AMBULATION OF POST TRAUMATIC PARAPLEGIC PATIENTS WITH A SIMPLE METHOD OF GAIT TRAINING

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ABSTRACT:

Progress made in the field of rescue services, anaesthesia, intensive care,spine surgery, neurourology and diagnostics (CT , MRI) as well as in pharmacology, have decisively enhanced the possibilities of clinical rehabilitation of paraplegics resulting from Spinal Cord Injuries (SCI).At the Department of Orthopaedic Surgery and Workshop of Orthopaedic Technology, King Edward Medical College and Mayo Hospital, Lahore a comparehensive treatment and rehabilititation system for post-traumatic paraplegics was evolved by the authors in 1989. The focus of the treatment concept had been to save the life of the person, stabilize the spine if unstable and provide gait training. For spondylodesis a cheap 4.74 mm Rush rod with sublaminar wires was used . To provide gait training a L-shaped wooden board was designed and manufactured locally. Patient was fastened to the board with the help of harnesses. The training programme consisted of stages of training with L-board in parallel bars, followed by bilateral Knee Ankle Foot - Orthosis (KAFO) and parallel bars followed by training with walking frame and axillary crutches. A total of 30 patients with post traumatic paraplegia were managed according to this protocal. The mean duration of gait training was 9 weeks after which 28 out of 30 patients (93.3 percent) have aquired the ability to walk with KAFO and walking frame.This study reports a very simple and low cost technique which have been used in rehabilitation of paraplegic patients.

INTRODUCTION

The history of SCI in World War I had been depressing, with an early mortality of over 50 percent and a three - years death rate of 80 percent, while those who had not been lucky enough to die were left as institutional wrecks (Davidle Vay, 1990). In Second World War the policy in England was to segregate these patients in special hospitals, of which Stock Mandeville was the earliest and largest .

In primary care, careful and rapid evacuation, maintanance of nutritional status, bladder evacuation/drainage, transfusion, back care and treatment of chest problems reduced the mortality rates. The over all death rate in U.K dropped to 7 percent (Davidle Vay, 1990), in Canada to 7.8 percent (Botterall et al, 1948) and in United States of America to 4 percent (Prather, 1948).

Open reductions of unstable and displaced SCI , advocated by Albee (1940) and Taylor (1941) in early stages of Second World War found no acceptance. Ludwing Guttmann, a refugee from Nazi Germany who was director of Stock Mendiville

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Hospital in England stressed conservative approach. Culler (1945) reported that Laminectomy was useless in complete lesions and of dubious value for incomplete ones. Muscle spasms were best treated by correct position and passive movements of the muscles. Useful procedures included obturator neurectomy and achillis tendon elongation, tenotomy of tibialis posterior and flexors of big toe. To relieve pain and spasm intrathecal injection of alcohal was advocated by Guttmann (1947) and Sheldon and Borg (1948). The best treatment for pain was early mobilization and rehabilitation.

For the bladder, no intervention was advised for the first 24 hours, after which mannual expression or possibly suprapubic aspiration were used. After 24 - 48 hours a sterile catheter was inserted at first

ercent. The three main groups at risk are Tetraplegia, Paraplegia and Total Hip Replacement Surgery.

Long standing paraplegia is characterized by a high percentage of secondary structural changes in the lower urinary tract, especially at the blader outlet and lead to increase in the resistance to out flow of urine. Madersbacher and Ober Walder (1987) therefore advocated that passive voiding by abdominal training may cause unphysiologically high intra vesical and intra-abdominal pressure and should be replaced by intermittent Catheterization.

