



Indian Journal of Physical Medicine and Rehabilitation

[IJPMPR](#)

[Archives](#)

[IJPMPR 1990 Apr; 3](#)

IJPMPR 1990 April; Volume 3

Contents

Original Articles

1. Designing aids for physically handicapped in developing countries. PK Sethi
2. Claw finger correction in leprosy - newer approaches. GN Malaviya
3. Missile injury of peripheral nerve leading to complicated irritative nerve lesions. Yaho Jian Xiang, Zhu Sheng Xiu, Zhou Zhong Ying.
4. Self clean intermittent catheterization - two years follow-up study. MK Mathur
5. Evaluation of underarm plastic spinal orthosis in management of scoliosis. Ratnesh Kumar, UK Jain, AK Agarwal, VP Sharma
6. A clinical study of upper limb amputees. VP Sharma, AK Agarwal, US Mishra, AK Singhal
7. Poliomyelitis - a study of 500 cases. SC Goel, SV Sharma, HP Singh, A Prasad.
8. A follow up study of usefulness of wheel chari. AK Agarwal, VP Sharma, OP Singh, R Kumar, AK Singhal, US Mishra
9. Polypropylene ankle foot orthosis. Rajendra Singh Sohal
10. Simple suspension system of Thomas split on bamboo Balkan beam. Navnendra Mathur, KKR Sharma, AS Sahai
11. Rehabilitation Management of mentally retarded amongst physically disabled. Rajendra Sharma, RK Srivastava, Anil Gaur

Editorial Board

IAPMR Executive and Editorial Board



Print Edition

Editor:

Dr AK Agarwal

ISSN

0973-2209

Go to

[IAPMR](#)

Designing Aids for Physically Handicapped in Developing Countries*

P. K. SETHI

Emeritus Professor of Orthopaedics, S. M. S. Medical College, Jaipur

Since 1981, which the United Nations declared to be the "Year of the Handicapped", there has been, at long last, a growing awareness about the disabled population in our country. Special census have been carried out on the disabled, and their staggering number in our vast country, with 80% of its people living in inaccessible rural areas, has posed major challenges to our planning bodies. But we are passing through some heady days in our country and the numerous problems which beset our society are believed to be solvable by mere technological and managerial interventions. Technology Missions are being set up to speed our entry into the 21st Century because firm promises have been made. This has set the pace for some hectic activity since targets have to be achieved. 'Targeting' is the new word. We need more targeted research, more mission-oriented science. This is said to be the new drift. There is little time to waste in rediscovering the wheel and so it is considered prudent to buy technology packages from the west. This is affirmed as the speediest path to tackle the problem of the vast numbers of disabled in our country.

I sense serious trouble when we initiate such a "top-down" move. Such moves require a much greater store of usable information, with coherence and connectedness, than actually exists. We presuppose that we know what the needs of the disabled are, and all that is required is to activate our already existing centralised production agency for rehabilitation aids, prepare managerial flow-charts to set up an

efficient distribution system which can reach the remotest areas in our vast country and use the existing government machinery, with some NGO's thrown in, to assist the implementation of our schemes and another problem would be solved. Statistics are being reeled out to demonstrate the success of such a move.

There is one factor which does not figure in all this hectic activity and that is the disabled persons themselves as human beings. We have never really bothered to find out what their felt needs are. Are they really using the appliances we are handing out to them. What is the incidence of a drop-out rate? If the appliance is not being used, is it because our people are ignorant and do not realize what is good for them, as is being affirmed by many specialists, or is there a possibility that our appliances are not suitably designed for them? Can there really be a standard universal solution for a particular locomotor deficiency or dysfunction or do we need a more culture-specific and location-specific alternative? Is it fair to offer them only one design option, take it or leave it, or is it better to work out a range of options from which a particular individual has the possibility to choose what suits him best? Doling out such aids as if the disabled are objects of pity or charity or a mere statistic is a demeaning business and instead of making the beneficiaries more self-reliant, which ought to be the purpose of such aids, one can often erode their pride and confidence.

Raising such questions is always awkward

*Professor B. D. Tilak Lecture 1988, delivered on 16 January 1989. "Reproduced from the Proceedings of the Indian National Science Academy, Part B (Biological Sciences) Vol. 53, PP. 7-14 (1989)".

and one is likely to be misconstrued as an obstructionist. It is my submission that the central figure in all such activity has to be the user himself. If the appliance actually helps him or her, it would certainly be used. If not, it will be rejected and good luck to him/her. After all it is the user who knows best what is good for him/her.

Designing such aids, I have learnt, is a very complex business. It not only calls for more science but a much better understanding of our society, its culture, its gross economic disparities and its stratified structure. One would then realize that there is a lot more of basic work which needs to be done and even though this would necessarily be time-consuming, it is likely, in the long haul to be more cost-effective and more appropriate for our target group. Such work, of course, must obviously take into account the pressing needs of our deprived and marginalised people, and reaching the largest number in the shortest time has got to be one of the objectives of such research.

I would like to illustrate some of the complexities of this problem by using two examples. One involves an appropriate design of artificial lower limbs for our amputees and the other deals with the polio problem which still remains the largest single cause of physical disabilities in our country.

It is almost exactly three decades from now when I got involved with the problem of providing physical aids to many of my patients. I could not amputate a limb and then wash my hands off by directing the patient to fend for himself in trying to get an artificial limb. Likewise, there seemed to be little point in correcting neglected deformities in children affected by poliomyelitis, performing multiple operations to straighten out the lower limbs and then advising them to get braces which were then required to support their otherwise flail limbs. From where could they secure these appliances? At that point of time, the only available facilities for such appliances were located at Bombay

or Poona. While the affluent could go there, the majority of my patients were poor and the advice to travel a thousand miles away for securing an appliance was totally unrealistic. I realized that without a neighbourhood facility, the bulk of the disabled would remain deprived of aids they desperately need.

This impelled me to organize a workshop in our hospital where such appliances could be made. I somehow succeeded in achieving this objective and I became rather proud when we started making artificial limbs and braces locally.

Having been a product of western education and with a psychology which was heavily influenced by a colonial heritage, my ambition was to see that our appliances were as good as anywhere in the west. Of course, all I could achieve were "blurred xerox copies" of the limbs made in London or New York. In spite of this, I seemed to be satisfied with the progress made.

My initial elation soon received a setback when I started encountering some of my amputees reverting to their crutches. Whenever I encountered such a situation, I questioned them. "Why are you not using the limb we made for you", I would ask. My suspicion was that there was some technical flaw in them; the socket might be hurting their stump or else something must have broken down. But the feedback I got was something completely unexpected. It became obvious to me that I was taking a very simplistic, almost naive approach to the problem of limb substitution. I was taught in the medical school that the function of the lower limbs is to be able to stand and walk on them. I now realized that there are many other attributes in our lower limbs which are equally important to our people but which the western-designed limb did not cater for.

Two Cultures—Floor-Sitting vs. Chair-Sitting

In the cold climate of Europe or North America, the feet have to be protected from cold

by using warm socks and closed shoes. One has to move away from the cold floor and design a chair to sit on. A table then becomes their work-surface. Also, in most advanced countries, people walk on paved floor and level streets and the foot is not required to adapt to uneven surfaces. On the other hand, our warm climate makes a closed shoe uncomfortable and most of our people walk barefoot or else in open, well-ventilated footwear, often on the rugged terrain of our countryside where the suppleness of the foot becomes a vital attribute to adapt itself to uneven surfaces. We use the floor for squatting, sitting cross-legged, working, eating or sleeping on it. And so there is the social custom of removing one's shoes on entering a home, or a kitchen, or a place of worship. This is a sensible and hygienic thing to do to prevent dirtying the floor.

It is important to distinguish thus between a chair-sitting and a floor-sitting culture because, as you would see, there are important design implications involved.

The Western Designed Limb

One of the important features which characterises a western limb is its footpiece. It is not shaped like a human foot. Instead, its shape is such that it can easily slip into a shoe, which then hides its odd appearance and also protects it from damage. A closed shoe, in other words, is an integral part of the limb design. Take the shoe off and you cannot use the limb.

Providing this kind of limb to our amputees, therefore, made it compulsory for them to wear shoes to be able to use it. You can easily appreciate how such a simple demand can lead to major problems when closed shoes are not only uncomfortable in our hot climate but because they have to be repeatedly removed in a floor-sitting culture. Our women would not agree to wear such shoes anyway and in a rural environment, one cannot expect a farmer to wade through water and mud wearing a pair of ex-

pensive Oxford shoes!

Not only this, Squatting requires a range of mobility in the knee and ankle which is not available in a western limb. Likewise, the foot is twisted inwards when sitting cross-legged on the floor. The western footpiece, which is otherwise a very clever design, has a solid wooden keel, which prevents any movements at the ankle. So the patient cannot squat on the floor. An attempt to sit cross-legged presses the stiff footpiece, which in turn forces the entire limb to rotate, causing unbearable pressure on the stump. The upshot is that an amputee using a western limb has to remove it repeatedly several times a day when entering his home. When he works sitting on floor, he takes the limb off and then has to use crutches to be able to move around. And so, unless the amputee changes his life style into a shoewearing, chair-sitting culture, this artificial limb disables rather than helps him. My colleagues keep on telling me that our people are uneducated, stupid and stubborn. The fact is, and I have repeatedly learnt this lesson, that our people are not irrational. They are perfectly capable of making rational decisions. It is we, because of the blinkers we wear, and our lack of sensitivity, who are unable to understand the rejection of our solutions.

Evolution of Jaipur Foot

So the first item we took up was to redesign the footpiece. A set of desirable functions was listed out. The footpiece should not require a shoe to hide it and protect it. So it should look like a normal foot and be made of a material which is not only flexible but also tough, abrasion-resistant and waterproof. The internal design should provide adequate mobility to enable sitting on floor and walk on uneven ground where the foot is required to adapt to the rugged terrain of our countryside and yet the foot should offer a stable support while walking.

We decided to use a solid rubber elastomer

as the outer casing for our footpiece. Several reasons prompted us to choose this material. Solid rubber has many unique properties combining flexibility, toughness, and abrasion and tear resistance. A material which is durable enough for an automobile tyre should be adequate for our footpiece. The material is readily available in our country and an extensive trade in retreading tyres has made our people familiar with vulcanization.

To reproduce the shape of the foot, a 4-piece aluminium die was prepared locally by our traditional craftsmen, who used the age-old sand-casting methods and the cost of this mould was a fraction of what the fancy die-designing firms were asking. By packing rubber into the die and vulcanizing it in our hospital autoclave, a footpiece resembling a natural foot can be obtained.

But mere appearance is not enough. The desirable range of mobility must be available to provide the activities already listed out. Our first sample was made of solid rubber and it was so heavy and stiff as to be totally unusable.

To reduce the weight of this foot, it occurred to us to place a western footpiece into our aluminium mould and then fill the remaining space around it with solid rubber. This encapsulation substituted for a built-inshoe which resembles a natural foot. The footpiece was now much lighter and became suitable for barefoot walking.

However, the problem of mobility still remained. The main obstacle was the wooden keel of the western footpiece which prevented squatting on floor. We tried to tinker with the keel, cutting wedges into it to provide mobility but these proved inadequate. Our minds were still wedded to the conventional design and it is no easy matter, you would agree, to move away from our preconceived ideas.

Repeated failures ultimately forced us to make a fresh start and finally we arrived at a completely new design concept. For the ankle

region a block of wood had to be provided for securing a carriage bolt which connects the footpiece to the leg. The front part of the foot (forefoot) also had a separate block of wood to provide stiffness when this part of the foot is loaded when the heel is off the ground. Between these two rigid wooden blocks, a large micro-cellular rubber block was interposed and this behaved like a universal joint, with a freedom of movement in all directions.

Now squatting was possible.

We had tested our footpieces in the engineering college laboratories and characterised its behaviour under different loading conditions. Field trials on amputees revealed that we could meet all our design criteria. The foot was shown to be very strong, breaking up only under a vertical loading strain of two tons. We were happy.

What we did not take into account was the problem of fatigue as well as disaster failure. Soon amputees started returning with the external shell of rubber cracking open and the internal components virtually spilling out. Then it was suggested that we use reinforcement with rubberized tyres cord which is used in car tyres to prevent such disaster failures. We had then to become familiar with this new material, learn how to lay out the re-inforcement so that the desirable range of mobility was not adversely affected and we ended up with a product which had a durability span of 3 to 5 years under tough field trials in rural areas.

Periodically, amputees would come back to us with cracks in the footpiece. The curious thing we noticed was the almost consistent location of distribution of these cracks. So we started plotting the cracks in the damaged footpieces. These were always around the ankle region. The moment we realized this, the reason became obvious. The encapsulation around the wooden blocks was immobile. The entire mobility resided in the junctional area which was in the hindfoot region and this was the place where all stress concentration was located.

A major design revision was then made and we replaced the forefoot wooden block with another MCR block of a higher Shore hardness and appropriately stiffened with the tough tyre cord. This has resulted in a more uniform distribution of stresses spread over the entire hindfoot and forefoot. Not only has it added to the life of the footpiece but it has provided us with an additional bonus of the forefoot gaining an independent range of mobility. This allows for a much better adaptation of the footpiece to uneven surfaces.

We realized then that what started off with a relatively culture-specific design need paid us dividends in several other respects so that today even the western countries are getting interested in the functional attributes of Jaipur Foot. During the last few years, a whole series of new designs of footpieces is emerging in the west which are based on some of the design features of Jaipur Foot.

When we walk along a slope, our feet can turn in or out to adapt to the slope. In the old fashioned single axis metallic ankle joint of a western footpiece, this adaptation is not possible and so the entire artificial limb is deflected, causing considerable pressure on the skin of the stump at the stump-socket interface. In a more modern western footpiece, some degree of mobility is available and so the peak pressures at the stump-socket interface get reduced. But in Jaipur Foot, because of a much greater mobility, the stump gets very little pressure even when walking on uneven ground. In other words, our footpiece is comparable to the rubber bearings which are being talked about for earthquake proof buildings. The base isolation by these bearings reduces the whiplash effect in which top storeys are literally shaken to destruction. These rubber bearings effectively "detune" the building from earthquake frequencies by a factor of ten. Our footpiece offers a similar protection.

A study was conducted in the University of

Strathclyde at Glasgow where, in a sophisticated gait analysis laboratory, a comparative evaluation of the western foot and Jaipur Foot was carried out, using data recording the ground reactions through pressure transducers in a pylon dynamometer. The Scottish amputee who acted as an experimental subject was asked to return the Jaipur Foot after completion of this study. This amputee refused to part with the foot on grounds that it enabled him to climb the mountains much more easily. Prof. Hughes, when presenting this paper, emphasized that this subjective, human response was far more valuable and revealing than any computerized study. This underscores the value of the weightage one ought to give to the user response.

Another interesting spin-off of our design was the capacity of the leg to rotate on the foot. The University of California group have been emphasizing that during normal human walking, various segments of our lower limb rotate on each other during different phases of the gait cycle. In the conventional western footpiece, the leg cannot rotate on the foot and this causes the entire artificial limb to twist around the stump while walking, causing considerable friction and discomfort. The Jaipur Foot, having got rid of the solid keel, allows this rotation and so the user of the limb is more comfortable.

The reason I am making this point is that while our original objective were to provide a limb suitable for a floor-sitting culture, some of the spin-off is being held to be of basic importance even to our western counterparts and there is now a renewed interest in the role of a footpiece as a dampener of ground reactions and what was formerly a low priority item on the research agenda in the west has suddenly been elevated to a higher level in the hierarchy of design of artificial lower limbs.

One can now match the list of our earlier objectives to what has been achieved. The foot fairly closely resembles a normal foot, and I

often amuse myself by asking visiting surgeons to identify the amputated side. Even experienced orthopaedic surgeons have a 50% failure rate! In fact, women often adorn their feet in a manner which has even fooled me.

The amputee can squat and one can witness the angle which the footpiece can make with the leg. There are amputees who are employed in our workshop who sit cross-legged on floor and work the whole day without the need for taking their limbs off.

The limb can now be used by our villagers, walking comfortably on a rugged terrain because of the adaptability of our footpiece.

The limb is waterproof and many amputees work in their farms, wading through water or mud. Drawing water for irrigation from a traditional well is a heavy duty job and yet these amputees perform such work like able bodied individuals. Rickshaw pulling is an urban vocation chosen by many poor amputees. They can even climb trees! The footpiece can grip the trunk and adapt to its contours. Such activities widen the horizons of amputees who can continue to stay in their villages with their families and friends and carry out their former vocations. It is no longer necessary for most of them to migrate to urban areas, frequent the corridors of Social Welfare Ministry and end up with a sedentary occupation in an alien setting.

This is what 'true rehabilitation' ought to mean and it would be appreciated that there is a built-in element of rehabilitation in the design of these artificial limbs.

For the socket and the leg piece of our limbs, we opted for aluminium as a suitable material. Most of my colleagues adversely comment on the choice of aluminium. "The modern world is moving towards polymers and composites and you are moving back to metals", they comment. There are some very good reasons why I have preferred aluminium—atleast for below-knee limbs. We have skilled artisans in our country who can shape metal sheets with such ease and

deftness that it takes one by surprise. A statue of a poor, emaciated amputee, which stands before the building of our Rehabilitation Centre was made by one of our craftsmen with aluminium sheets beaten into shape without any casting. It is a stunning piece of art. For people who have skills like this, and whose work adorn our handicraft emporia, shaping an aluminium limb is a child's play.

