Opinion

Jaipur prosthetic and orthotic technology

Volume 5 Issue 1 - 2016

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Received: May 12, 2016 | **Published:** May 31, 2016

Introduction

"Jaipur Foot".[1] as it is popularly known, is the foot piece component of an artificial lower limb. Finding that artificial limbs, designed and conceived in the colder climate of Europe and North America were not acceptable for most amputees in India, with their barefoot, floor-sitting lifestyle and walking over an unpaved irregular terrain.

Floor sitting culture required much more mobility at the ankle to allow squatting and sitting cross legged on floor. For the chair sitting lifestyle in the west, such mobility was not required and so not provided for.

It looked like a normal foot. The outer surface was made of a tough, flexible and waterproof vulcanized rubber shell, suitably reinforced with rubberized tyre cord. Inside, this shell was filled with layers of microcellular rubber. A wooden ankle block anchored a bolt through which the rest of the leg could be attached. Jaipur foot has more contact area with the ground as compared to other foot pieces so amputee feels more stable.

A farmer working in mud and water, traversing the rugged rural landscape, walking barefoot, may need a replacement after 3 to 5 years.

The widespread civil wars, use of landmines globally increasing number of road traffic accidents, rising incidence of cancers and diabetes mellitus has enormously increased the number of amputees and thus the demand for Jaipur Foot in middle and low income population.

Jaipur foot is available in US $10/-, making it the cheapest prosthetic foot in the world. Jaipur foot is environment friendly product and all its ingredients accept ankle bolt and two nails are biodegradable.[2]

Jaipur Limb

To reduce the cost of the artificial limb, and rapidly fit them to an ever increasing number of amputees and thus cut down on the long waiting lists, aluminium sheets, readily available everywhere, have been chosen to fabricate the sockets and legs. Aluminium is light, easily shapeable, strong and rust proof. Without the need for preparing plaster moulds, using simple hand tools, local craftsmen are trained to take measurements, much as tailors do, draw a pattern on a 16 gauge aluminium sheet, cut it with hand sheers and fold it into a tube, weld the seam and then with strokes by a mallet, shape the limb. The amputee inserts his stump into this hollow tube and guides the limb maker to reshape it till the limb comfortably fits to the amputee's satisfaction.

A footpiece is then attached, prefabricated leather straps for suspension are fixed and the amputee is ready to walk. The entire process takes a mere one hour. Any error in alignment can be quickly rectified.

The use of locally available raw materials, utilizing the skills of local artisans and with simple tools, then Jaipur Foot and Jaipur Limb provides one of the most inexpensive and durable system which permits even poor farmers to return to their original vocation and pursue gainful employment, living with their families and friends.

Even the more sophisticated limb centres around the world are getting increasingly interested in the controlled mobility provided by the foot piece for a much greater comfort at the "stump-socket" interface and it is increasingly realized that what was originally designed as a "culture specific" solution has, in fact, a much greater universal relevance.

For Jaipur foot only one study for bio mechanical comparison with other foot pieces is available done by AP Arya et al.[3,4]

It was concluded that the performance of Jaipur foot is more natural and nearer to normal foot as compared to SACH and Seattle foot.[4]

The major shortcoming in Jaipur foot is its heavy weight and lack of quality control due to non standardization of raw materials and fabrication process. We are continuing our efforts to improvise Jaipur foot and make it a well standardized global product.

We did a research project to replace rubbers in Jaipur foot by polyurethane, funded by Government of India in collaboration with Indian Institute of Technology, Mumbai and National Chemical Laboratory, Pune from 1991 to 1998. It did not work as polyurethane foot was not as durable as Jaipur foot and its outer surface was slippery compromising with stability. We no more use polyurethane in making Jaipur foot.

In 1994 International Committee of Red Cross and our centre worked together to mix Jaipur prosthetic technology with ICRC technology to make it more durable and acceptable.

We trained teams from Vietnam, Cambodia, Angola, Mozambique and Bangladesh. We work with Michigan Technology University, USA from 2012 to 2013 to improvise Jaipur foot by replacing microcellular rubber with EVA to reduce its weight. EVA did not adhere to outer rubbers due to difference in vulcanizing characteristic, leading to reduction in durability and stability.

National Science Foundation, USA in collaboration with Ohio State University, USA and Malviya National Institute of Technology, Jaipur granted a research project for 3 years to modify Jaipur foot which will continue up to 2017.

Jiv Daya Foundation, Texas, USA supporting one project at our centre to perform in depth evaluation of effectiveness of services we are providing and are impacting lives of persons with severe locomotor disability at personal, family, social and professional level.

The other area where we worked is substituting wood and metal conventional calipers with low weight thermoplastic calipers for paralytic poliomyelitis. Majority of these calipers we designed permitted swing phase knee flexion while walking thus reducing energy consumption significantly. They allowed the patients to use shoes of their choice. Walking on uneven terrain improved significantly. Since these are total contact orthosis, they can be worn inside the cloths and are not visible from outside. 90% rejection rate converted to above 95% acceptance rate. The calipers initially designed for poliomyelitis were successfully used in many other paralytic and musculoskeletal conditions like - cerebral palsy, spinal injury, Nerve injuries, head injury, stroke, myopathies, spina bifida, fracture bracing, congenital deformities, LGB syndrome, diabetic foot etc.

Ganesh Jangir Engineer by profession innovated "Jaipur belt system for body support". Later he joined hands with us and we further upgraded the belt funded in a project by TePP scheme of DST through Delhi IIT to make it light weight and easy to use. This is still under evolution and likely to come us preventive as well as therapeutic device for back pain and other spinal problems.

This has been now selected by US-India Science and Technology endowment fund (USISTEF). We are involved in its modification and will conduct clinical trials.

Discussion

I would like to share my experience. I have six technicians working with me and none of them has undergone any formal degree course recognized by university or any other institutional body.

They all were picked from family of carpenters, blacksmiths and goldsmiths. After passing 10th class, they were chosen because of their excellent hands on skills and willingness to get involved in this kind of work. Two trainee technicians were attached to each trained technician and learning by doing was facilitated. To make them understand why, what and how, one hour theory classes were arranged every day by Rehabilitation Medicine specialist.

Periodic assessments were done. Even when they were able to work independently, it was made compulsory for them to join ongoing, in house training programme so that, they could constantly upgrade their skills.

We regularly keep getting difficult patient in our department which is discussed with all of them. To improve their communication skills, English language classes were held every alternate day for few years. Now they can understand technical details from my prescription. Since 1993, I am closely involved in all these and have seen them working hard carrying out, all our routine as well as Research & Development activities sponsored by Department of Science and Technology, Government of India.

We at our workshop trained technicians and doctors from Vietnam, Bangladesh, Mozambique, Angola etc. Our technicians have been to all these countries to take care of initial teething troubles faced in bringing up similar centre there to accomplish our mission.

After writing prescription, I supervise every step of the work done by technicians, right from measurement taking to final fitting and post fitting training with advice about follow up visits. Educating the patient and attendant about proper use of appliance ensures good compliance hence increases cost effectiveness. This is a shining example to project magic of non formal education and how it can create wonders.

I agree that formal schooling and university degrees do have an important place in our profession, but there is considerable demand and supply gap. If we keep waiting for trained Prosthetist and Orthotist to do the job, it will take another 50 years to provide these services in entire country.

Acknowledgments

None.

Conflicts of interest

None.

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