The most commonest complications of SCI patient were respiratory (43 percent) including 20 percent who had pneumonia (Wilmot and Hall, 1986). In 60 percent of SCI patients associated with injuries of varying importance are found and 20 percent of patients suffer from a traumatic shock

Denmark the SCI were largely sustained during 15- 24 years of age , and new admission to the hospital with SCI was 9.2 per million per year, 47 percent traumatic SCI were due to traffic accidents, 23 percent to falls, 8 percent to attempted suiside and 6 percent to shallow water diving (Biering, S; 1990). In Nigeria the commonest cause of SCI is a fall from Palm Tree (Okonkwo, 1988). The analysis of the various causes of the SCI in Napales, USA, showed that the occupational activities take the first place (32.2 percent); injuries in recreational activities and road accidents accounted for the majority of the remaining cases. (Palma et al., 1992)

The overall death rate at German Orthopaedic Hospitals as reported by Katthagen and Schwarz (1984) was 0.6[illegible] intermittently, later indwelling, and then intermittently again as automaticity developed. Suprapubic cystostomy as proposed by Ward (1944) and Riches (1944) was denied by Guttmann because this always lead to ascending urinary tract infection.

Bed Sores were prevented by frequent turning of patient in the bed, care of bed surfaces and maintenance of protein nutrition. Physiotherapy, muscle exercises and sports were encouraged .

It was estimated by Francis,D, (1984) that of the 18,000 Spinal injuries occurring annually in United States, approximately 4,700 result in paraplegia. 80 percent of spinal cord injury victims are males younger than 40 years of age.

The mean age of the SCI patients at the time of injury had been 37.1 years (range 7 to 74 years), (Palma et al, 1992). In

which is frequently mistaken for a spinal shock (Meinecke, 1984). Reines and Haris (1987) reviewed 123 SCI patients 23 (19 percent) had paraplegia , 44 (37.5 percent) had pulmonary complications, mainly Atelectasis and Pneumonia.

Schubert and Fagrell (1991) studied the response of skin blood cell flux (SBF) to locally applied pressure by laser dopler fluxmetry over the sacrum and gluteus maximus muscle and reported that in paraplegics without sensations over the sacrum a prolonged time to peak SBF was found

Pietschmann et al (1992) measured the circulating levels of osteocalcinin in serum and found that osteoporosis in paraplegia is linked to an enhanced osteoblastic acivity.

The core temperature in patients with SCI, is highest in tetraplegics than paraplegics (39.5 degrees C and 38.1 degrees C). Antipyretic analgesics are ineffective, in reducing the high core temperature in these patients (Essiet and Onuba; 1992).

Sexual dysfunction is a serious issue in paraplegic men. Slot,et al (1989) carried out a study to estimate the magnitude of the problem. They found out that 95 percent of the patients could obtain an erection ; 61 percent on a purely reflex basis ; 66 percent experienced erection sufficient for coitus and 45 percent could obtainejaculation / emission.Significantly, more of the patients aged below 30 years reported erection sufficient for coitus (p less than 0.05). 45 percent of the patients experienced complications of the sex activity , mainly in the form of bladder dysfunction and pain or spasm ,and these patients need relevent information and sex counselling.

Hjeltnes, N (1986) evaluated Oxygen Supporting System. He found that peak oxygen uptake (VO2) was as low as 0.74 l/min in males with complete tetraplegia and 1.9 l/min in patients with conus and cauda lesions. This study also showed that patients with incomplete lesions has high VO2 value and that peak VO2 in females with thoracic paraplegia was on the average lower than in male with corresponding injury levels (16 ml/kg/min against 22 ml/kg/min, respectively). This study pointed out that such investigation must be carried for design of rehabilitation programme as a routine.

Syringomyelia, namely autonomic dysfunction, has been reported in 8 percent (n=463) of patients with post traumatic paraplegia (Rossier et al, 1985). These patients develop a slow proximal migration of their sensory level several months or year after trauma and often complain of intractable pain. Radiological diagnosis is best made by metrizamide myelography with standard films followed by immediate postmetrizamide computerized tomography (CT). This must be repeated about 2 or 4 hours later to demonstrate the metrizamide in the pos-raumatic syrinx (Francis Denis, 1984). If sufficient motor function is at risk the syrinx should be decompressed.