Visitors from abroad gape with amazement when, within 45 min., from start to finish, a below-knee trial limb is fitted. The tools for this work are simple; no plaster moulds are needed. The limb is shaped and fitted directly on the amputee who participates in the entire proceeding, guiding and informing the limb maker about the accuracy of the fit. This live human interaction between the amputee and the limb maker is a marvellous thing to watch. There is empathy and understanding between the two and a lot of feeling goes into this work.

Aluminium is available to us, easy to work with, light and strong and does not rust. Any pressure points can be easily lifted off with a tap of a mallet. Use modern FRP and you get into a much more expensive system where such maneuverability after the resin is cured is just not available. So what is wrong about using aluminium? It is this simplification of the technology which enabled us to increase our turnover from one limb in a week in 1975 to ten limbs a day in 1982.

Materials are important but several considerations must go into their selection. I am not averse to new materials. In fact, we are the first in our country to use sophisticated materials like carbon fibre composites for rehabilitation aids and as of today, my choice for an above-knee amputee is a combination of flexible polypropylene socket with a carbon fibre load bearing frame. Having tried many materials, I find this, on various counts, to be a superior alternative. But for a standard below knee limb, my preference for aluminium stands.

Availability, cost, familiarity, physical properties, ease of modification, climate, skin allergy and many such factors must be put together and an entire range of options generated, from which an optimal selection ought to be made. What may be choice at Jaipur may be different from what I might use in Nagaland or Bombay.

The approval of the design of our footpiece by the west has brought out another dilemma. There is now a continuous demand by centres from abroad for our footpieces. Jaipur foot centres are already functioning in Sri Lanka, Thailand, Indonesia, Peshawar and Zimbabwe. While this excites us at one level, it makes us very apprehensive at another level. Using rubber as our basic material, we use a very labour intensive technology. Our footpieces are heavier than the western analogues and they are not refined in their appearance as the western market would expect. There is lack of standardization and no two footpieces have absolutely identical performance characteristics. We felt we should refine our product and turn to new materials such as polyurethane. The Department of Science and Technology came to our assistance and currently we are working on this material substitution. It has meant, of course, that the present properties of Jaipur Foot must be accurately characterized. The data base for the formulation of such a variable density polyurethane foot must be available before the polymer engineers can prepare proper formulations. This has forced us to generate the basic data with the help of structural engineers. This, I think, would be an extremely useful exercise which has not been carried out so far. At the same time, however, such materials require extremely critical operating conditions for manufacture. A much higher capital investment outlay is needed, both for R & D and for setting up a production unit. If optimal conditions are not available, there can be a catastrophic failure to the footpiece. A rubber foot may not be as elegant but it is much less likely to fail. An analogy

of the debate on traditional vs high yielding variety of wheat may not be out of place. Amulya Reddy is fond of reciting the nursery rhyme—"When she was good, she was very very good, but when she was bad, she was horrid".

What we should not lose sight of is the "worst case scenario" rather than the "best case scenario" when evaluating costs and benefits. It is also important to resist the temptation of yielding to an applause from the west and in the process, forget our rural amputees, for whom this work was taken up in the first instance.

Comment is often made, especially from the prestigious rehabilitation centres in our large metropolitan towns that our footpiece prevents their amputees from wearing fashionable shoes. "These are too broad" they say, "and there is a major problem of "foot entry" into narrow shoes". I concede this because my target group has been the barefoot walking rural amputee. Our footpiece has to match the broader splay foot of a barefoot villager. There is nothing to prevent, however, for another set of dies to be made for the urban rich, to produce footpieces which may have all the design advantages of Jaipur Foot and yet which can easily slip into elegant shoes. We have made a few such pieces, and with a detachable heel too which can be inserted to preserve correct alignment of the limb, when the shoe is taken off at home.

There is a need, also, to update the technology for producing better rubber Jaipur feet. A lot of progress has been made in rubber technology since we started working in this field in 1965. Better rubber formulations, lighter and stronger, improved die design and a production technology which can ensure greater standardization and quality control checks, should be effective in overcoming some of the existing shortcomings of Jaipur Foot.

There are thus several options available which could be pursued:

- (i) The Jaipur Foot could exist as it is; it is inexpensive and has stood the test run in at least 20,000 amputees.
- (ii) For urban rich, a modification could be used to allow easy foot entry in fashionable shoes.
- (iii) Improved rubber feet could be produced using updated rubber technology, or
- (iv) Polyurethane could be substituted as a better material for export quality footpieces. Depending on the nature of consumer demand, a footpiece could be made available for different population groups. All these options could exist side by side.

Appliance for Poliomyelitis

The second example I would want to present deals with the polio problem. Poliomyelitis is the largest single cause of physical disability in our country. With its disappearance from the west, not new ideas are coming forth from abroad on designs of appliances for poliomyelitis. Whatever new thinking had to go into this problem has now to be generated by us.

It is not commonly appreciated that it is much more difficult to design appliances for polio than an artificial limb. This is because the polio child has a choice. If he does not walk better with the device, he just won't use it. The amputee, on the other hand, has no choice. One of the major problems in polio is when the muscle of the thigh, the quadriceps, is paralysed. The knee joint then becomes unstable and the child has to use his hand on the thigh and press the knee backwards to prevent the knee from buckling. There is no suitable operation which can stabilize the knee and so a metal brace is used to lock the limb into it. This liberates the hand and now the child can walk upright without the fear of falling down.

Such metal calipers have been in use, without a major design change over the last century.

While we keep on prescribing them, any honest follow up would reveal that there is a very high rejection rate by the users. The reasons are not difficult to understand. These calipers are heavy and the already paralysed limb has to drag this extra weight. The knee cannot bend while walking and this poses a problem of clearing the ground while swinging the limb forward. The lower limb, which normally behaves like a compound pendulum, is converted into a simple pendulum with a long lever arm. This demands an extra effort by the muscles to swing the limb. And so, instead of acting as an energy-saving device, this caliper in fact becomes an energy-consuming gadget. Since the metal side bars are fixed to a heavy duty shoe which is the foundation of the device, the child gradually starts nursing a hostility towards these shoes which are not interchangeable and differ from those worn by other children. It should not surprise us, therefore, that our patients usually reject this solution.

This basic design of a caliper is related to the use of metal side bars. Metals can only be used in certain ways and impose a tyranny of their own. But now a variety of new materials are available which can be easily shaped and some of them are stronger than metals. Thus, we can now think of different ways to stabilize an unstable knee by using new geometries of designs. We have now been using a carbon fibre composite, a spin-off from aerospace engineering, and utilizing a totally different design concept. By artificially keeping the foot at an angle so that instead of the heel, the front part of the foot strikes the ground first, and with the help of two lateral bars and a cross piece in front of the knee, the device behaves like a cranked lever where the body weight from above is used to push the knee back and prevent it from buckling.

This so-called floor-reaction orthosis has now been used in over 500 cases with an 85% acceptance rate. It is four times lighter than the

metal caliper, allows the bending of knee while walking and can be used with any shoes. Carbon-fibre has poor abrasion resistance but a polyurethane sole, stuck to it, can probably allow our rural patients to walk barefoot in their farms.

The cost of this appliance turns out to be actually cheaper than a conventional caliper. The technique of fabrication does not require any expensive outlay and anyone who enjoys working with his hands, without any formal education, can be taught to make this appliance. It still suffers from disadvantage that carbon fibre is an imported material, the selection of cases suitable for this appliance requires considerable experience, each appliance has to be custom made and the margins of error permitted are very narrow.

This is only a beginning. Already a number of new designs are under trial and we foresee a major shift from metals to polymers in these appliances in the near future.

Because of the need for shoes, a major problem in the logistic of supply of conventional calipers is encountered. Not only are these expensive but they need to be custom made. An analysis of the reasons for long waiting lists in the delivery of calipers in most rehabilitation centres reveals that the major hold-up occurs in the footwear section. Recalling that closed shoes are not well tolerated in our warm climate, and to speed up production, we had worked on the idea of substituting shoes with wooden clogs, an idea initially mooted by Huckstep in Uganda. Huckstep's design of a wooden sandal was too simplistic and inefficient. So we had to work out a new design, with a roll characteristic which allowed a much better gait. This wooden clog could be made very quickly and with prefabricated leather straps and a large stock of such clogs of different sizes, it is feasible to fit the child on the same day that he is seen.

The design of a caliper with its wooden clog was so simple that the idea of using out village

craftsmen to prepare such calipers occurred to us. Every village has a cobbler, a carpenter and a blacksmith. They are needed by the rural community. Why can't we use this available manpower so that polio children could be fitted with braces in their own village? An experiment was conducted at Tilonia, through the help of Bunker Roy. We took our caliper there and showed it to these craftsmen. They were able not only to make these with the locally available materials and tools but actually came out with a product which was superior to ours in workmanship. The innovative capacity they demonstrated in making their own version of a limited motion stop at ankle came as a surprise to me. Who says our rural poor are not intelligent?

This provides a totally new dimension to a problem which is confounding our administrators sitting in Delhi, counting the millions of polio children spread out over our vast country and wondering how to handle this massive-problem. Looked at a village level, however, where there may not be more than 4 or 5 cases per village, it can be a very solvable problem provided we are willing to leave our institutional hideouts, share this knowledge with village craftsmen and encourage them to become self-reliant in providing a neighbourhood facility for preparing atleast simple rehabilitation aids. I know how our professionals react to such ideas which they find outrageous. This is truly a Hobson's choice. On the one hand, such a strategy may provide *inadequate aids*. On the other hand, adequate technologies are *inaccessible*. Sticking to the idea of providing only the best usually means that 90% of our poor population have to go without any aid whatever.

There are thus three different kinds of options available for aids in poliomyelitis. One is to continue with the present strategy of a centralised production agency, supplying factory made metal components to be assembled and fitted locally. Any change in design is not

permitted here and one needs a large bureaucratic machinery to manage the supply and fitting.

The other is to continue research into the use of new material and new designs and field test them. A lot of R & D effort has to go into option because it is now futile to look to the west for any fresh ideas on poliomyelitis.

The third is to simplify the existing designs and work out a strategy of using rural craftsmen to provide a neighbourhood facility.

The costs and benefits of each will have to be worked out but in all this exercise, let us not forget the user—who would usually belong to the group of rural poor. The constraints of time prevent me from multiplying such examples endlessly.

The main point I have tried to make is that in a dual society such as ours, and this is true of all developing countries, we are constantly running into a Hobson's choice. The technologies and designs evolved in the west are preferred by our rich urban elite and they really constitute the market forces which influence our bureaucratic machinery. The poor are outside the market forces and have no voice. Modern technologies are inaccessible to them. To permit the poor to escape from this dilemma, scientists and technologists must generate new options, each more effective than the traditional, and more accessible than the modern. Ideally, the options should constitute a hierarchy of technologies with upward compatibility. Then with rising income, the poor can climb from a cheaper, less cost-effective option to a costlier, more cost effective option. Only in such a situation the people will have genuine choices. Thus, the role of scientists and technologists is to be option-generators and choice-wideners.

People who control decision-making in our country are understandably in a hurry. They overlook that a more appropriate and equitable generation of technology involves a "learning curve". During the initial part of

this learning curve, there has to be intense back-and-forth interaction between the lab and the field. The feedback from users in the field must lead to modifications and improvements of the product/process. This modified/improved product/process needs further "test marketing" in the field. As a result of this interplay between technology generation and dissemination, and between technologists and potential consumers of the technology, the penetration of the "market" is necessarily very slow during this phase. Only later, our learning curve shows a steep climb.

All these points are generally ignored when technology dissemination is planned and implemented. There is a general tendency for technology generation and technology dissemination to be thought of as two distinct non-overlapping sequential stages with the generation ending when the dissemination begins, and the generators "washing their hands off" the technology dissemination process.

However idealistic and romantic it may appear, my conviction is that the technologists must approach such work with empathy and affection for the people. Otherwise, they tend to be afraid of the people and hide behind their institutional walls. The poor are far more understanding of our failures than so-called educated who cheer when the satellite goes into the orbit and jeer when it falls into the sea.

Science and technology ought not to be "value-free" and would stand to gain from these feelings of empathy and affection. Without this value-system, it tends to become amoral, unjust and violent.

A lot of hard and painstaking work lies ahead of us. The problems facing us are open-ended. This is why I am worried about a 'top-down' managerial approach which, some people think, will quickly solve our problems. Bernard Shaw's approval of "the inevitability of gradualness", carries for me, a lot of wisdom.

Claw Finger Correction in Leprosy—Newer Approaches

G. N. MALAVIYA

Central Jalma Institute for Leprosy, Agra-India.

A better understanding of the biomechanics of finger clawing has helped to develop improved surgical procedures for correction of claw finger deformity and restore function of paralysed fingers. Four such procedures which are in current practice have been reviewed for their merits, demerits and effectiveness to define proper indications for their use.

Clawing of fingers because of intrinsic muscle paralysis is the most common deformity seen in leprosy patients. Ulnar nerve paralysis results in a number of cosmetic and functional problems which an affected hand has to face. These are:

1. Loss of abduction and adduction of fingers.
2. Instability of metacarpophalangeal joint (MCPJ).
3. Flattening of distal transverse metacarpal arch.
4. Flattening of ulnar half of the hand.
5. Hollowing of intermetacarpal and thumb web space.
6. Anaesthesia of the ulnar half of hand.

The overall effect is a poor grip due to unstable MCP joint; poor grasp due to inadequate opening of hand and poor pinch due to unstable MCP joint of index finger and thumb.

Biomechanically there is loss of equilibrium anteroposteriorly and independent control of MCPJ and proximal inter phalangeal joints (PIPJ). The equilibrium can be restored if both MCPJ and PIPJ or at least one of them is stabilised. The aim of claw finger correction therefore is to restore a stability of proximal phalanx in each digit so as to correct the internal balance of digits during prehension. The appearance has to be restored so that the patient can be socially accepted and restoration

of functional capabilities to help him in carrying out various activities effectively.

Successful restoration of function involves erasing of adaptive movement patterns, pre-operative muscle exercises to increase power in the muscle to be transferred and postoperative learning of new movement patterns to integrate the transferred muscle into its new place.

Timing of surgery

The patients can be operated if their disease is stable i.e. they should have atleast six months of anti-leprosy treatment with good clinical response and freedom from exacerbations and reactions for six months. Risks of reaction after surgery is very little and reactions, if occur, can be easily controlled with available antireaction drugs.

Ideally patients should have a 'cured' disease but this means that number of years will lapse before the patients are deemed fit for surgery. During this waiting period, adaptive movement patterns get deeply ingrained and are difficult to get rid off later. The soft tissues and joints also undergo changes and contracture making subsequent corrections very difficult. However the paralysis should be stable i.e. of one year or longer duration. During this period the hands can be adequately managed with regular oil massage and exercises.

Condition of the hand

All the finger joints should be fully mobile passively. Long flexors and extensors of fingers should preferably have normal power. However, one can afford to have only moderate power in flexors of ring and little finger and normal in index and middle fingers for better pinching. The extensors should have a normal power, if not, power should be restored in these prior to finger correction.

Bourrel's MCP Joint stabilisation test is of much help in selecting the cases as it brings out the extensor deficiencies and long flexor contractures. Absence of secondary deformities is desirable. If these are present and likely to interfere with the postoperative results (viz. pseudoboutonniere deformity) those should be corrected pre-operatively in order to get satisfactory results. All the four fingers require correction because interossei are paralysed for all fingers and MCP Joints are unstable. If thumb is also paralysed, it can be operated along with the fingers in the same sitting or separately at a later date. Choice of operation involves a consideration for disease status, condition of the hand, extent of paralysis, age, occupational needs and socioeconomic background. Many of the operations require some re-education specially those which involve a muscle tendon unit transfer. These patients have to learn as to how to activate the transfer and calls for active cooperation of the patient. Re-education is difficult in older patients, in cases with long standing paralysis and in patients of low intelligence.

The key joint is MCP Joint which needs to be stabilised and a balance between flexors and extensors at this joint needs to be restored. The corrective operations practised in the past tried to mimic lumbrical muscle action as evident by insertions made into lateral bands in number of procedures described^{2, 3, 4}. These operations provide additional power to the extensors which are otherwise normal. This extra force leads to

over correction in about 20% cases where PIP joint goes into hyperextension making fist closure difficult which is a serious disability. The possibilities of over correction are enhanced if flexor digitorum superficialis is removed from finger for transfer to thumb and fingers. These procedures should be reserved for cases where extensor apparatus requires some mending in addition to claw correction.

The improvement in function and correction of deformity can be obtained either by muscle substitution to replace the paralysed intrinsic muscles or by redistribution of the available forces to restore balance at MCP and PIP joints.

Procedures where existing forces are redistributed

(a) Extensor diversion procedure⁵

Here the over action of long extensors on MCP joint is prevented by diverting part of the forces volarly through a tendon graft attached to long extensors proximally and to lateral bands distally, passing volar to deep transverse metacarpal ligament. As a result, MCP Joint is prevented from hyperextending when the hand is opened up (Fig. 1).

Isolated finger movements are possible but significant increase in grip and pinch strength are lacking. Normal sequence of finger closure is not achieved and clawing recurs when lumbrical position is attempted. The reversal of distal transverse metacarpal arch can also get exaggerated.

However no re-education is required and operation does not involve any dissection in deep tissues. It is simple to perform and can be undone if needed. It is useful for active cases who opt for surgery due to cosmetic reasons and also in cases with extensive paralysis where other muscles are not available for transfer.

