In the case of the legs being affected, the calf muscles and quadriceps cannot support the body weight, which reflects in the improper gait. The orthotic device, supports this frail leg. It generates a turning movement which locks the knee cap in response to the reaction forces from the floor to the body weight applied when the patient walks. The lateral uprights developed by the DRDO facilitate this crucial action for the polio patient.

The FRO consists of three modular pieces - foot piece, lateral uprights and a knee piece. The effort now is towards producing the foot piece in a couple of sizes, like shoe sizes based on a comprehensive survey of the polio patients. Which means, designer FROs that a polio patient can pick up, try and buy could be a distinct possibility in the future.

Yet another product under development is the thermo-plastic socket for people who have lost their limbs either in accidents, war or medical amputation. The device will aid in transferring body load to the rest of the artificial leg. Here again the Jaipur foot is the best available option at the moment. ■

Somasekhar Mulugu

In 484 BC, Herodotus recorded history's first mention of an amputation. He reported that Hegesistratus, a Persian soldier confined in stocks, freed himself by cutting off his foot and replacing it later with a wooden one. In the 4th century BC, Hippocrates reported the use of ligatures but the technique was lost during the Dark Ages only to be reintroduced by Ambroise Pare, a French military surgeon in 1529. Pare even designed artificial limbs for his patients and supervised their fabrication by a locksmith. In 1674, Morel introduced the tourniquet and amputations became commonplace in Europe.

In this century, world wars, civil wars and the rise in the accident rate the world over have given an impetus to developments in amputation surgery and artificial limbs. For victims

who have lost their legs, Dr P.K. Sethi's 'rapid fit' Jaipur Foot and Limb is proving a boon.

In the recent past, Jaipur Limb centres have proliferated in many countries such as Kenya, where in barely one-and-a-half years over 2,000 amputees were fitted with artificial limbs. Similar centres have come up in Thailand, Afghanistan, Zimbabwe, Vietnam, Laos, Cambodia and Sri Lanka.

The prosthetics designed in the shoe-wearing, chair-sitting culture of the colder countries of Europe and North America were quite inappropriate for the barefoot-walking, floor-sitting culture of the warmer countries. "Our Jaipur foot resembles a human foot, is flexible and tough, abrasion and tear resistant and waterproof unlike the prosthetic made in the West where the shoe not only hides the odd appearance but also protects the prosthetic from damage," opines Padma Shri Dr.

costs up and local technicians and craftsmen work better with what they are familiar with.

"Our formally trained prosthetists are drawn from the urban middle class where there is no culture of manual work or innovations. They are admitted to the training schools because they have learnt English, a prerequisite to admission. But it is the traditional, illiterate craftsmen who are the real possessors of manual skills in our countries. Craftsmen like Masterji and Babulal, who have been working with me since the origin of the Jaipur Foot, have tremendous capacity to innovate with locally available materials."

Dr Sethi prefers steel to polymers because, "We have skilled artisans who can shape metal sheets with such ease and deftness that it takes one by surprise. Within 45 minutes from start to finish a 'Below Kne' trial limb is fitted. Steel is easily available, its easy to

work with, light and strong and does not rust. The ease of shaping this material and altering it for a correct alignment, without the need for preparing plaster moulds is quite unique."

While the Jaipur Foot has come of age, good training programmes need to be innovated for technology transfer. More production units have to be set up.

Dr. Sethi suggests that two versions of foot pieces be made available - one suitable for barefoot-walking and the other for people who prefer to wear shoes. The Jaipur Foot has to be made lighter, quality control and product assurance ensured, cosmetic appearance and durability enhanced and research into knee mechanisms intensified. ■

Left: Fitted with a Jaipur limb, this young man learns how to walk with it; right: manufacturing the aluminium stumps.