Rehabilitation as carried out by Guttman during 1940 - 1945 was based upon following Principles:

1. To bring the patient into the best possible physical condition by the elimination of sepsis from bed sores and urinary tract.

maintain the equilibrium of the body external supports (parallel bars, walkers, or canadian crutches) were used,

MATERIAL AND METHODS

Thirty patients of spinal cord injury with paraplegia were included in this study. The patients with recent history of paraplegia were admitted to the Department of Orthopaedic Surgery,Mayo Hospital and private rooms of Albert Victor Hospital, vertebrae above and two vertebrae below the exact level of injury. For bone grafting the bone was obtained from posterior iliac crest.

Gait training of the paraplegics if the SCI is of recent onset was started immediatly after surgical stabilization of the spine. If the injury was not of recent onset the patient was admitted for gait training. In case other problems like foot deformities , pressure sores, associated fractures are present then these are treated before the gait training is started.

Gait training to all paraplegic patients in this study was provided at the workshop for orthopaedic technology. This workshop for orthopaedic technology aims at improving orthotic and prosthetic service in Mayo Hospital. The Gait training was provided to all patients in present study by fastening the patients in wooden L-Board .

Wooden L - Board

This board was designed and manufactured by the first author (Syed M. Awais) to provide support to the patient in standing position to overcome the imbalances of autonomic nervous system and treat postural hypotension. The L-board due to its inherent stability against topling also provided feeling to the patient that inspite of paralysis of legs, standing is not impossible. The L-Board has a foot rest and back support , and three straps one for the chest and two for each knee. (Fig 1 and 2).

Lahore. All unstable SCI with paraplegia were operated upon to stabalize the fracture/dislocation.

The stabalization of the spine was performed by technique popularized by Luque and Hartshell. This was the idea of one of the authors (Prof Naseer M. Akhtar) that a simple Rush rod available in the market can be bent into U and used with sublaminar wires for fixation to two

Materials other than L-board required to provide gait training to the paraplegic patients in present study were as under;

1. Parallel Bar Walk Way
2. Ramps
3. Stairs
4. Walking Frame
5. Crutches
6. Plaster of Paris back slabs and cylinder for legs.
7. KAFO (Knee Ankle Foot Orthosis)
8. Axillary Crutches.

Methods of Gait Training

The paraplegics were informed that if they want they can once again stand straight and walk with the support of a walking frame and orthosis . It was emphasized very clearly that the role of the rehabilitation team in very little and will comprise of suggestions and guidence regarding what to do. Most of the job patients have to do themselves. It was also

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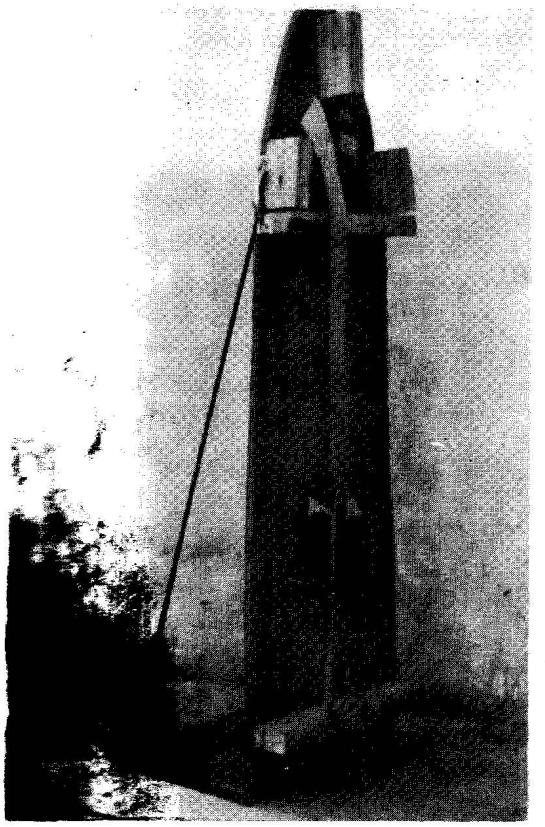