(b) Dermadesis and pulley advancement⁶

The MCP joint, if maintained in 5 to 10° volar flexion, can be flexed actively by existing

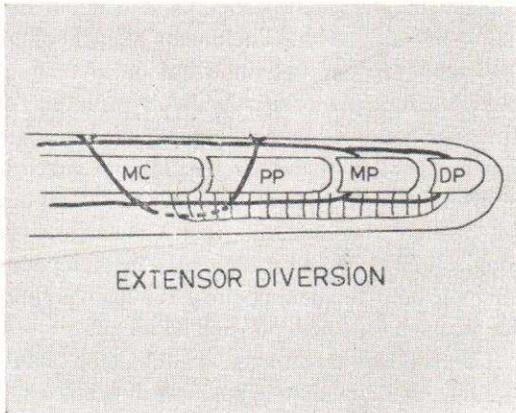


Fig. 1. Extensor diversion procedure.

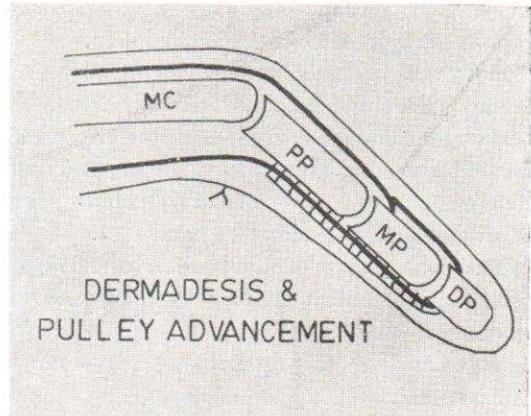


Fig. 2. Dermadesis and flexor pulley advancement.

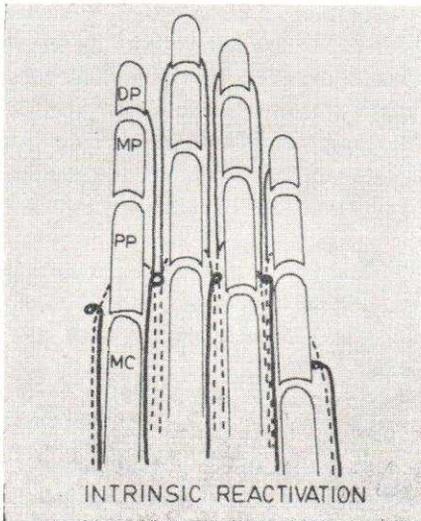


Fig. 3. Intrinsic reactivation procedure.

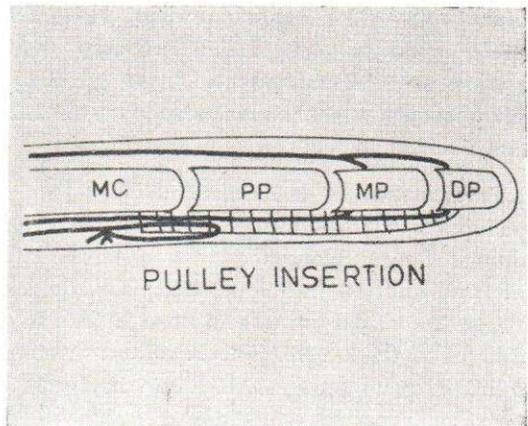


Fig. 4. Pulley insertion procedure.

extrinsic long flexor muscles. This principle has been successfully utilised in this procedure where an elliptical piece of skin overlying MCP joint is excised from distal palm. The subcutaneous tissue is left in situ and skin edges are sutured to produce a skin contracture to keep MCP Joint in 30° flexion. The wound stretches during post-operative mobilisation to give $10-15^\circ$ flexion only. Before suturing the skin, flexor

forces are optimised by excising A_1 and part of A_2 pulleys of the long flexors so that the angle of approach of long flexors on MCP Joint increases. This in turn increases the leverage and enhances the flexor forces acting over proximal phalanx. The two procedures are complementary to each other (Fig. 2).

Independent control of fingers is not possible and the residual deformity (of MCP Joint

flexion) is not acceptable to many patients who keep on straightening their finger joints.

However, the procedure is technically simple and improves pinch and grip strengths. No re-education is required. The procedure can be repeated if needed. It is also useful in cases with extensive paralysis where suitable motors are not available for intrinsic replacement.

The contracture produced in skin can over stretch in some cases leading to recurrence of deformities. The procedure fails to work in hands with long fingers because leverage is not adequate.

Muscle substitution procedures

Here new muscle tendon unit is transferred to replace the paralysed muscle. Since additional forces are generated, grip and pinch strengths improve considerably and sequence of closure of finger is restored to normal. However, muscle re-education is required. Since these transfers are volarly placed, these can lose their tension if wrist flexing habit persists. This in turn results in recurrence of clawing.

(a) *Intrinsic reactivation procedure*⁷

Here an extrinsic muscle wrist dorsiflexor or palmaris longus elongated with a fascia lata graft and splitted into four slips, is tunnelled through the carpal tunnel and brought into mid palm. Each tendon slip is then routed through lumbrical canal and inserted into first dorsal interosseus; palmar and dorsal interossei in each inter digital space and hypothenar muscles close to the proximal phalanx (Fig. 3).

The operation is technically demanding but restores distal transverse metacarpal arch. Deformity correction is good and functional restoration is satisfactory. Over correction can occur in some cases (8%) specially with long hypermobile fingers, but is relatively uncommon.

(b) *Pulley insertion procedure*⁸

Here the motor tendon-wrist dorsiflexor or palmaris longus elongated with fascia lata graft

or flexor digitorum superficialis is divided into 4 slips in mid palm. The flexor sheath of all the fingers are exposed in distal palm through transverse incision to identify A₁-A₂ pulleys. The four slips, one for each finger, are tunnelled separately along the inter metacarpal space to be brought near flexor sheath. The slips are then routed through the flexor sheath to be brought out through middle of A₂ pulley and tied to itself after flexing the MCP joint 80-85° with wrist in neutral position (Fig. 4).

The tone of transferred muscle keeps MCP Joint in 5 to 10 flexion—a position of mechanical advantage for flexors.

The operation gives good anatomical and functional results. In few cases, arch reversal also gets corrected. It is specially suitable in cases with hypermobile finger joints where over correction is usually a problem. Insertion into A₁-A₂ pulley through the flexor sheath gives better leverage and avoids suturing into the sheath. Bony insertion as advocated by Burkhalter⁹ is not desirable because bones are osteoporotic.

Individual control of fingers is not possible but sequence of closure is restored to normal. Intrinsic plus deformity is not seen after this operation.

The merits and demerits of these procedures are summarised in table 1. The over all good results from these above procedures vary between 75-85% in the reported series. As discussed, the limitations and advantages of these procedures are different.

Though, none of the procedures are complete in themselves the aim should be to achieve best possible in a given set of circumstances. The selection of procedures should be need based and individualised. Even the active cases can be operated, if required. Use of so called 'Standard operations' should not be a regular practice. As far as possible surgery should be done before a patient is debilitated.

Table I. Comparison of Different Procedures

	Extensor Diversion	Dermadesis and Pulley Advancement	Intrinsic Reactivation Procedure	Pulley Insertion Procedure
Operative Technique	Simple	Simple	Demanding	Relatively Demanding
Successful Results	75%	80-85%	85%	90%
Grip Strength	Same	± Increased	Increased	Increased
Pinch Strength	Same	± Increased	Increased	Increased
Re-education Required	Nil	Nil	Yes	Yes
Arch Reversal	can get exaggregated	± exaggregated	Corrected	can get corrected
Lumbrical Position	deformity recurs	can form	can form	can form
Individual Finger Control	Present	±	Nil	Nil
Revision	can be done	can be done	difficult	difficult
Sequence of Closure	Not Normal	± Normal	Normal	Normal
Can be used in				
a. active cases	Yes	± Yes	No	No
b. extensive paralysis	Yes	Yes	No	No
c. hypermobile fingers	±	can fail	± Yes	Yes
Acts by	Redistribution of forces	Redistribution of forces	Generating new forces	Generating new forces

REFERENCES

1. **Bourrel, P.** : Palliative operations for correction of claw fingers. *Ann. Chir. Main* 5: 230, 1986 (In French).
2. **Brand, P. W.**, Paralytic claw hand. *J. Bone Jt. Surg.*, 40-B: 618, 1958.
3. **Riordan, D. C.**, Tendon transfers for median, ulnar or radial palsy. *The Hand*, 1: 42, 1969.
4. **Antia, N. H.**, The palmaris longus motor for lumbrical replacement. *The Hand*, 1: 139, 1969.
5. **Srinivasan, H.**, Extensor Diversion—A new approach in correction of intrinsic minus fingers. *J. Bone Jt. Surg.*, 55-B, 58, 1973.
6. **Srinivasan, H.**, Dermadesis and flexor pulley advancement—First report on a simple operation for correction of paralytic claw fingers in patients with leprosy. *J. Hand. Surg.*, 10: 979, 1985.
7. **Palande, D. D.**, Correction of intrinsic minus hand with reversal of transverse metacarpal arch. *J. Bone Jt. Surg.*, 65-A, 514, 1983.
8. **Malaviya, G. N., Husain, S. and Shantagunam, P.**, Correction of hypermobile claw fingers in leprosy by pulley insertion procedure. *Euro. J. Plas. Surg.*, 10: 148, 1987.
9. **Burkhalter, W. E. and Strait, J. L.**, Metacarpophalangeal flexor replacement for intrinsic muscle paralysis. *J. Bone Jt. Surg.*, 55-A: 1967, 1973.

Missile Injury of Peripheral Nerve Leading to Complicated Irritative Nerve Lesions

YAO JIAN-XIANG

Orthopaedics, General Hospital of People's Police Armed Forces, 69-Yong Ding Road, Beijing, China

ZHU SHENG-XIU

Orthopaedics, General Hospital of P. L. A.

ZHOU ZHONG-YING

Orthopaedics, General Hospital of Military Kun Ming

In 1979 we diagnosed and treated 141 cases of missile injury of peripheral nerve, 22 cases of which (15.6%) complicated by severe causalgia have been reported. In the following page we are going to report on the 44 cases complicated by the irritative neuralgia.

CLINICAL DATA

44 cases, all male, ranging from 18 to 37 years old. 27 cases are bullet wound, 15 cases are bomb wound and 2 cases are unknown. 50 nerves of the 44 cases are injured (see table 1).

There are 5 cases whose ulnar nerve and median are both injured and one case whose median and radial nerve were injured. And all the cases concerning the injury of median nerve are causalgia. 32 cases (38 nerves) were operated upon respectively one to five months after injury. The type of injury and treatment with operative microscope are shown in table 2.

The results of reexamination (29 cases, 35 nerves) two years after operation are shown in table 3 (there is 1 case out of 29 cases whose median nerve and ulnar nerve are both injured). The rate of excellent and good is 82.8%.

DISCUSSION

Causalgia is caused by injury of peripheral nerve has been paid great attention and studied in western countries for a long

time. Several hypotheses have been put forward. Untill now, there has not been a generally acknowledged name for irritative neuralgia. In 1927, Foerster first used irritative neuralgia. In 1947, Kolmer and Budinger used it to describe pain syndrome which was not causalgia. Seddon divided it into two groups: (1) causalgia; (2) irritative neuralgia, including painful digital nerve injuries, painful amputation stumps and painful phantom limbs. Here is the clinical manifestation of irritative neuralgia.

Symptoms and Signs

The hyperpathia in the areas controlling the injured nerves: A gentle touch on a small part of affected area would cause a violently disagreeable response. However, an abrupt touch on a large part of the affected area, such as a tight grasp on the affected hand or foot, would not cause such a response. That is superficial pain. There are 40 cases in the group. The deep pain group has only 4 cases, of which 3 cases are brachial plexus nerve injury, one case is sciatic nerve injury. It is described as a dullache, crushed or burning pain and

Table 1. 44 cases (50 nerves) of irritative nerve lesion

Nerve	Operation	Non-operation	Total
Brachial plexus	4	0	4
Radial n.	2	3	5
Median n.	7	2	9
Ulnar n.	10	3	13
Femoral n.	0	2	2
Sciatic n.	7	1	8
Tibial n.	4	1	5
Common Peroneal n.	4	0	4
Total	38	12	50

Table 2. 32 cases (38 nerves) of injury and operative procedure

Injury types	Interfunicular neurolysis	Interfunicular neuroanastomosis	Interfunicular nerve-grafting	Total
Adhesion	21			21
Partial injury		1	4	5
Complete injury		2	10	12
Total	21	3	14	38

Table 3. 30 cases (35 nerves) follow-up results

Nerve	Excellent	Good	Fair	Poor	Total
Brachial plexus	3				3
Radial n.	1	1			2
Median n.	4	2	1		7
Ulnar n.	6	2	1		9
Sciatic n.	3	2		1	6
Tibial n.	3	1			4
Common Peroneal n.	1		3		4
Total	21	8	5	1	35

Standard : Pain, hyperaesthesia and Tinel's sign

Excellent : disappeared

Good : not so obvious

Fair : bearable

Poor : no change

becomes worse when weather changes. It is only a kind of slight dullache when the patient's attention is held by work or by pleasant diversion. Tinel's sign is positive at the injured part. The irritative neuralgia genesis rate (31.2%) is higher than causalgia (15.6%). It may affect any peripheral nerve (see table 1). Yet causalgia may affect median nerve or the proximal sciatic nerve or brachial plexus. The deep pain or the superficial pain is not so severe as causalgia. Stimuli of normal contralateral or ipsilateral limb or sudden lightness, noise or emotional pressure can not cause this pain. And there are no obvious changes of skin, finger nails (or toe nails), skeleton or arthrosclerosis on the injured part.

Causes

According to our operations and observations under operative microscope in 32 cases (38 nerves), we found 3 kinds of nerve injuries (see table 2). But they are not completely the same as the causes of irritative neuralgia though they are directly related with them. Epineural or intraneural adhesion and neuroma are the two main causes.

High speed projectiles such as bullets or bombs are very destructive to the organism. They injure the peripheral tissues of the nerve as well as the nerve. Even if the nerve keeps its continuity, the injury of its peripheral tissues still causes intraneural or epineural adhesion and nervopathy made by the compression of scar for instance, 3 cases of injury of brachial plexus nerve are in the group. After the epineural and interfunicular neurolysis and scar, the nerve recovers its functions and the deep pain disappears. In a case of irritative neuralgia on the sciatic nerve, a metal foreign body which was the size of a grain of rice was found under the epineurium of sciatic nerve in the thigh. The epineurium around the foreign body

thickened and the nerve had interfascicular adhesion. After the extirpation of the foreign body, the interfascicular neurolysis and the removal of the thickened epineurium, the superficial pain disappeared. A case of injury of Sciatic nerve in the hip, had irritative neuralgia on the Tibial nerve which lacked 10 cm, and the Common Peroneal nerve lacked 12 cm. As the proximal adhesion had reached the pelvis and the interfascicular neurolysis and removal of neuromas were not complete, the superficial pain remained after the interfascicular nerve-grafting. The cases mentioned above show that one of the cause of irritative neuralgia is epineural and intraneural adhesion.

After injury of the whole or part of the nerve, the neuroma occurred at the stump of the injury nerve, which may also cause irritative neuralgia of the injured nerve. For instance we had a case of penetrating bullet wound in the ankle and metatarsal bones which caused the irritative neuralgia due to the complete injury of Tibialis Posterior nerve. Satisfactory results were achieved after complete removal of neuroma on the stump, the injured nerve 10 cm and scar around the nerve and the interfascicular nerve-grafting of contralateral Sural nerve. In this group, every injury of the whole or part of the nerve resulted in neuroma on the residual extremities. After removal of neuroma, interfascicular neuroanastomosis or interfascicular nerve-grafting, the irritative neuralgia dispelled or improved. That shows that neuroma is also one of the causes of irritative neuralgia.

Treatment

In Seddon's opinion, there was no specific medicine for the treatment of irritative neuralgia, the patient often improved or remitted spontaneously. A suitable shoe-pad can remove irritative neuralgia of Sciatic nerve or Tibialis Posterior nerve from indisposition

and pain and enable the patient to bear weight and walk. Operation, examination, removal of foreign body, burial of nerve, neuroanastomosis and removal of nerve are also specific method of treating irritative neuralgia.

This group was observed after injury for three to five months. We used the technique of microscopic surgery to operate on those patients whose symptoms and signs remained unchanged to repair their nerves. The method of operations were neurolysis, removal of neuroma, injured nerve fasciculus, fasciculus groups or the whole nerve and then interfascicular neuroanastomosis or nerve-grafting according to the deficiency of the nerve.

Seddon thought that neurolysis disappointed. The experiences in this group prove that neurolysis efficacy is determined when the nerve after neurolysis is put on the normal tissue base. The "normal" case to the naked eye may show interfascicular adhesion and cicatrital tissues, which must be removed. After neurolysis the nerve must be put in normal muscle tissue or subcutaneous fat instead of putting in cicatrital tissues or on the fibrosis muscle, fat or fascia. The operative hemostasis should be thorough to prevent post-

operative hemorrhage, oozing of blood or hematoma in order to avoid the postoperative recurrence of epineural or intraneural adhesion.

We maintain that interfascicular neuroanastomosis or interfascicular nerve-grafting under operative microscope can make nerve fasciculus accurately coincident and avoid the inversion of fascicular membrane or the exposure of nerve fasciculus. The inversion of fascicular membrane can hinder growth of the nerve axon. The exposure of nerve can make the regenerated nerve axon unable to reach the tunica intima canal of the nerve in far extremity and neuroma may occur near the place of neuroanastomosis. Thus the pain may recur.