Fig 2 Wooden L-Board, back oblique view

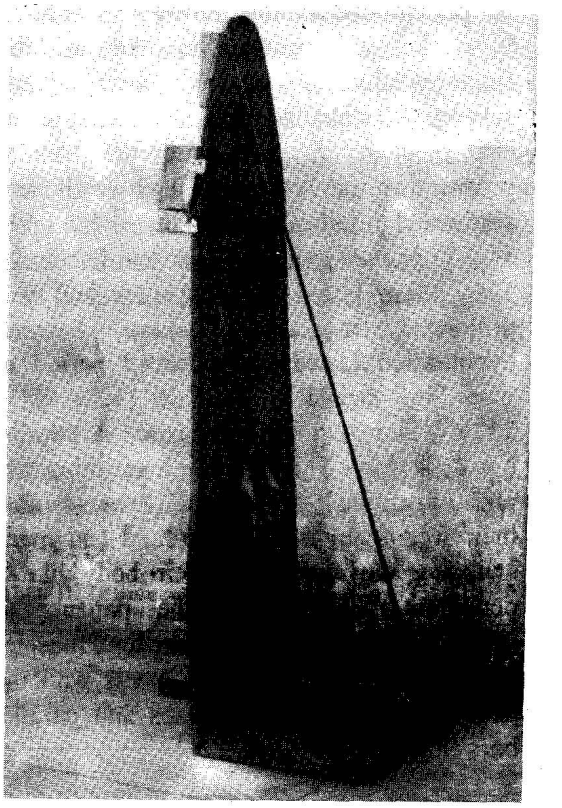

Fig 1 Wooden L-Board front oblique view

Fig 4 Patient fastened in L-Board from behind

Fig.3 Patient fastened in L-Board from front.

made clear that with full cooperation from the patients the training period will be about 9 weeks. Patients who had unstable fracture/dislocation of spine were advised surgery to stabalize the unstable spine to enable them to enter into the training programme for gait training which was performed in following steps:

1. Standing in the wooden L-board . This phase lasted for one week and was prolonged in cases where postural hypotension lasted for extended period of time (Fig 3 and 4).

2. Swinging with L-board in parallel bar walk way. This was the most important phase in training programme. Patients lifted their weight up from the ground and made swinging movements of their body like a pendulum. This helped the patients to improve strength of their upper limb muscles and control their body movements with the help of their own upper limbs and parallel bars (Fig 5)

Fig.5 Gait Training of Paraplegic Patient Fastened to the L-Board Swinging in the Parallel bar.

At the end of this phase patients are encouraged to perform turning. (Fig 6)

Fig.6 Gait Training of Paraplegic Patient Fastened to the L-Board , turning in the Parallel bar

This phase in most of the cases was complete in about 2 weeks period (majority of paraplegics in our gait training programme were young males). This period was extended in few cases where patients took more time to get confidence and become familier to the exercises they are supposed to perform . Drawings of this phase are given in Fig 7, 8and 9.

3. Swinging and moving forward with plaster of paris (POP) cylinders or slabs on the legs. The L-board at this stage in discontinued, the measurements for manufacturing knee ankle foot orthosis (KAFO) are taken and POP cylinders or slabs applied. Patients feel unstable at hips

but feel relief from the weight of the L-board (Fig 10).

4 Swinging and moving forward by tilting manoevers of the pelvis with the KAFOs applied to the legs in parallel bars walk way. During this phase patients are fitted with KAFOs and move forward with two manoevers, by swining and by tilting of the pelvis,

5 Moving with the help of walking frame outside the parallel bars walk way. During this phase patients are provided walking frame and are told to move out of the parallel bars and keep moving forward. (Fig 11).

During this phase they are encouraged to start standing even without the support of the walking frame. This is most exciting phase and paraplegic patients feel more strong and able (Fig 12).

6 Moving up and down the ramp and stairs. This is the next phase of training and carries new challenges for the paraplegics (Fig 13 - 14)

7 Standing without walkers. This stage was successfully reached by only few of the paraplegics, however when achieved showed the physical ability and ability to learn tricks of equilibrium by the paraplegics (Fig 15)

RESULTS

This study comprises of 30 paraplegic patients of both sexes. The surgery when required was carried out in the department of orthopaedic surgery, Mayo Hospital, Lahore. Out lines of the important data which could be retrieved are summarized in Table I

Before performing gait training anterior decompression of spine was performed in 3 patients and spondylodesis in 17 patients. Other patients either came late and spinal injury had become stable or could be taken care of with spinal brace. Partial motor neurectomies were performed in 2 patients and tenotomy in 1 patient to overcome the spastic contracture.9 patients required treatment of bed sores, in 4 cases myocutaneous local flaps were rotated and in one case split thickness skin grafting was carried out.

The age of the patients ranged between 16 years to 45 years (Mean age 28 years). The sex was male in 27 and female in 3 patients. The cause of injury to the spine in these paraplegic patients was as in table II.

Table II. Causes of Injury to the Spine

Sr. No	Causes of SCI	No of Patients
1.	Road Traffic Accidents	20
2.	Bullets	5
3.	Fall	4
4.	Farm Injury	1
	Total	30

The mean duration of gait training was 9 weeks (minimum 7 weeks and maximum 14 weeks).

During Gait training, majority of patients required 1 week standing in the L-board (mean time 1.3 weeks). Mean duration of 2 weeks was spent during training with L-board in parallel bars , 1 week was required with POP in parallel bars, 2 wee s with KAFOs in the parallel bars and 2 weeks while walking with the walking frame.

The over all abilities of the patients at the end of the training programme are given in (Table III).

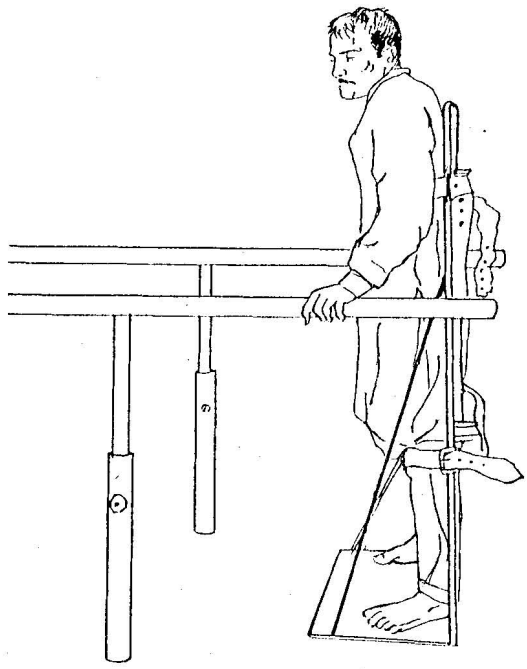

Fig 8 Drawing of the Gait training with L-Board in Parallel Bar from side.

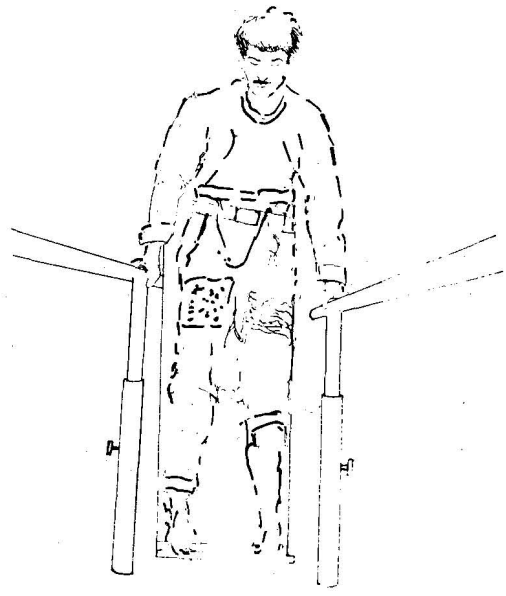

Fig.7 Drawing of the Gait training with L-Board in Parallel bar from front.