We do not adopt simple removal of nerve to relieve the patient of his pain because of two reasons. First, the nerve will lose the abilities of motion and sensation. Secondly, after removal of the nerve, neuroma will surely be formed at the residual extremities or there will appear the necrosis of neurocyte and the fibrosis of nerve axon which will cause the pain to recur. That point has been proved by many people's experiences.

REFERENCES

1. **Seddon H.**, *Surgical Disorders of the Peripheral Nerves*. 2nd ed. Edinburgh London New York; Churchill Livingstone, 1975: 139-153.
2. **Yao Jian-xiang et al.**, "A study of Missile Injury of peripheral Nerve Treated by Microsurgical Technique. *Beijing Med.J.* 1982; 4 (6): 329.

Self Clean Intermittent Catheterisation Two Years Follow-up Study

M. K. MATHUR*

One hundred and thirty-six traumatic paraplegia patients with neurological dysfunction of the bladder were trained in the technique of self-clean intermittent catheterisation at Rehabilitation Research Centre, S. M. S. Medical College Hospital, Jaipur. One hundred and eighteen were males and eighteen were females. Although all of them mastered the technique, twelve patients had to be discontinued from the programme for various reasons (ten males and two females) while still hospitalised, rest all continued on self-clean intermittent catheterisation after discharge from the hospital and were followed up for a period of two years.

The infection rate during self-clean intermittent catheterisation is low and most patients welcome the advantage of freedom from drainage bag, the rural paraplegic is also spared of travelling for long distances to the Primary Health Centre for changing or irrigation of blocked indwelling catheters frequently. However, the patient must be both well motivated and independent in transfers to be able to continue indefinitely with such a programme.

INTRODUCTION

Sterile intermittent urethral catheterisation has been used for a long time as a means of initial management of patients with neurological dysfunctions of the bladder since it was introduced by Guttman in 1966. Later on it was widely used as a bladder retraining technique during the rehabilitation phase of patients with neurological diseases who, had been wearing Foley's catheter. Nearly 12 years ago, Lapidès and his co-workers introduced the concept of self clean intermittent catheterisation as a permanent method of emptying the bladder for patients with various neurological dysfunction².

In the paraplegia centre of Rehabilitation Research Centre, S. M. S. Hospital, Jaipur, sterile intermittent urethral catheterisation is being used as a bladder retraining procedure for

the last 3 years. A large number of patients in whom satisfactory method of evacuation of bladder could not be developed, were discharged with an indwelling self retaining catheter.

This group of patients faced the greatest difficulties as a large number of them were from rural areas where even primary health care was not available and they had to travel long distances to primary health centre for change of catheter or irrigation of a blocked catheter. This frequent shuttling from their village to primary health centre and back led to development of large pressure sores accompanied by severe urinary tract infection. Ultimately they land up at the centre as severely ill patients. In view of these problems, a self clean intermittent catheterisation programme for management of neurogenic bladder has been started in this centre.

*Assistant Professor, Physical Medicine & Rehabilitation, Rehabilitation Research Centre, S. M. S. Medical College & Hospital, Jaipur.

MATERIAL AND METHODS

We began using this method since 1st January, 1984 and since then the one hundred thirty-six traumatic paraplegia patients have been trained in this technique but only one hundred and twelve of them have reported for regular follow up and the present report describes our experience with hundred and three male and nine female patients. In twelve patients the training had to be stopped in between due to various reasons.

All the traumatic paraplegia patients with bladder dysfunction, who were able to use the hands freely were considered for this training. However, some patients had to be rejected at the outset on account of obesity or severe autonomic dysreflexia.

All the patients in this series were already hospitalised and all were wearing Foley's indwelling catheter for a variable period ranging from three weeks to two months. No urodynamic studies were conducted to formally classify the bladders, as the ideology behind the study was to provide the self clean intermittent catheterisation as a permanent method of evacuation of bladder for both types of bladder.

The self intermittent catheterisation programme was started only after urine of the patient was found sterile on three subsequent cultures with urine having less than 100 CFU/ml with less than 5 WBC/HPF of spun urine.

The Foley's catheter was removed early in the morning on the first day and urine was sent for urine analysis and culture. The Senior Registrar then visited the patient and instructed the patient on the procedure to be followed. The patient was also instructed on fluid restriction and was given a fluid out-put record sheet making it obligatory on him/her getting it filled every time he or she emptied the bladder or voids incontinently. The patient was then catheterised. In case of female patient, the patient was placed in a lithotomy position and

a mirror was placed so the patient could see what is being done.

After this demonstration the patient was asked to perform all subsequent catheterisations himself or herself in bed under supervision, using a clean dry catheter (washed with soap and water) and lignocain jelly as lubricant. The patients catheterised themselves four times a day at 6 A.M., 12 Noon, 5.30 P.M. and 11 P.M. The fluid intake was restricted to 125 ml per hour from 6 A.M. to 10 P.M. totalling 2000 ml per day.

Twenty patients had reflex detrusor activity and were treated with Imipramine hydrochloride 75 mg per day for a week. It did not interfere with their sleep and kept the patients dry. In the following week, the dose of the drug was adjusted according to the need of the patient.

All the patients had sterile urine at the start of self clean intermittent catheterisation programme, urinary infections have been treated with a specifically indicated antibacterial drug before starting the training programme. No antibacterial drug was used as prophylactic during the treatment unless the patient developed signs of urinary tract infection.

Weekly cultures, and urine analysis with sediment examination were performed on all the patients while in the hospital. Following discharge the patients attended the out-patient clinic at an interval of eight to ten weeks. At the time of follow-up urine culture and urine analysis with sedimentation were performed in each case. In addition, patients were encouraged to attend the out-patient clinic or bring urine specimen at any time if they had any indications of infection i.e. loss of continence or change in character of the urine. 6 months after discharge, pyelogram & serum creatinine values were obtained.

OBSERVATIONS

One hundred & twenty-four patients successfully completed the training and were

discharged. Only one hundred and twelve (103 males and 9 females) of them reported for regular follow up.

The male patients became proficient in the technique of self catheterisation on an average in one day and female became proficient on an average in 7 days. Average stay of the patient after they became proficient in the technique of self catheterisation was on an average 1 month for other rehabilitation purposes.

There were no incidents of febrile urinary infections while the patients were in hospital nor during the follow up period.

Table I. Results in 112 Cases of Traumatic Paraplegia

No. of Pts.	Period of Catheterisation		No. of Patients developed Bacteriurea	
	Indwelling	Self Intermittent	In Hospital	Follow up
5	4 weeks	80-90 weeks	1	2 (1)*
4	4-8 weeks	80-90 "	3	4 (1)*
4	4 "	70-79 "	—	2
6	4-8 "	70-79 "	4	4 (2)*
4	4 "	60-69 "	1	2 (1)*
8	4-8 "	60-69 "	3	6 (2)*
4	4 "	50-59 "	1	2 (1)*
6	4-8 "	50-59 "	2	4 (1)*
7	4 "	40-49 "	2	3 (1)*
6	4-8 "	40-49 "	4	6 (2)
8	4 "	30-39 "	1	4
7	4-8 "	30-39 "	2	5 (2)*
8	4 "	20-29 "	1	3
6	4-8 "	20-29 "	2	4 (2)*
11	4 "	10-19 "	2	2
6	4-8 "	10-19 "	3 (1)*	3 (1)*
8	4 "	0-9 "	—	—
4	4-8 "	0-9 "	2	—

*The number in brackets are the number of those patients who developed bacteriurea more than once during the period of study.

Table II. Antibacterial drugs given to patients on self intermittent catheterisation when they developed significant bacteriurea

	MM	Nf	TMP-SMZ	Other
In Hospital	6	10	12	6
In follow up	8	28	20	12

MM — Methenamine Mandecate 1 gm QID.

Nf — Nitrofurantoin 50 mg 12 hourly.

TMP — SMZ—Trimethoprim—sulfamethoxazole 1 tab. 12 hourly.

During hospitalisation 34 patients out of 124 who entered the study, developed significant bacteriurea with more than 1 lakh C. F.U./ml with more than 20 KBC/HPF of spun urine. A 15 days course of specific antibacterial therapy was given for each infection case and there were no recurrence except in the case of middle aged rather obese lady, who experienced two incidents of *E. coli* bacteriurea at intervals of 3 weeks.

In the present study patients are available for follow up study for a period of 2 months to two years. 56 patients were seen on routine follow up visits to have significant bacteriurea, 17 of the 56 patients had two such incidents.

Both in-hospital and the out-patients clinic, the most commonly isolated organism was *E. coli* with lesser number of *Proteus* and *Klebsiella* and an isolated incident of *Citrobacter* bacteriurea.

Dilatation of the ureter and pelvis of kidney was observed in two patients. Intermittent catheterisation was continued in both the patients. On subsequent visit pyelogram was repeated and a trend towards normalisation of the size of ureter and pelvis of kidney was observed in both the patients. We have seen no urinary calculi developing during intermittent catheterisation. Eight patients had a single incidence of haematuria without any identifiable cause. Patients who were on indwelling catheter for

more than 4 weeks had more incidence of bacteriurea than those who were on indwelling catheter for less than four weeks.

DISCUSSION

This study was conducted on the hypothesis postulated by Lapidès et al.² that most cases of urinary tract infection are due to some underlying structural or functional abnormality of the urogenital tract which leads to decreased resistance of tissue to bacterial invasion. The urothelium or renal parenchyma can be affected through damage to its structural integrity by neoplasm, calculi, foreign bodies such as inlying catheters, traumatic instrumentation and so forth. However, the most common cause for increased susceptibility to bacterial invasion is decreased blood flow to the tissue. Blood flow to the bladder can be reduced by increased intravesical pressure and/or by over distension of the organ. The resulting ischemic bladder tissue is then prey to invading gram negative organisms from the patient's own gut via the hematogenous or lymphogenous route. Transient bacteremia is believed to be a common phenomenon in healthy individuals. In the female patients poor voiding, is the primary cause of cystitis whereas obstruction is the leading cause in the male patients. Thus it can be inferred from our theory that the maintenance of a good blood supply to the renal pelvis, ureter, bladder and urethra by avoiding high intraluminal pressure and over distension is the key to prevention of urinary tract infection. Residual urine in itself and organisms supposedly ascending through the urethra are of doubtful importance in the genesis of urinary infection. Results of the present study are quite in conformity of this hypothesis.

The most commonly isolated organism from the urine in the present study as well as in the study conducted by Elizabeth Joiner et al.⁴ was *E. coli*, this common finding provides further credence to the hypothesis of Lapidès et al.

The technique of self intermittent catheterisation is easy to learn as in the present study, male patients took only a day and female patients took only seven days to become proficient. This fact has been well emphasised in the studies conducted by Lapidès et al.² and by Elizabeth Joiner et al.⁴ The ease in learning the technique lies in uncomplicated instruction and simple instrumentation. Sterile intermittent urethral catheterisation as advocated by Guttman¹ never became popular in India and this part of World since it was believed that not enough physicians were available to perform the number of daily catheterisation in the manner suggested.

Fewer patients developed bacteriurea within the present series as compared to the study conducted by Elizabeth Joiner et al.⁴ It appears to be due to the fact that in her study all the patients were females only, but in the present study the number of male patients is much larger.

Dilatation of ureter and pelvis of kidney were seen in two patients in the present series and both of them showed trends towards normalisation. As the follow-up of our patients was short, our results in this regard are not as good as in the study by Elizabeth Joiner⁴ where the pyelogram returned to normal after a longer follow-up. An interesting observation was that the patients who were on indwelling catheter for more than four weeks, suffered more with incidence of bacteriurea in follow-up period. This observation is difficult to explain and may be due to residual effect of the trauma which the bladder sustained during the period patient was on indwelling catheter.

The sole idea with which we adopted to self clean intermittent catheterisation was to some how relieve our rural paraplegic patients of the problems faced by them due to indwelling catheters. The significant reduction in urinary tract infection rate, which led to reduction of the cost of antimicrobial drugs from the total cost of treatment was, however, a welcome spin off. It

not only cuts on the cost of antibiotics but spared these patients from frequent visits to distant primary health centres for change of catheters and irrigation of blocked catheter. The patients acceptability of the procedure is very high. Under Indian scenario where a large number of traumatic paraplegia patients come from rural

area, we feel that it is a fairly good procedure of evacuation of bladder and control of large number of urinary tract complications which develop following this condition. The patients are also relieved of carrying an indwelling catheter and drainage bag, making them more socially acceptable.

REFERENCES

1. **Guttmann, L. & Frankel, R.**, The value of intermittent catheterisation in early management of traumatic paraplegia and tetraplegia. *Paraplegia*, 4, 63-84, 1966.
2. **Lapides, J., Dionko, A. C. & Lowe, B. S.**, Clean intermittent self catheterisation in the treatment of urinary tract disease. *J. Urol.*, 107, 458-461, 1972.
3. **Perkash, I.**, Intermittent catheterisation and bladder rehabilitation in spinal cord injury patients. *J. Urol.*, 114, 230-233, 1975.
4. **Elizabeth Joiner R. N.**, Experience with self intermittent catheterisation for women with neurological dysfunction of the bladder. *Paraplegia*, Vol. 20 Number 3, 147-153, 1982.

Evaluation of Underarm Plastic Spinal Orthosis in Management of Scoliosis

RATNESH KUMAR, U. K. JAIN, A. K. AGARWAL & V. P. SHARMA

INTRODUCTION

Spinal bracing is known since prehistoric era. During last few decades, introduction of plastic, better understanding of biomechanics of spine & coordinated approach of medical and engineering has revolutionised the conservative modalities for scoliosis management. Milwaukee brace popularised spinal orthotic and later replaced by Boston brace due to its high acceptability. Due to high prevalence of Poliomyelitis, paralytic scoliosis as childhood disability is common in India. The massive involvement of limbs and trunk muscles has put restrictions to the surgical management. These cases require early spinal bracing. The changing social norms besides cost factor & high skill required in fabrication of Milwaukee brace, opened further the chapter of plastic spinal orthosis (UPSO). In India, plastic has come in use for orthotic recently. In northern India, we have used it first time in conservative management of scoliosis. The present study was planned to evaluate the effectiveness, acceptability & long term effects of UPSO in growing scoliotic patients.

MATERIAL AND METHOD

Skeletally immature patients of scoliosis irrespective of age, sex & aetiology, who attended department of Ortho. Surgery and Physical Medicine & Rehabilitation, King George's

Medical College, Lucknow were included in the study. They were clinically & radiologically evaluated as per proforma based on the data card published by the Scoliosis Research Society of United States for initial recording & follow up. Curve was measured by Cobb's method (1948). While Nash & Moe Index (1969) was used to find out the rotation of the apical vertebra.

Prerequisite for UPSO—

- Patient should be skeletally immature.
- Apex of curve should be at or below T7 vertebra.
- Curve should be flexible.
- Pulmonary functions should be within normal limit.
- There should be no congenital unsegmented unilateral bar.
- Patient & family should be cooperative.

Fabrication of UPSO

A negative POP mould of TLSO was taken on Risser's localizer casting table by applying head haulter & pelvic traction. The extent of POP cast was superiorly from manubrium sterni anterior, axillary fold laterally & cervicothoracic junction posteriorly, to greater trochanter, pubic symphysis & coccyx inferiorly. Positive mould was further modified to relieve, pressure points & to provide proper corrective forces. A thermoplast sheet of proper size was moulded on POP positive cast. Trimming of

¹Medical Officer, District Rehabilitation Centre, Sitapur.

²Prof. of Orthopaedic surgery, K. G. Medical College, Lucknow.

³Sr. Med. Officer cum Reader, Dept. of Physical Medicine and Rehabilitation, RALC, K. G. Medical College, Lucknow.

⁴Lect., Dept. of Phy. Med & Rehab. RALC, K. G. Medical College, Lucknow.

plastic mould followed by proper padding & adhesive straps were fixed. For ventilation, additional punched holes were made. Skiagram, pre-POP cast, in POP cast & in brace, were taken. During the use of brace, chest & spinal exercises were explained to the patients. The patients were followed up clinico-radiologically at periodic interval. In brace & out of brace skiagrams were taken in follow up visits besides clinical examination.

OBSERVATION

45 cases of scoliosis of varied aetiology, age & sex etc. were studied & presented here in subsequent tables.

Table I. Distribution of scoliosis cases in relation to aetiological type and sex

Aetiological type	Male	Female	Total
Congenital	3	6	9
Idiopathic	9	9	18
Paralytic	12	6	18
Total	24	21	45

Among the studied cases, 53.3% were males & 46.7% females. 20% cases were of congenital type followed by 40% in idiopathic & paralytic type each. In idiopathic, male & female distribution was equal, where as females were representing 2/3rd of cases in paralytic group.

Table II. Distribution of cases in relation to aetiological type and age

Aetiological type	Age group (years)				Total
	0-4	5-9	10-14	15-17	
Congenital	4	2	3	—	9
Idiopathic	—	3	10	5	18
Paralytic	2	9	5	2	18
Total	6	14	18	7	45

Cases were of varied age-ranging from 18 months to 17 years. Majority of scoliosis cases (18) were in the age group '10-14 years' followed by age group '5-9 years' (14). 50% cases of paralytic group were in the age of 5-9 years, whereas 55.5% idiopathic cases were in the age group of '10-14 years'.

Table III. Scoliosis cases and curve pattern

Aetiological type	Dor-sal	Dorso-Lumbar	Lum-bar	Dou-ble	Total
Congenital	1	5	1	2	9
Idiopathic	4	11	—	3	18
Paralytic	2	16	—	—	18
Total	7	32	1	5	45

Five cases were having double curve, thus making it a total of 50 curves in 45 cases. Dorso-lumbar curve (32) was found to be commonest. Double curves were found in congenital (2) & idiopathic (3) cases.