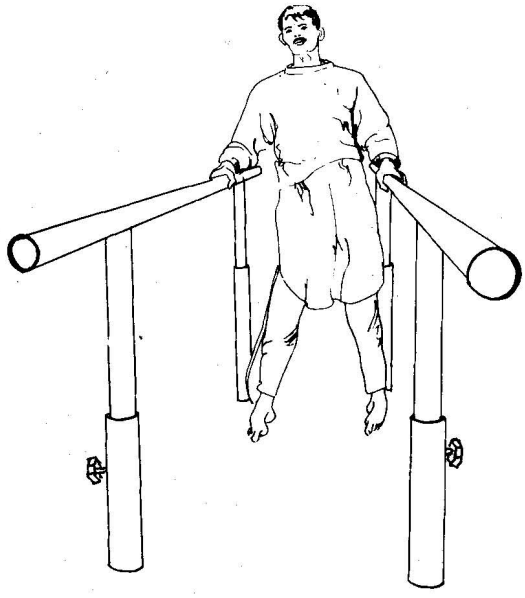

Fig 10. Drawing of the Gait training with POP on legs in Parallel bar walk way.

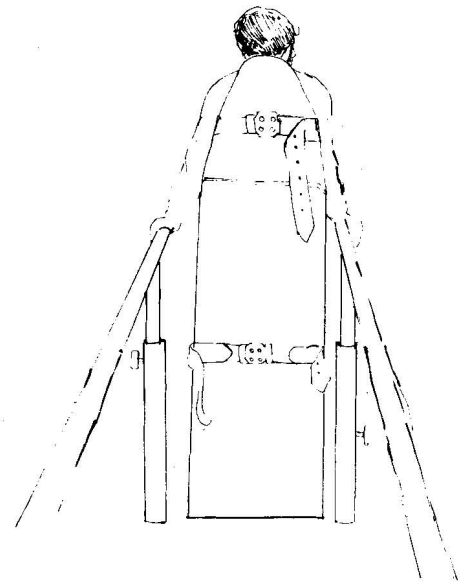

Fig.9 Drawing of the Gait training with L-Board in Parallel bar from behind.

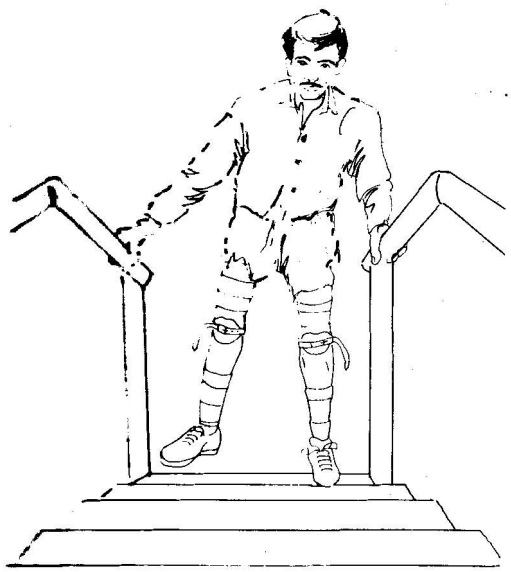

Fig 13 Drawing of the Gait training. moving up the stairs from front

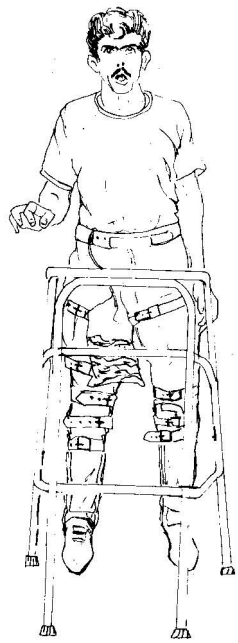

Fig 12 Drawing of the Gait training and standing with KAFO even without support of the walking frame.

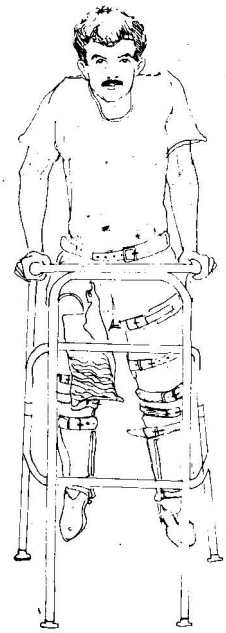

Fig 11 Drawing of the Gait training with KAFOs and walking Frame.