Table IV. Aetiological type and severity of deformity

Severity of curve (in degree)	Cong-enital (C)	Idio-pathic (I)	Para-lytic (P)	Total
Less than 25°	1	—	1	2
26-45	4	10	8	22
46-65	5	9	4	18
66-85	1	2	3	6
86 & above	—	—	2	2
Total	11	21	18	50

All cases (except two) were having curve more than 25°. Majority of curves (44%) were of '26-45 degree' severity, followed by 18 curves in '46-65 degree'. Two cases were having curve more than 86°.

Flexibility of curve has been calculated by the following formula (Winter R.B. et al. 1974).



Fig. 1A. A. V., 8 years, a case of Congenital Scoliosis.

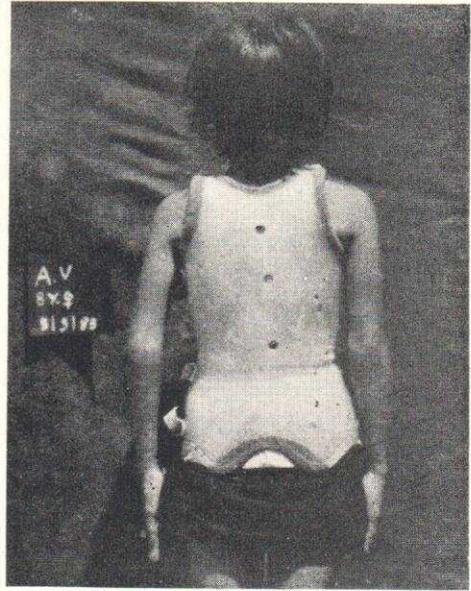


Fig. 1B. Same case with Brace.

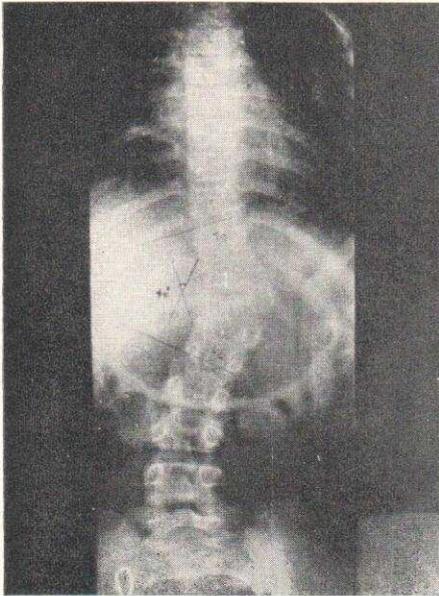


Fig. 1C. Pre-Brace Cobb's Angle 40°.

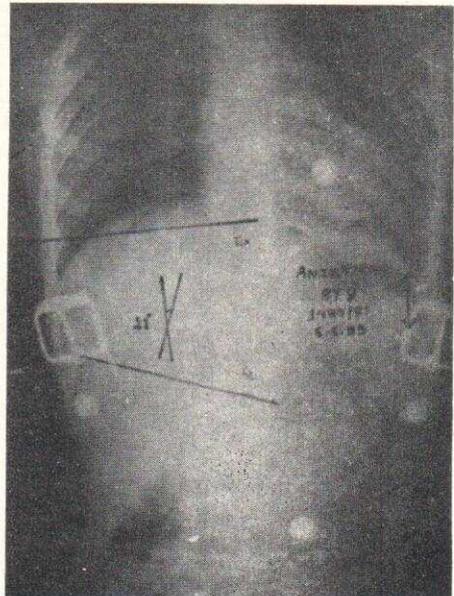


Fig. 1D. Same case with Brace, Cobb's Angle 22°.



Fig. 2A. Baby 5 years, a case of Paralytic Dorso-Lumbar Scoliosis.

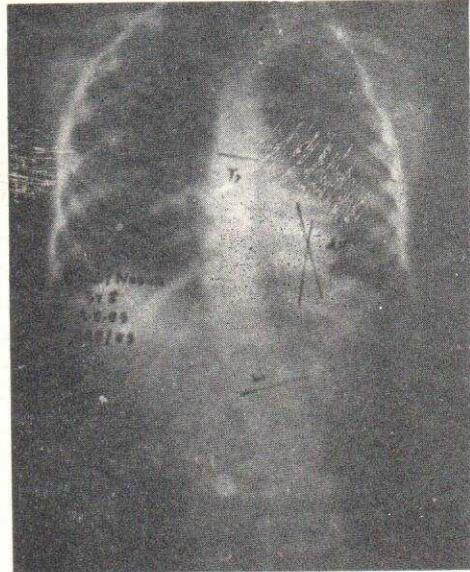


Fig. 2B. Pre-Brace Cobb's Angle 25°.

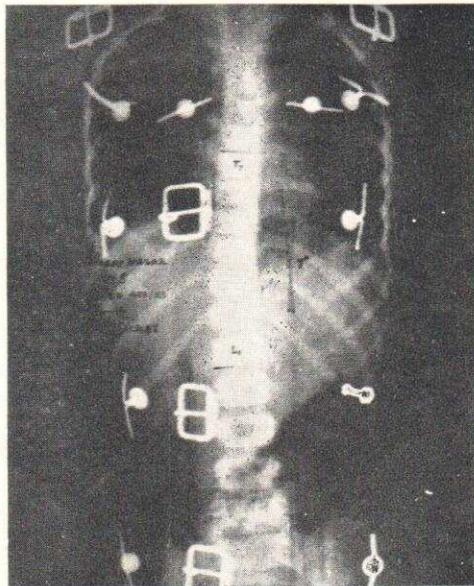


Fig. 2C. Same case with Brace, Cobb's Angle 7°.



Fig. 3A. Shama 12 years, a case of Idiopathic Dorso-Lumbar Scoliosis.

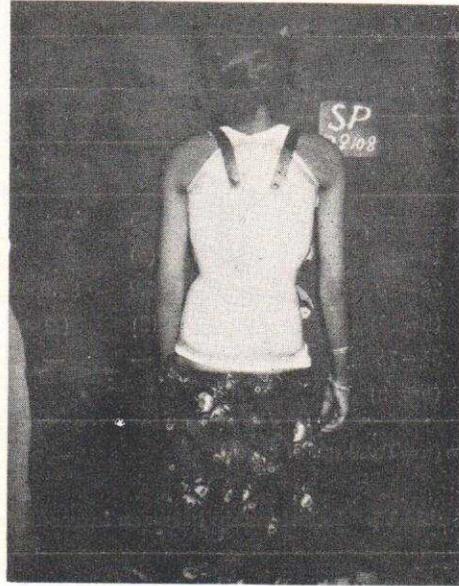


Fig. 3B. Same case with Brace.

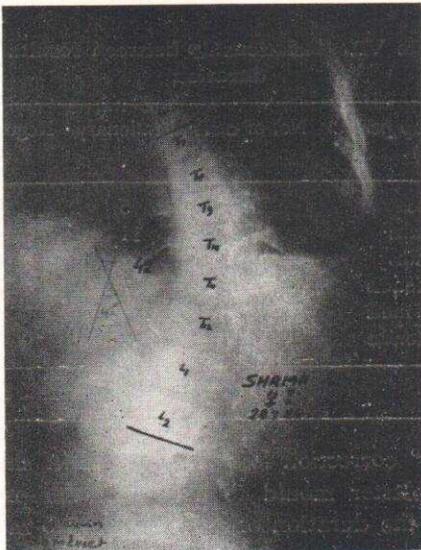


Fig. 3C. Pre-Brace Cobb's Angle 42°.

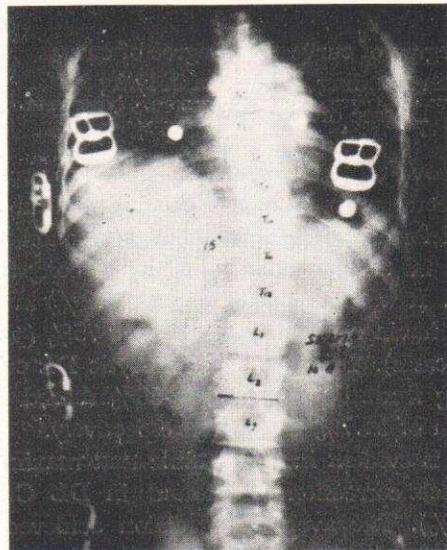


Fig. 3D. Same case with Brace, Cobb's Angle 15°.

Table V. Relationship between flexibility of curve and in-brace correction (immediate)

Flexibility of curve (%)	Mean Correction									Average correction (%)
	Dorsal curve			Dorso-lumbar			lumbar curve			
	C	I	P	C	I	P	C	I	P	
Less than 25 (n=27)	11.6 (1)	32.5 (5)	—	39.8 (7)	35.4 (7)	47.9 (4)	36.6 (3)	—	—	34
26-50 (n=20)	—	44.2 (2)	38.6 (2)	—	57.7 (7)	57.3 (9)	—	—	—	48
51-75 (n= 3)	—	—	—	—	—	72 (3)	—	—	—	72

(n=Total no. of curve)

Table VI. Relationship between immediate correction achieved in relation to severity of curve

Curve pattern	No. of curve	Mean correction in		Average correction (%)
		curve less than 40°(%)	curve more than 41°(%)	
Dorsal (D)	10	50.8	24.0	37.4
Dorso—Lumbar (DL)	37	44.0	47.5	45.8
Lumbar (L)	3	38.9	32.0	35.5

$$= \frac{\text{Degree of curve in standing} - \text{Degree of curve in lying}}{\text{Degree of curve in standing}} \times 100$$

Above table shows that in-brace correction is directly proportional to flexibility nature of the deformity. The minimum correction was noted in the partially rigid dorsal congenital curve. It was maximum (average 72%) in DL curve having flexibility between 50-75% (paralytic cases). Idiopathic & paralytic DL curve having flexibility between 26-50% shared correction of 51.7% & 57.3% respectively.

It is evident in above table that maximum in-brace correction was found in DL Curve (45.8%). The average correction achieved in dorsal & lumbar curve was found to be practically same 37.4% & 35.5% respectively.

Table VII. Relationship between results & duration

Follow-up period (months)	No. of cases	Stationary	Regressed
3 Months	5	5	—
4-6 Months	11	11	—
7-9 Months	6	2	4
10-12 Months	11	7	4
13-15 Months	6	4	2
16-20 Months	6	4	2
Total	45	33	12

2-6° correction loss was noticed in shifting from plaster mould to brace. In the present study, the duration of deformity was 5 months to 12 years. In most of cases (24), it was 1-6 years. Cases were followed clinico-radiologically

at three monthly interval. Maximum follow up was of a 20 months whereas minimum was of 3 months only in 5 cases. In 33 cases curve was stationary, whereas there was regression (out brace) in 12 cases. Majority of cases (41) were using brace 20-23 hours daily as per instructions given, except one who was irregular & there was no drop out.

Table VIII. Complications

Discomfort	..	3
Heat (subjectively)	..	5
Skin rash	..	2
Cycling problem	..	1
Social problem (cosmetic)	..	1

Continuous use of brace (except one) itself is indicative of absence of any significant complication. The commonest problem noticed by patients (5) was of feeling of warmth. 3 cases had mild discomfort but exact nature could not be explained by them. Two cases reported mild skin rashes which were insignificant. One case reported social problem of cosmetic nature. None of case reported functional or physiological hinderance.

DISCUSSION

In the present study, under arm plastic orthosis was used as a modality of conservative management of scoliosis. All the cases, except one, were in growing skeletal stage. In contrast to the observation of Hall J. (1975), Walt H. G. (1977) & Bunnel, W. P. (1980) who selected curve of 25 to 28° only. In the present series, the increased deformity (more than 40° in 56% cases) at the time of first attendance might be due to lack of awareness of complication of spinal deformity & also due to full coverage of the back in females, thus deformities were noticed very late in our society.

In this study DL curve was commonest (71.1%) followed by dorsal curve, similar to findings of Bunnel, B. P. et al. (1977) & Walt

H. G. et al. (1977). Park J. et al. (1977) recorded higher incidence (53%) of lumbar curve & Hall J. et al. (1975) reported dorsal curve in 31% cases. In idiopathic cases we found double curve in 16.6% cases against the observation of Hall J. et al., Walt H. G. (1977) & Bunnel W. P. et al. (1977) who reported in 28 to 31%. The difference could be due to variation in geographical area. According to Carr W. A. et al. (1980) long term results of brace treatment can be predicted by response of curve to brace during first year of treatment. Maximum correction (72%) was observed in patient's curve having flexibility of 50-75%, followed by 48% correction in cases with flexibility of 25-50%. A mean correction of 34% was observed in lesser flexible curve (25%). Immediate correction was found to be directly proportional to flexibility of curve, irrespective to aetiology. This observation was similar to Winner, R. B. & Moe, J. H. (1974). 47 out of 50 curve were having flexibility less than 50%, hence the correction achieved was less than 50%. In these cases significant correction can be expected (Carr, W. A. et al., 1980).

In our series from POP to brace shift, the average loss of angle was 5°, similar to those of Bunnel, W. P. et al. (1980). Patient having dorso-lumbar curve responded best (45.8%) amongst the patient with different curve pattern. It is similar to observation of other workers. Since there were only two lumbar curve, no inference could be drawn for lesser correction achieved.

Cases were followed up for up to 20 months, curve showed regression in 30% & stationary in remaining 70% cases. Cases (29) who used brace for more than 6 months, curve was stationary in 58.6% & regression in 41.4% cases. The cases are still under brace treatment & weaning has yet to be started. Our results are satisfactory similar to Park J. et al. (1977), who showed satisfactory results in 80% cases during 36 months follow up.

In the present study, 8 cases had reported problems during use of brace. Subjective feeling of warmth by five cases in brace was similar to observation of Bunnel, W. P. (1980). This problem was further minimised by making multiple punched out holes in the brace. We recorded mild discomfort in 6-7% cases against 21% reported by Walt, W. P. et al. (1977). Various mild skin reactions as hyperemia, blistering & skin rash were reported ranging from 5-38% cases by Walt, H. G. et al. (1977), Hall, J. et al. (1975), Bunnel W. P. et al. (1980). We noticed

mild skin rash in 4.5% cases only. No treatment was required. This could be due to different material used by various authors besides changed climatic condition & body resistance in Indian population.

We found high acceptability of brace similar to Walt, H. G. et al. (1977), Park J. et al. (1977) and Bunnel, B. P. et al. (1980). The female patients reported cosmetic & social problem, which was minimised by modifications in their clothings.

REFERENCES

1. **American Academy of orthopaedic surgeons, Atlas of Orthotic, C. V.,** Mosby Company St. Louis, 1975.
2. **Bunnel W. P. and Moe Ewen GD,** Use of the orthoplast Jacket in the non operative treatment of scoliosis J. Bone Joint Surg. 62 A, 62-1, 31-38, 1980.
3. **Cobb J. R.,** Outline for the study of scoliosis instructional course lecture, Edited by J. W. Edwards Ann. Arboi, Michigan American Academy of Orthopaedic surgeons, 1948.
4. **Hall J. Miller W., Shumann W. and Stanish W. A.,** A refined concept in the orthotic management of scoliosis. Orthot. Prosth. 29, 9-16, 1975.
5. **Nash C. L. & Moe J. H.,** A study of vertebral rotation J. Bone Joint Surg. 51 A, 223-229, 1969.
6. **Park J., Houtkins, Grossman J. and Lavine D. B.,** A modified brace (Prenyl) for scoliosis. Clin. Orthop. 126, 67-73, 1977.
7. **Watt H. G., Hall J. E. and Stanish W.,** The Boston brace system for the treatment of low thoracic and Lumbar scoliosis by the use of a girdle without superstructure, Clin. Orthop, 126, 87-92, 1977.
8. **Winter R. B. and Loveli W. W.,** Orthotics for spinal deformity. Clin. Orthop, 102, 72-91, 1974.

A Clinical Study of Upper Limb Amputees

V. P. SHARMA¹, A. K. AGARWAL², PROF. U. S. MISHRA³ & A. K. SINGHAL⁴

Department of Physical Medicine & Rehabilitation, (R.A.L.C.)

K. G. Medical College, Lucknow.

In one year (1988) 76 upper limb Amputees attended the centre. Male & Female ratio was 18.2:1. 75% amputees were from rural areas. 46.05% amputees were in 3rd decade. Cause of amputation was Trauma in 92.1% cases. 55.26% were below elbow and 25% were Above elbow amputees. Mostly stumps were ideal for Prosthetic fitting. Amputation was more common in farmers. Functional Prosthesis were given in 61 and cosmetic in 15 cases. Unless proper and effective preventive measures are applied, manpower loss and demand for Prosthetic Services will continue.

In India upper limb amputations are still uncommon as compared to the lower limb amputations. Rapid industrialisation specially of cottage industries, mechanisation in agriculture and increase in the rail-road traffic have tremendously increased the number of upper limb amputees. In Northern India, specially in Western U. P., Haryana and Punjab where farm machines are maximum, number of upper limb amputees are also more. However there had been gradual increase in the numbers of upper limb amputees reporting to this centre for Prosthetic fitting.

In contrast to the lower limb amputations which are mainly due to rail-road accidents, the upper limb amputations are mainly due to improper use of farm machines by untrained personnels and also due to inadequate protection in the machines.

METHOD AND MATERIAL

This study is based on the number of upper limb amputees, who have attended Rehabilita-

tion and Artificial Limb Centre (RALC), Department of Physical Medicine and Rehabilitation, K.G.'s Medical College, Lucknow, during the year 1988.

Detailed clinical history and stump examination was done in each case. The upper limb prosthesis were made from prefabricated parts manufactured by ALIMCO, Kanpur. All these patients are being followed up.

OBSERVATION AND DISCUSSION

During the year 1988, 76 upper limb amputees attended RALC, out of which 72 were males and 4 were females. The maximum cases were in third decade followed by 25% in 2nd decade as shown in Table No. 1.

Out of 76 cases, 57 cases (75%) were from rural area and 19 from urban area (Table no. 2)

Causes of amputation

Significantly, trauma was the commonest cause of amputation. Mostly males from rural area were exposed to accidents as a result of

¹Lecturer

²Senior Medical Officer Cum Reader

³Director Professor

⁴Chief Resident

Table I.

Age gr.	Male	Female	Total
1-10	2	—	2
11-20	18	1	19
21-30	32	3	35
31-40	9	—	9
41-50	7	—	7
51-60	2	—	2
Above 60	2	—	2
	72 (94.73%)	4 (5.27%)	76

Table II.

	Male	Female	Total
Rural	54	3	57
Urban	18	1	19
	72	4	76

thresher machines, chopping machines, water pumps and other agriculture machines. In remaining cases it was present since birth. After 5th decade lesser people were affected in general.

Site of amputation

Out of 76 upper limb amputees, majority of the cases (42 cases) were below elbow, followed by above elbow (19 cases). Finger and wrist involvement were found in ten and four cases respectively.

In above elbow amputees, stump was of adequate length and shape in 11 out of 19 cases while in 7 cases it was short stump. Among below elbow amputees more than half of the cases were of adequate length and shape.

In below elbow amputees it was normal length and shape in 19, short in 16 and long in 4 cases, out of 42 cases. It was too short in two and too long in one case only.

Occupation

43% of upper limb amputees were farmers while 26.3% were engaged in some service. It was relatively uncommon among teachers and students. Prevalence was less in self employed persons (Table 6).

Prosthetic fitting

In all the 42 below elbow & 19 above elbow amputees functional Prosthesis were fitted. The cosmetic Prosthesis was given in all other cases.

DISCUSSION

Upper limb amputations are less common as compared to lower limb amputations. During the last many years, there has been increase in the number of upper limb amputees. The upper limb amputations are generally caused by trauma like rail-road accidents, mechanisation in agriculture etc. Blast injury, accidents in factories, electrical injuries and other causes of trauma leading to upper limb amputations were relatively less causative factor (PE 1988). The overall male and female ratio was 18.2:1. Hla (1988) had also reported the similar incidence. Narang and Jape (1982) had observed reversal of the ratio. The male predominance may be due to more exposure to farm mechanisation and traffic accidents etc. The mean age of the amputees was in early 30's (PE1988) unlike in HongKong where the males were slightly older than the females (Chan et. al., 1984).

Mostly the amputees (75%) were from rural areas. The reason may be that more than 80% of our population lives in rural areas. Further due to increase in the number of rural based cottage industries and farm mechanisations, the upper limb amputations have increased considerably in rural areas.

55.26% of upper limb amputees were below elbow. This may be due to badly crushed hands in thresher, oil expellers etc. leading to

Table III. Cause of amputation

Age group	Trauma							Total
	Road	Agri.	Blast	Fact	Ele.	Misc.	Cong.	
1-10	—	—	—	—	—	—	2	2
11-20	—	1	1	1	2	14	—	19
21-30	3	3	2	7	2	15	3	35
31-40	1	—	—	—	—	7	1	9
41-50	1	—	—	—	1	5	—	7
51-60	—	—	—	—	—	2	—	2
Above 60	—	—	—	—	—	2	—	2
	5	4	3	8	5	45	6	76

Table IV. Site of amputation

Age group	A.E.	B.E.	Dist. Wrist	Finger	Thumb	Total
1-10	—	1	—	1	—	2
11-20	4	10	1	3	1	19
21-30	6	23	1	5	—	35
31-40	4	3	1	1	—	9
41-50	2	4	1	—	—	7
51-60	2	—	—	—	—	2
Above 60	1	1	—	—	—	2
	19	42	4	10	1	76

Table V. Site Vs. Size

SITE	2"	2"-5"	5"-7"	7"-9"	9"-11"	11"	Total
A. E.	1	7	9	2	—	—	19
B. E.	2	16	19	4	1	—	42
D. W.	—	—	—	—	3	1	4
Finger	7	1	—	1	1	—	10
Thumb	1	—	—	—	—	—	1
	11	24	28	7	5	1	76

Table VI. Occupation Vs. Site

	A.E.	B.E.	Dist. Wrist	Thumb	Finger	Total
Service	6	10	—	1	3	20
Farmer	8	18	4	—	3	33
Self Emp.	5	8	—	—	3	16
Teacher	—	2	—	—	1	3
Student	—	4	—	—	—	4
	19	42	4	1	10	76

Table VII. Prosthesis Prescribed

	Functional	Cosmetic
A. E.	19	—
B. E.	42	—
Dist. Wrist	—	4
Finger amp.	—	10
Thumb amp.	—	1
	61	15

below elbow amputations. The above elbow amputations were as a result of fracture and or dislocations around elbow, fractures of forearm bones added with infection and vascular insufficiency.

Mostly above and below elbow stumps

(44.7%) were ideal in length and shape for Prosthetic Rehabilitation. Seven out of 19 above elbow were short and one was very short stump. These stumps were bad stumps for fitting of a prosthesis. There is not much awareness amongst the treating surgeons regarding ideal stump for prosthetic fitting.

Adherence of scar, bony projection, flabby muscles & neuroma etc. are some of the complications in the stumps leading to revision of stump and thus make them suitable for prosthesis.

The incidence of accidents in the upper limb are mostly preventable. General awareness, proper medical facility and legislation are the few methods by which this incidence can be minimised.

REFERENCES

1. Chan, K. M., Cheung, D., Sher, A. Leung, P. G., FU, K. T., LEE, J. C., : A 24 years survey of amputees in Hong Kong, Prosth. Orthot. Int. 8, 155-158, 1984.
2. Hla, P. E. : A 15 year survey of Burmese amputees. Prosth. Orthot. Int. 12, 65-72, 1988.
3. Narang, I. C., Jape, V. S. : Retrospective study of 14,400 civilian disabled (new) treated over 25 years at an Artificial Limb Centre, Prosth. Orthotics. Int. 6, 10-16, 1982.

Poliomyelitis—A Study on 500 Cases

S. C. GOEL¹, S. V. SHARMA², H. P. SINGH³ & A. PRASAD⁴

Department of Orthopaedics, Institute of Medical Sciences, Banaras Hindu University,
Varanasi-221 005

Poliomyelitis though practically wiped out from some parts of the world, still continues to be a common affection in developing countries like India. The disease can be witnessed from acute stage, convalescent stage to residual paralytic stage with crippling deformities in any moderately attended Rehabilitation practice (2 per cent of Orthopaedics O. P. D. at B. H. U.) in our country. The present study was undertaken in 500 cases of poliomyelitis during convalescent and residual paralytic stages to study pattern of muscle involvement in poliomyelitis. All these patients were examined clinically and the group of muscles involved were assessed as per M. R. C. grading of muscle power.

It was observed that most patients belonged to less than 5 years of age. Adult polio was

rarely seen and number of patients in the 11-15 years were very small.

Table II. Regional Distribution

Single Upper limb	22(4.4%)	All Four limbs Both upper and one lower limb	4 3 Bil.
Single lower limb	273(54.6%)	Ipsilateral	10
Both lower limbs	174(34.8%)	Contralateral Trunk and Head	2 2

We observed that lower limb was involved more frequently than the upper limb. Similarly ipsilateral involvement was more common than the contralateral.

Table I. Age in Years at onset of Disease

	Less than 2 years	2-5	6-10	11-15	Un- known
No. of cases	173	225	12	9	51
Per- cent	34.6	51	2.4	1.8	10.2
Most of patients presented during convalescent stage					
Distributed equally on both sides and in both sexes					

Table III. Distribution Pattern of Hip Muscles Involvement

	Total number of cases 447		
	M.R.C. 0	M.R.C. 1-4	M.R.C. 5 (Normal)
	No.	No.	No.
Flexors	21	372	54
Extensors	75(17%)	347	25
Abductors	46(10%)	378	23
Adductors	93(20%)	332	22
Ext. Rotators	10	381	47

¹Reader, Deptt. of Orthopaedic.

²Reader, Deptt. of Orthopaedic.

³Sr. Resident Deptt. of Orthopaedic.

⁴Physiotherapist Deptt. of Orthopaedic.

Distribution pattern of muscle involved in lower limbs around hip revealed involvement of extensors, adductors and internal rotators, more common than others.

Table IV. Pattern of Knee Muscles Involvement

Total number of cases—447

	M.R.C. 0	M.R.C. 1-4	M.R.C. 5 (Normal)
	No.	No.	No.
Flexors	50(11.1%)	373	24
Extensors	103(22%)	312	32

Similarly knee extensors were more commonly involved than flexors.

Table V. Pattern of ankle, foot and toe muscles involvement

Total number of cases—447

	M.R.C. 0	M.R.C. 1-4	M.R.C. 5 (Normal)
	No.	No.	No.
Dorsiflexors	114(23%)	227	46
Planterflexors	30	348	69
Evertors	93(20%)	298	56
Invertors	102(22%)	310	35
Toes	32	350	65

Around ankle and foot, dorsiflexors and invertors were affected in large number of cases than planter-flexors and evertors.

In the upper limb, paralysis of abductors of the shoulder showed a particular affinity (Table VI).

Around elbow, extensors were more involved. Muscles acting on wrist and fingers showed rarely any gross involvement, except thumb (Table VII).

Table VI. Pattern of Shoulder Muscles Involvement

Total number of cases—34

	M.R.C. 0	M.R.C. 1-4	M.R.C. 5 (Normal)
	No.	No.	No.
Flexors	4(12%)	27	3
Extensors	4	27	3
Abductors	14(41%)	20	0
Adductors	4	29	1
External Rotators	4	29	2
Int. Rotators	3	29	2

Table VII. Pattern of Elbow and Forearm Muscles Involvement

Total number of cases—34

	M.R.C. 0	M.R.C. 1-4	M.R.C. 5 (Normal)
	No.	No.	No.
Flexors	2	24	8
Extensors	5(14%)	28	1
Pronators	1	29	4
Supinators	2	29	3

Table VIII. Pattern of wrist Muscles Involvement

Total Number of cases—34

	M.R.C. 0	M.R.C. 1-4	M.R.C. 5 (Normal)
Dorsiflexors	0	19	15
Palmerflexors	0	17	17
Radial deviators	0	24	10
Ulnar deviators	0	25	9
	0	85	51

No case was seen in paralytic group, and in partial paralytic group also number of cases are much lower than the shoulder and elbow.

Abductors and extensor were commonly involved (Table VIII).

Table IX. Pattern of Fingers Muscles Involvement

Total number of cases—34

	M.R.C. 0	M.R.C. 1-4	M.R.C. 5(Normal)
	No.	No.	No.
Flexors	0	16	18
Extensors	0	24	10
Abductors	1	20	13
Adductors	1	16	17

No. of cases in paralytic group were very small & extensors were more frequently involved than the other groups.

Table X. Pattern of Thumb Muscles Involvement

Total number of cases—34

	M.R.C. 0	M.R.C. 1-4	M.R.C. 5(Normal)
Flexors	1	18	15
Extensors	5(14%)	27	2
Abductors	5(14%)	27	2
Adductors	1	23	10
Opponens	1	23	10
	13	118	39

Extensors and abductors were commonly involved.

DISCUSSION

The distribution pattern of muscle paralysis as observed can not be explained by the qualities of muscle such as size, function or position in the limb. The specific tendency of a muscle for paresis or paralysis is explained by the relative length of their spinal nuclei such as—Tibialis anterior muscle which has a short col-

umn and tensor fascia femoris and hamstrings have a long column. Further, if a focus of destruction by polio virus affects one particular level, the muscles innervated by the short motor cell columns are more often paralysed, than being paretic, because all the motor cells to that particular muscle are likely to be destroyed. The muscles innervated by long motor cell columns are affected more frequently owing to the long length of their nuclei but seldom get paralysed totally and remain only paretic.

Table XI. In order of more frequent involvement: Lower Limb

	Muscles	Root Value
HIP	: Internal Rotator	L4—S1
	Adductors	L2—S2
	Extensors	L5—S2
	Abductors	L4—S1
KNEE	: Extensors	L2—L4
ANKLE	: Dorsiflexors	L3—S1
	Invertors	L5—S1

Table XII. In Order of more frequent involvement: Upper limb

	Muscles	Root Value
Shoulders	: Abductors	C5—C6
Elbow	: Extensors	C7—C8
Wrist	: Only Partially affected	
Fingers & Thumb	: mostly thumb abductors and extensors affected	

Punatar and Patel (1977) in their study observed involvement of L_{2/3} spinal segment most frequently, while L₄ spinal segment was more often completely paralysed. Kumar and Kapahtia (1988) observed more often involvement of L₅ & S₁ segment and association of L₅ segment with paralysis of muscles while S₁ segment with paresis of muscles. For upper limb

involvement, Kumar and Kapahtia (1986) observed involvement of shoulder and elbow as most common.

In the present study it was observed that lumbar spinal segment for L₂ to S₁ and cervical spinal segment from C₅ to C₇ are the vulnerable

site for polio-virus affection. Thoracic spinal segment and upper cervical segment are not commonly involved.

It was also felt that the disease most often involved only a part of the spinal column since contralateral affection is uncommon.

REFERENCES

- Kumar K. and Kapahtia N. K.**, The pattern of muscle involvement in poliomyelitis of upper limb. *Int. Orthop. (SICOT)*, 10, 11-15, 1986.
- Kumar, K. and Kapahtia N. K.**, Pattern of muscle involvement in lower limbs in poliomyelitis. *Ind. J. Orthop.* 22, 138-143, 1988.
- Punatar B. and Patel D. A.**, Pattern of residual paralysis in poliomyelitis. *Ind. J. Orthop.* 11, 174, 1977.
- Sharrard W. J. B.**, Distribution of permanent paralysis of lower limbs in poliomyelitis—A clinical and pathological study. *J. Bone Joint Surg. (Br)* 37, 540, 1955.
- Sharrard W. J. B.**, *Paediatric Orthopaedics and fractures*, 2nd Edition. Blackwell Scientific Publications, Oxford, London, 1979.

A Follow up Study of Usefulness of Wheel Chair (Preliminary Report)

A. K. AGARWAL¹, V. P. SHARMA², O. P. SINGH³, R. KUMAR⁴, A. K. SINGHAL⁵ &
U. S. MISHRA⁶

Department of Physical Medicine & Rehabilitation, K. G.'s Medical College, Lucknow

101 cases who were provided with mobility aid like wheel Chair/Tricycle in the last three years have been studied in relation to its usefulness. The maximum cases were due to Spinal cord injury in the age group of 2nd, 3rd & 4th decade. The majority of cases were from low income group of rural background. The 22 cases out of total 31 cases, who have responded, were able to use wheel chair during toilet activities. More than half number of cases were using wheel chair between 4 to 6 hours a day. All the disabled have accepted the usefulness of wheel chair in their daily life. Nearly 30% of cases have reported some minor wear and tear in wheel chair which was repaired locally.

INTRODUCTION

Wheel chair mobility is an important aspect of the rehabilitation of spinal cord injured patients. Several factors affect mobility like material, design, physical dimensions of the wheel chair, level of fitness, strength and ability of user along with external factors such as texture, hardness and uniformity of road surface and the home situation of the patient.

In developing countries apart from above, socio-economical and cultural factors also contribute significantly in overall suitability and acceptability of the wheel chair. Our majority of spinal cord injured cases are from rural background with low socio-cultural status wherein neither home surroundings nor roads are suitable for the mobility of wheel chair.

In view of above, it has been envisaged to study the usefulness, suitability and acceptability

of the wheel chair in their activities of daily life.

METHOD & MATERIAL

All the cases to whom wheel chair was provided during last three years have been studied. A detailed questionnaire was prepared and sent to each case along with stamped envelope. Out of 101 cases, nearly 31 cases have responded by filling the questionnaire and returned to us. The present study is based on the analysis of these questionnaires.

OBSERVATION & DISCUSSION

In the present study 101 wheel chairs were provided to the cases who have attended Deptt. of Physical Medicine & Rehabilitation, K. G. Medical College, Lucknow in the last three

¹Senior Medical Officer cum Reader, Deptt. of Physical Medicine & Rehabilitation K. G.'s Medical College, Lucknow.

²Lecturer, Deptt. of Physical Medicine & Rehabilitation K. G.'s Medical College, Lucknow.

³Reader, Deptt. of Ortho. Surgery.

⁴Medical Officer, D. R. C. Sitapur.

⁵Chief Resident, D.P.M.R.

⁶Director Professor, Deptt. of Phy. Med. & Rehab.

years. These aids were provided under ADIP scheme of Ministry of Welfare, Govt. of India.

Table No. 1 shows incidence of age in relation to sex. Male out numbered the females. More than three fourth of cases were in 2nd, 3rd and 4th decade of life and then gradual decline was noted as the age advances.

Table I. Incidence of age & sex

Age (years)	Male	Female	Total
0-10	2	2	4
11-20	18	4	22
21-30	29	4	33
31-40	22	1	23
41-50	5	3	8
51-60	5	1	6
above 60	5	—	5
	85	15	101

Various causes of locomotor disability were analysed as shown in Table 2. Majority of the cases were due to spinal cord injury followed by amputations and poliomyelitis of both lower limbs. Out of 66 spinal cord injury cases, the maximum cases were in 3rd decade of life.

Among 101 cases, eight cases were given Tricycle (hand driven) and the rest were provided with wheelchair, manufactured by

ALMCO (Artificial Limbs Manufacturing Corporation of India) Kanpur. 80% cases were from rural areas and nearly all the cases were provided with free aid under ADIP scheme. Thirty-one disabled persons who were using wheelchair were followed up in our study. These wheelchairs were provided during the period of 1986 to 1989. There were 28 males and 3 females. The maximum number of cases were in age group of 11-30 years (Table No. 1) with a range between 10 years to 88 years. Six cases were illiterate and rest of them were at least junior high school.

Out of 31 persons in follow up only nine were unemployed before being disabled while after disability, twenty were without vocation despite using wheelchairs.

Out of 31 persons, 21 were from rural areas & rest were from urban background. As far as economic status is concerned, 19 persons were from low income group while 9 were from middle income group & rest were from high income group.

The causes of disability were analysed. The maximum cases (20) were of spinal cord injury cases, four were amputees and one was of myopathy.

Most of the wheelchairs provided were folding type and hand driven except one who was using autodriven Tricycle. Out of 31 cases,

Table II. Incidence of various locomotor disorders versus age

Age (years)	Total	Spinal cord inj.		Amputation		Bilat.	Poliomyelitis Myopathy		Hemiplegia	Misc.	
				BK	AK						
0-10	4	1	—	—	—	—	1	1	—	—	1
11-20	22	13	5	—	—	—	3	—	—	—	1
21-30	33	27	1	—	—	3	2	—	—	—	—
31-40	23	17	1	1	—	2	—	—	—	—	2
41-50	8	7	—	—	—	1	—	—	—	—	—
51-60	6	—	1	—	1	1	1	—	—	—	2
Above 60	5	1	—	—	—	1	1	—	—	2	—
Total	101	66	8	1	1	8	8	1	—	2	6

Table III. Age & sex

Age	Male	Female	Total
0-10	1	0	1
11-20	8	3	11
21-30	8	0	8
31-40	8	0	8
41-50	1	0	1
51-60	0	0	0
Above 60	2	0	2
Total	28	3	31

Table VI. Occupation

Occupation	Before Disability	After Disability
Student	2	3
Farming	7	2
Service	6	1
Self Employed	7	5
None	9	20
Total	31	31

Table V. Rural/Urban

	Male	Female	Total
Rural	20	1	21
Urban	8	2	10
Total	28	3	31

Table VI. Types of disability

	Male	Female
Paraplegia	17	3
Quadriplegia	3	0
Amputation	4	0
Myopathy	1	0
Misc.	3	0
Total	28	3

Table VII. Toilet facilities

	Male	Female
Outside Home	19	0
Inside Home	9	3
	28	3

Table VIII. How many hours a day use of wheel chairs

	Parap.	Quad.	Amp.	Myop.	Misc.	Polio	Total
Less than							
2 hours	7	1	0	0	1	3	12
4 hours	5	1	1	1	2	—	10
6 hours	7	0	2	0	0	—	9
Total	19	2	3	1	3	3	31

Table IX. Application of wheel chair in domestic works

Partial	13
Incomplete	6
Complete	12
	31

25 were self driven and six cases were using the wheel chair with the help of others. 18 persons were having toilet facilities outside house. Rest of the 13 cases were having toilet facilities inside the home including three female patients. 22 cases were able to use their wheel chairs for their toilet activities while rest were unable to reach to the toilet.

The utility of wheel chair in terms of number of hours in a day was also studied. 12 persons were using wheel chair for less than two hours a day, in whom nine were paraplegics. Ten patients were using wheel chair for less than four hours a day and the remaining cases (nine) were using for more than six hours a day. All the disabled persons accepted utility of wheel

chairs in daily life except one who kept aside the wheel chair without giving any reason.

Difficulty in use of wheel chairs was also studied. Three persons had pain in both upper limbs while using wheel chair. Some of the cases have reported wear and tear in the wheel chair as well. Front wheel was broken in five cases, while rim in two wheel chairs. The spokes and rexin seat was damaged in one case each but repaired locally with minimum expenditure.

The usefulness of wheel chair for education and vocational purposes was also studied. In

younger age group (eight cases) wheel chair was being used for purpose of education while in nine cases, for vocational purpose and in two cases for ADL.

The wheel chair was completely used for domestic purposes in 12 cases while partial usefulness was stated by 13 cases. 18 out of 31 cases were using cushion in the seat of wheel chair. Three had cotton cushion and 15 had of foam. In out of thirteen remaining cases, five developed pressure sores for which they have taken treatment locally.

REFERENCES

1. **J. Gordan, J. J. Kauzlevich & J. G. Thacker**, "Tests of two new polyurethane foam wheel chair Tubes". J. R. R. & D. Vol. 26, No. 1, 33-46 Winter 1989.
2. **G. M. Clark & R. A. Cooper**, "Racing wheel chair crown compensation". J. R. R. & D. Vol. 26, No. 1, 25-32, Winter 1989.
3. **R. A. Cooper**, "Racing wheel chair compensation". J. R. R. & D. Vol. 26, No. 1, 47-50, Winter 1989.
4. **C. E. Brabaker**, "Wheel chair prescription. An analysis of factors that effect mobility & performance". J. R. R. & D. Vol. 23, No. 4, 19-26, Oct., 1986.
5. **P. Engel & K. Seeliger**, "Technological & Physiological characteristics of a newly developed hand lever drive system for wheel chair. J. R. R. & D. Vol. 23, No. 4, 37-40, Oct. 1986.
6. **Carroll N. C.**, Wheel chairs & Mobility aids, In: Atlas of Orthotics (2nd ed.), Am. Acad. Ortho. Surgeons, Saint lious M. O. C. V. Mosby. Chap. 23, 413-439, 1985.
7. **Kamenetz, U.**, "Wheel chairs & other indoor vehicles for Disabled" In: Orthotics Etcetera (3rd Ed.) Williams & Wilkins, Batlimore, 464-517, 1986.

Polypropylene Ankle Foot Orthosis

RAJENDRA SINGH SOHAL*

In this study assessment of Polypropylene Ankle foot Orthoses: TIRR, Molded and Posterior Solid Ankle were made for various patients with below knee impairments. Criteria for their prescription are evaluated in reference to its utility and effectiveness in our circumstances.

It has long been felt that the conventional double bar below knee orthoses do not adequately meet the needs of individual patients. It is not only women but also men object to its conspicuous appearance. They are heavy weight. The metallic joints are noisy and liable to wear out. Use of lubricants soil clothes. The patient is not allowed interchangeability of the shoes and with gradual disappearance of leather sole shoes, considerable difficulty is experienced in providing suitable footwear for attaching the foot-pins in the conventional orthosis.

Biomechanical Considerations

The major drawback with the conventional metallic orthoses are biomechanical considerations. The work of Inman and Associates (1978) had radically modified our understanding for the foot and ankle mechanics. An orthosis must provide for individual tibial torsion and toe out. It must have adjustments for specific inclinations of the axis of ankle joint, subtalar joint and transverse tarsal joints and their movements. Likewise an orthosis should allow for transverse rotation of components of lower limb which are transmitted from talus to tibia and vice versa.

But, the conventional orthosis does not provide for congruence of anatomic and orthotic ankle joint. This incongruence causes undue foot discomfort and/or deformity. This lack of alignment also results from failure to accommodate

for individual tibial torsion and toeout in the brace. This bracing, is infact overbracing in some patients—as it does not allow subtalar movements and the orthosis prevents normal plantar flexion after heelstrike, even in case of just dorsiflexor weakness.

These were some of the factors which lead to development of newer designs of the Ankle Foot Orthoses or FAO. These newer designs were possible because of availability of thermoplastics like Polypropylene, Polyethylene, Ortholen etc. Plastics did not simply substitute for metal but a newer designs concept was developed (Lehneis). In fact Sarno and Lehneis (1971) Stated that there is no longer any indication for prescription of conventional FAO. All such requirements can be fulfilled by newer plastic orthoses.

MATERIAL AND METHODS

In this study, conducted at Rehabilitation Research Center, SMS Hospital, Jaipur, an attempt was made to prescribe twentyfive plastic AFO's in place of Conventional FAO. Patients with below knee impairments were evaluated, their history of illness, progress, patient's experience with previous brace (if any), his environmental demands, his shoe wearing habits—all were noted. Through Physical examination was carried out to record motor and sensory deficit, medio-lateral instability, spasti-

*25, South Model Gram, LUDHIANA-141002

city, fixed deformities of ankle foot complex, oedema and abnormal movements, patient's gait pattern with and without shoes and with previous brace, if any, were also noted. Then an attempt was made to classify patients on the basis of impairments and prescribe polypropylene AFO following Sarno (1979). Only three types of AFO's were designed and prescribed.

- (i) Molded AFO as described by Melvin Stilles and AB Wilson (1975);
- (ii) TIRR AFO as described by Engen (1972); and
- (iii) Polypropylene posterior solid ankle AFO designed by Sarno and Lehneis (1973).

After fitting and checkout, the patients were followed at two months interval. Following points were noted at check out and followup clinics:—

- I. Breakage in the shoe and orthosis.
- II. Capacity of device to control deformities and help in improvement in the gait pattern.
- III. Patient's view about orthosis—its advantages and disadvantages over previous brace, weight, cosmetic factor, comfort and strength or otherwise.
- IV. Pressure spots.
- V. Clinician's opinion regarding device.

The main weightage was given to improvement in the gait pattern and patient's acceptance, in Indian environment. All these orthoses were made at our center.

OBSERVATIONS

The main purpose of this study was to assess the feasibility, acceptability and effectiveness of polypropylene AFOs in our patients. The prescription criterias laid down by Sarno and Engen were also assessed for their utility in our setup. In this study, twenty-five AFOs were fitted on twenty-one patients. The major bulk of our cases had lower motor neuron paralysis. Twelve AFOs were fitted for residual poliomy-

elitis; two each for Sciatic nerve injury, Meningomyelocele and Peroneal Muscular Dystrophy and one each of Pantalar fusion, Lateral Popeteal nerve palsy, post head injury hemiplegia and residual paralysis after cervical spine injury. Rest of the three cases had cerebral palsy. Ten fittings were made for patients above 12 years., eleven for those between 3 years. and 12 years. while rest were under 3 years. TIRR AFO, Molded AFO and PSA AFOs were provided for eighteen, six and one case respectively. In two cases where molded AFO was used, three point pressure system was incorporated for the mediolateral instability.

Five cases developed pressure sores at/or around malleoli, two of these had sensory deficit. On the contrary, two cases with sensory deficit did not develop sores. This emphasises that pressure sores were not due to sensory deficit but due to irregular sharp margins or tight fitting at the ankle area of the orthoses.

One case who was using a toe raising spring previously, used to twist/invert his foot during fast walking or on uneven grounds. He was immensely satisfied with the TIRR AFO. Another case with spastic hemiplegia had proprioceptive sensory deficit and had to glue his eyes to floor while walking. A TIRR AFO with total contact at sole and calf and transmission of sensory impulses provided him with adequate proprioceptive feedback. A case which was provided with posterior solid ankle AFO to hold all movements at ankle and foot, was also provided with SACH wedge, steel shank and rocker bottom in his shoe to allow heel-toe gait pattern. This patient had better gait pattern but the device was little flexible and allowed some mobility. Two cases with calcaneus deformity were provided with Molded AFO, but results were not satisfactory. A case with severe spasticity was fitted TIRR AFO, which was not sufficient to control spasticity. Some affluent patients were extremely happy because of lack of conspicuousness and interchangeability of shoes allowed

with these orthoses. But many did not like to wear closed shoes or to wear shoes with his dhoti. These orthoses were more difficult to make as they were tailor made for patients; they were expensive and used to break within six months particularly in adolescents and adults.

DISCUSSION

In 1970, Committee on Prosthetic Research and Development of the USA identified eleven designs of newer AFOs. These included TIRR AFO, IRM (New York), Spiral and Hemispiral AFOs, VAPC shoes clasp AFO, UC BL dual axis AFO, NVU shoe insert AFO, and IRM Posterior solid ankle AFO. Teufel AFO was made from Ortholen in the West Germany. Thermoplastic used for the spiral and hemispiral AFOs is Plexidure. Lehmann (1979) has reviewed the basic biomechanical principles used in fitting a patient with ankle foot orthoses. Depending upon the amount of plantarflexion and dorsiflexion which is allowed by plantarflexion stop, knee instability is either minimal or maximal. If more is the dorsiflexion provided at the ankle, the better is the clearance during swing phase but the bending moment at the knee is also greater, which must be overcome by voluntary effort. The more is plantar flexion provided, toes drag more but less is knee bending movement at the knee. This principle can be used

for providing stability at the knee with the help of AFOs. Lehmann also stated that such bending movement can be reduced by heel wedge like in the SACH wedge. Further according to him, effectiveness of the plastic AFO can be determined by manually twisting into dorsiflexion, plantarflexion or mediolaterally. Orthotic's influence on the knee can also be estimated.

The rigidity/flexibility of the TIRR AFO can be selectively adjusted by material left at the cross sectional area, (Engen, 1972).

Our experience with these orthoses make us to believe that these have to be used very selectively. The polypropylene posterior solid ankle AFO is indicated in patients with severe spasticity, moderate to severe mediolateral instability, severe sensory and proprioceptive loss, flail ankle foot complex and in patients with pain in the ankle joint due to arthritis. The TIRR and Molded AFO, both can be prescribed for the patients with Sarno's Type I and Type II impairments. In more than milder degree of mediolateral instability, a molded AFO can be used along with incorporation of the three point pressure system. TIRR AFO is also preferred by patients because of skin ventilation.

In spite of higher cost, higher breakage rate and technically greater difficulty to tailor made such orthoses, patient acceptance rate has been higher.

Acknowledgements

I am obliged to Prof. P. K. Sethi and Dr. S. C. Kasliwal, former and present Directors of the R.R.C., S.M.S. Hospital, Jaipur. I also appreciate help rendered by Mr. A. M. Peethambaran, Orthotist, now at King Fahd Hospital, Gizan, Saudi Arabia. Thanks also to Mr. Sharad Ranga, presently Asstt. Bio-engineer, Rajindra Hospital, Patiala.

REFERENCES

1. **Engen, T. J.**, Instruction Manual for Fabrication and fitting of a Below Knee Corrugated Polypropylene Orthosis, Pub. by Texas Institute for Rehabilitation and Research, Houston, Texas, USA.
2. **Engen, T. J.**, The TIRR Polypropylene Orthosis. *Ortho. Prosth* 26(4) : 1-15, Dec. 1972.

3. **Inman, V. T. and Mann, R. T.**, Biomechanics of the foot and ankle In: 'Duvries' surgery of the foot. Ed. R. A. Mann, Pub. The C. V. Mosby Co. 1978.
4. **Lehmann, J. F.**, Biomechanics of AFO : Prescription and Design, Arch. Phys. Med. Rehabil. 60(5) ; 200-207, May, 1979.
5. **Sarno, J. E.**, Below knee orthosis, A system for prescription. Arch. Phys. Med. Rehabil., 54(12) ; 548-552; Dec. 1972.
6. **Sarno, J. E. and Lehneis, H. R.**, Prescription considerations for plastic BKO, Arch. Phys. Med. Rehabil., 52 (II), 503-510, Nov. 1971.
7. **Stilles, M.**, Lower Limb Orthotics, Ortho. Prosth. 29(4) 41-51, Dec. 1975.

Simple Suspension System of Thomas' Splint on Bamboo Balkan Beam

NAVENDRA MATHUR¹, K. K. R. SHARMA², A. S. SAHAI³
Department of Orthopaedics, E.S.I. Hospital, Jaipur

A simple reusable suspension system of Thomas' Splint with bamboo Balkan beam used in the treatment of 25 cases of fracture shaft of Femur is described for its low cost, easy assembly, better mobility and care of the patient in the bed.

INTRODUCTION

Thomas' splint and Balkan beam are most commonly used in the orthopaedic practice. Reports on suspension system of Thomas' splint on sophisticated Balkan beam using springs (Denman, 1962) and elastic cords (Macpherson and McGregor, 1981) are available in the literature. Those are costly and not frequently available at small centres.

We present simple suspension system of Thomas' splint over a bamboo Balkan beam in the bed with the help of which, not only the patient is able to move in the bed, but is also helpful in daily nursing care.

MATERIAL & METHOD

Twenty-five cases of fracture shaft of Femur treated conservatively on Thomas' splint during 1983 to 1986, in E.S.I. Hospital, Jaipur, are included in this series. The age ranged between 16 to 60 years. All patients were applied fixed traction on Thomas' splint after reduction of fracture. A bamboo Balkan beam was constructed by 10 bamboos tied together. The Thomas' splint was then suspended by two discarded bicycle tubes (Fig. 1). The tubes are kept in



Fig. 1. Patient with Thomas' Splint suspended by discarded bi-cycle tubes in bamboo Balkans' beam.

such a tension so that the limb is suspended 15 cm. to 25 cm. above the surface of the bed. The patient can lift and move the body in both the axis on the bed (Fig. 2). This not only helps in the mobility and nursing care of the patient but helps in performing increasing resistance exercises of the hip muscles along with routine static Quadriceps exercises.

¹Civil Assistant Surgeon, M.S. (Ortho.), D.N.B. (P.M.R.)

²Senior Specialist, M.S. (Ortho.)

³Civil Assistant Surgeon, M.S. (Ortho.)

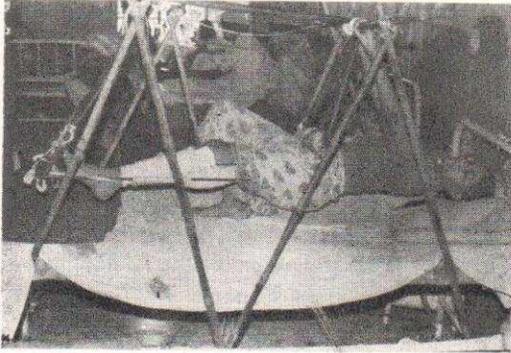


Fig. 2. Patient can lift herself from the bed and can move in both axis.

Thus movements at the hip is also an added advantage. The complaint of the patient which

we have encountered was pressure caused by the Thomas' splint ring over postero-medial aspect of the thigh. However the pressure is tolerable and without discomfort.

DISCUSSION

A simple method of suspending Thomas' splint on bamboo Balkan beam is presented. The material used to assemble the Balkan beam and suspending the Thomas' splint is easily available and cheap. This provides comfort and mobility to the patient in the bed and facilitates nursing care. This method is applicable easily at all places.

REFERENCES

1. **Denman, E. E.**, Spring Suspension for Thomas' Splint, *British Medical Journal*, 2, 47, 1962.
2. **Macpherson, I. S. and Mc Gregor, D. H.**, An Elastic Suspension System of Thomas' Splint, *Injury*, 12, 429-430, 1981.

Rehabilitation Management of Mentally Retarded amongst Physically Disabled

Methods of Monitoring Progress

RAJENDRA SHARMA¹, R. K. SRIVASTAVA², ANIL GAUR³

Mental Retardation amongst physically disabled persons, although incurable, is most of the time manageable problem. These children require Special education or training. Outcome of any rehabilitation intervention programme for such children can only be assessed by gain in functional status. The goal of rehabilitation in mild mental retardation is social adjustment with ultimate aim being functional independence. Similarly in moderate, severe and profound retardation aim is to achieve some degree of functional independence, atleast in self-care skills. The progress of rehabilitation intervention can be monitored by using various self care and functional assessment scales. A review of various prevalent methods is presented here.

The effectiveness of any programme of medical intervention is determined by its therapeutic outcome, similarly effectiveness of Medical Rehabilitation is improvement in functional status of the patient. Therefore the progress of patient undergoing medical rehabilitation programme can be monitored by repeated assessment of his functional status. There can be two types of methods which can be used for monitoring progress.

- (1) *Subjective*—Spontaneous observation, no predetermined behaviour or activity performance is recorded. It gives gross idea of improvement.
- (2) *Objective*—Structured, predetermined behaviour, or activity performance is recorded and scoring can be done numerically. Repeated performance can clearly indicate improvement.

Objective Methods—(a) Psychological Assessment
(b) Functional Assessment

(1) Subjective Method

In this method progress can be evaluated by repeated clinical observation at regular intervals. This method will include parental interview, regarding improvement in ADL performance, psychologist's opinion from time to time and feed back on activity performance from OT/PT.

Such method has its limitation in the form of proper recording, and inferences may vary if interviewer is not the same person.

(2) Objective Method

(a) *Psychological Assessment* at regular intervals, specially periodic assessment of adaptive behaviour. The most commonly used scale is Vineland Social Maturity Scale (1). This scale has been adapted for Indian population. In this scale information is elicited by means of semi structured interview with the child/parents guardian. It measures child's adaptive behaviour in following eight areas :

¹Assistant Director, Department of Rehabilitation, Safdarjang Hospital, New Delhi.

²Consultant & Head, Department of Rehabilitation, Safdarjang Hospital, New Delhi.

³P. G. (DPMR), Department of Rehabilitation, Safdarjang Hospital, New Delhi.

1. Self help general
2. Self help eating
3. Self direction
4. Self help dressing
5. Socialization
6. Occupation
7. Communication
8. Locomotion

(b) *Functional Assessment*—Functional Assessment (2), (3), (4) is a method for describing abilities and limitations in order to measure an individual's use of the variety of skills included in performing tasks necessary for daily living, leisure activities, vocational pursuits, social interactions and required behaviours. For a comprehensive functional assessment, selected diagnostic descriptors, performance (skill/task) descriptors, and social role descriptors are used to assemble the information desired.

Purposes and uses of Functional Assessment—Problems and areas of need can be identified more accurately and interventions can be developed that are more appropriate for enhancing personal independence and autonomy in fulfilling social roles.

1. Systematically developing a patient problem list that includes limitation in functioning.
2. Determining clinical care changes in patients by comparing functions before and after treatment.
3. Determining the benefits of clinical care in analysing cost benefits and cost effectiveness.
4. Manpower studies as to number and type to levels of severity of disabilities.
5. Prioritization of needs should it become necessary to ration scarce resources.
6. Programme evaluation & quality assurance.
7. Establishing comparability of groups of patients for research studies and for policy planning.

8. Facilitating case management—individualize programme.
9. Documented progress can enhance patients motivation and progress if improvement is feed back to patient.
10. It is possible to compare changes in status over periods of time by assessing functions at appropriate intervals to determine whether rehabilitation programme has been effective.

Desirable Features of a Functional Assessment System—A functional assessment system should meet certain objectives as summarised by Donaldson (5) :—

1. Objective description of functional status at a given point time.
2. Serial repetition allowing detection of changed functional status.
3. Data collected through observation relevant to and useful in monitoring treatment programme.
4. Enhancement of communication among treatment team members and between referral agencies.
5. Comparable clinical observation compatible with research questions.

Ideal System—An ideal functional assessment system should be—

- Simple
- Concrete, permitting consistent & reliable observations
- Comprehensive
- Uniformity of scaling
- Allow convenient manipulation
- Easy analysis

Development of Functional Assessment Instruments—Over the past 30 years many different scales have been developed on these activities performed independently or through assistance. These are used to measure functional independence. According to Donaldson (5) 25 scales met two of three criterias (1) had mechanism of scoring (2) had been used in a survey or research

(3) were applicable to a general rehabilitation population.

Few of these scales are presented here and can be used for assessing the progress of rehabilitation management of mentally retarded amongst physically disabled.

Various Functional Assessment Systems

(1) *Self care Scale (Kenny)* (6), (7) : Since ability to handle functional needs is usually the goal of a physical restoration programme and hence reflects the physical capabilities of the patient as well as his motivation drive and learning ability, it is felt that the numerical selfcare system is a basic tool for measuring improvement, individual patient's progress, as well as progress of an entire disability group which can be depicted numerically.

One such system was developed by grouping the specific self-care activities into larger; more general categories related through a similarity in strength, co-ordination and mobility requirements in six major self-care activities. Bed, transfer, locomotion, dressing, personal hygiene and feeding activities.

These categories are divided into five levels of improvement :

- 0—completely dependent
- 1—require extensive assistance
- 2—moderate assistance
- 3—minimal assistance/supervision
- 4—independent
- Total score of 0—Totally dependent
- Total score of 24—Totally independent

(2) *Pulses Profile* (8)—Developed by Moskowitz and McCann in 1957. The pulses profile is a scale consisting of 6 components, reflecting independence in life functioning the acronym derives from :

- P—Physical condition: basic health/illness status.
- U—Upper limb functions: Self care activities

(drinking, eating, dressing, upper/lower body, donning brace or prosthesis, washing/bathing, perineal care).

L—Lower limb functions : mobility (transferring chair/toilet tub or shower, walking, climbing stairs, propelling wheel chair).

S—Sensory components : sight, communication (verbal/hearing).

E—Excretory functions : control of sphincters (bladder/bowel).

S—Support factors : Psychological/emotional, family/social/financial supports.

Scoring for each component ranges from 1, intact and independent of help from another person to 4, fully dependent, for each function of component area. The subscores for each area are then summed to give an overall measure of functional independence.

Pulse Total—Best score is 6, worst score is 24

—More than 6 & less than 12 :

Mild Disability

—More than 12 & less than 16 :

Moderate Disability

—More than 16 :

Severe Disability

(3) *Barthel Index* (8), (9)—Described in 1965 by Mahoney and Barthel for measuring functional levels of self care and mobility in the physically impaired. These measures of life function have definite implications for assessing and describing medical rehabilitation outcomes and consequently for improving effectiveness of rehabilitation, evaluation and Management.

Barthel Index includes 15 self care, sphincter control and mobility factors; all of which are also included in the pulses profile, Barthel Index however, does not include recognition of physical condition, sensory components, or support factors, areas covered in pulses.

	Independent		Dependent		
	I Intact	II Limited	III Helper	IV Null	
					<i>Self Care Index</i>
1.	10	5	1	1	Drink from cup/feed from dish
2.	5	5	3	0	Dress upper body
3.	5	5	2	0	Dress lower body
4.	0	0	-2	0	Don brace or prosthesis
5.	5	5	0	0	Grooming
6.	4	4	0	0	Wash or bathe
7.	10	10	5	0	Bladder continence
8.	10	10	5	0	Bowel continence
9.	4	4	2	0	Care of perineum/clothing at toilet
					<i>Mobility Index</i>
10.	15	15	7	0	Transfer, chair
11.	6	5	3	0	Transfer, toilet
12.	1	1	0	0	Transfer, tub or shower
13.	15	15	10	0	Walk on level 50 yards or more
14.	10	10	5	0	Up and down stairs from 1 flight or more
15.	15	5	0	0	Wheel chair/50 yards only if not walking

Modified Barthel Index Scoring (8), (9)

The following presents the items or tasks scored in the Barthel index with the corresponding values for independent performance of the tasks :

Scoring—The 15 factors scored in this index are subdivided for scoring as independent (I—Intact, II—limited) and dependent (III—helper, IV—Null).

Total Barthel Score when summed ranges from Zero (Total dependence) to 100 (complete independence)

—A Score of 60 :

Mild to moderate degree dependence.

—A score of less 60 :

Moderate degree dependence.

—A score 40 or less :

Very severe dependence.

—A score of 20 or less :

Almost total dependence in self care and mobility.

(4) *Functional Life Scale*—Developed by Sarno et al. in 1973 (10), recognizes that knowing the actual performance of skills is better measure of degree of disability than knowing the elements that constitute performance. Scale is composed of 44 items designed for application outside of the hospital setting based on interview. It determines functions in 5 areas i.e.

1. Cognition
2. Activities of daily living
3. Home activities
4. Outside activities
5. Social interaction

Normal behaviour is used as the standard for comparison. Items assessed were judged for self initiation, frequency, speed, and overall efficiency and were numerically rated along a continuum from 0-4, yielding a series of sub-scores.

(5) *Long Range Evaluation System (LRES)*—Developed by Grangers and others in 1976 (11). LRES is a functional assessment system designed, tested and used in clinical settings, including medical rehabilitation for in-patients, and out-patients, patients in day-care and home care programmes and residents of long term care facilities. It is a measurement tool for describing areas of service need, severity of handicap, and change in individual over a period of time.

This system provides with a check list with four options and assess in the following area:

1. Active motion of limbs
2. Verbal communication
3. Hearing ability
4. Visual ability
5. Self care ability
6. Mobility
7. Need for physician or nursing services
8. Intellectual and emotional adaptability
9. Adequacy of home setting
10. The level of social interaction or dependence upon home service agency
11. Level of support from the family unit
12. The financial resources
13. Educational level
14. Vocational status

The data collection forms are descriptive checklists prepared for computer entry with

allowance for free text descriptions. Scores are generated as in pulses profile and Barthel Index and are used to represent physical dependence with regard to personal care.

(6) *Escrow Scale (11)*—is intended for persons who are not living in institutions. Rating is from 1 to 4. This scale measures social support. It is a newer scale. It is postulated that the physically disabled persons with a marginal level of independence in personal care are more likely to have potential for independent living if social supports are high as represented by Escrow Scale :

- E—Environment
- S—Social Interaction
- C—Cluster of family members
- R—Resources
- O—Outlook
- W—Work/School/Retirement status

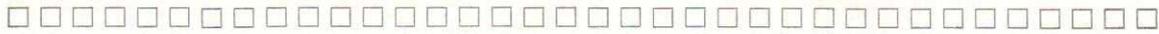
Conclusion

In view of the emphasis on evaluation of benefits derived from rehabilitation programmes, it is important that there be easily replicated measures for demonstrating effectiveness and efficiency of services provided, it is hoped that scales given above and extensively used in west can be used with some modification in our country also for measuring severity of disability and in monitoring rehabilitation progress over a period of time.

REFERENCES

1. **Vineland Social Maturity Scale**, Edgar A. Doll Ph.D. American Guidance Service, Inc.
2. **Muzzlo T. C. and Burriss C. T.**, Functional Limitations—A state of Art Review, 1979, Indices Inc. 5827 Columbia Pike, Folls Church, VA 22041.
3. **Breckenridge K.**, Medical Rehab., programme evaluation, Arch of PM & R—59 : 419-423, 1978.
4. **Granger C.V. and Greer D.S.**, Functional Status measurement and medical rehabilitation outcome. Arch of PM & R 57 : 103-109, 1976.
5. **Donaldson S.W., Wagner C.C., Gresham G. E.**, Unified ADL evaluation form. Arch Phys. Med. & Rehab. 54 : 175-179, 1973.
6. **Herbert A., Schoening M.D., Lenore Andergg R.N., MNA, et al.**, Numerical scoring of self care status of patients, Arch. of Phy. Med. & Rehab., 689-691, Oct. 1965.

- 7. **Schoening H.A. and Iverson I.A.**, Numerical scoring of self care status : A study of Kenny self care evaluation. Arch of PM & R—49 : 221-229, 1968.
- 8. **Outcome of comprehensive medical rehabilitation**, Measurement by pulses profile & Barthel Index Card V. Granger M.D., Gary Albrecht Ph.D., Byron B. Hamilton M.D., Arch Physical Med. & Rehab. Vol. 60, April, 1979, 145-154.
- 9. **Mahoney FL, Barthel DW.**, Functional evaluation—The Barthel Index, Md. State Med. J. 14, 61-65, 1965.
- 10. **Sarno J.E., Sarno M.T., and Levitz E.**, The functional life Scale. Arch of PM & R—54 : 214-220, 1973.
- 11. **Health Accounting**, Functional assessment of long term patients. Krusens Hand book of Physical Medicine & Rehabilitation, 1984.

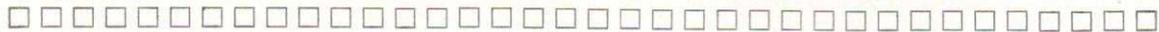


ARFLUR 100

- **RELIEVES** Night Pain
- **IMPROVES** Quality of Sleep
- **RELIEVES** Morning Stiffness

FDC Limited

66-LAKSHMI BUILDING, SIR P.M. ROAD, BOMBAY-400 001



**OFFICE BEARERS OF INDIAN ASSOCIATION OF PHYSICAL
MEDICINE & REHABILITATION
(1990-91)**

President

Dr. K. K. Singh, Patna

President Elect

Dr. K. Janardhanam, Madras

Vice President

Dr. M. H. R. Rizvi, Patna

Secretary

Dr. R. K. Srivastava, New Delhi

Jt. Secretary

Dr. S. Hariharan, Trivandrum

Treasurer

Dr. S. Wadhwa, New Delhi

Members of Executive Committee

Dr. B. D. Athani, Bombay

Dr. S. K. Jain, Pune

Dr. B. Rama Subramaniam, Salem

Dr. C. R. Gupta, Darjeeling

Dr. R. M. Nanda, Cuttack

Dr. M. K. Mathur, Jaipur

INDIAN JOURNAL OF PHYSICAL MEDICINE & REHABILITATION

(An Official Publication of Indian Association of Physical Medicine & Rehabilitation)

Editor

Dr. A. K. Agarwal, Lucknow

Jt. Editor

Dr. R. K. Srivastava, New Delhi

Dr. Shishir Rastogi, New Delhi

Editorial Secretary

Dr. V. P. Sharma, Lucknow

Editorial Advisory Board

Dr. S. K. Varma, New Delhi

Dr. B. P. Yadav, New Delhi

Dr. (Miss) S. Varma, Trivandrum

Dr. K. K. Singh, Patna

Dr. M. K. Goel, Lucknow

Dr. P. K. Sethi, Jaipur

Dr. U. K. Jain, Lucknow

Dr. R. Chandra, Lucknow

Dr. I. S. Shanmugam, Madras

Dr. U. S. Mishra, Lucknow

(Dr.) General A. S. Chahal, New Delhi

Dr. W. G. Rama Rao, Bombay

Dr. S. C. Kasliwal, Jaipur

Dr. G. Ramdas, Cuttack

Dr. S. K. Banerjee, Calcutta

Dr. N. Sircar, Calcutta

Dr. K. Janardhanam, Madras

Dr. A. K. Mukherje, New Delhi

Dr. S. Hariharan, Trivandrum

Dr. S. Rastogi, Kanpur

Dr. O. P. Singh, Lucknow

Dr. B. A. Buth, Srinagar

Overseas

Prof. John Hughes, U. K.

Ann Darnbrough, U. K.

Dr. Yasuhiro Hatsuyama, Japan

Address for Correspondence

Dr. A. K. Agarwal, Editor, I. J. P. M. R.

2, Quinton Road, Lal Bagh, Lucknow-226001, INDIA