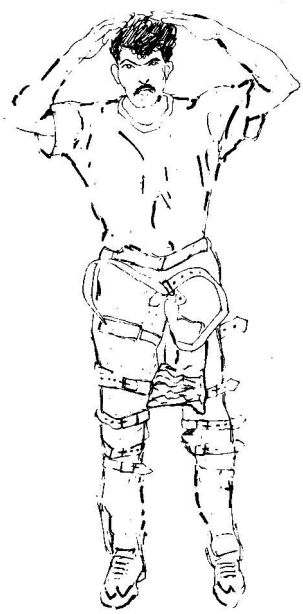

Fig 15 Drawing of the paraplegic standing without the support of FVwalking frame(with KAFOs).

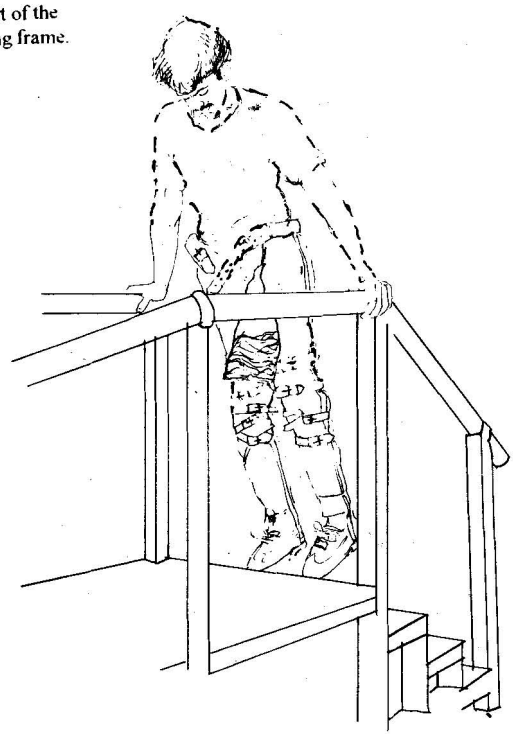

Fig.14 Drawing of the Gait training moving up the stairs from side.

TABLE I: DATA OF THE PARAPLEGICS TREATED IN PRESENT STUDY

Sr. No.	Age in Year	Sex	Level of Injury	Type of Injury	Associated Problems	Surgery if done for spine	Other Surgery if done	Duration of Training in Weeks					ABILITY			
								Standing Board	Board and parallel bar	POP and parallel bar	KAFO and parallel bar	KAFO and walking frame	Walk with walker	Walk with Crutch	Walk on Ramp	Climb Stair
1.	28	M	D8	RTA	Spasticty	Decompression	Neurectory	2	2	1	2	3	Average	NIL	NIL	NIL
2.	20	M	D8	RTA	Bed Sore	NIL	NIL	1	2	1	2	3	good	Average	Average	Average
3.	30	M	L3	Fall	___	Spondylodesis	NIL	1	2	1	2	2	good	Average	Average	Average
4.	45	M	D6	Bullet	___	NIL	NIL	1	2	1	2	2	good	Average	NIL	NIL
5.	20	M	D12	RTA	___	Spondylodesis	NIL	1	2	1	2	2	good	Average	Average	Average
6.	25	M	D11	RTA	___	Spondylodesis	NIL	1	2	1	2	2	Average	NIL	NIL	NIL
7.	18	F	L1	Fall	Bed Sore	NIL	Flap	2	2	1	2	1	good	good	good	good
8.	26	M	D11	RTA	___	Spondylodesis	NIL	2	2	1	2	2	good	Average	Average	Average
9.	27	F	L2	Bullet	___	Spondylodesis	NIL	1	2	1	2	2	good	Average	Average	Average
10.	30	M	D8	RTA	Bed Sore	NIL	NIL	1	2	1	2	2	good	Average	Average	Average
11.	33	M	L1	RTA	___	Spondylodesis	NIL	2	2	2	3	4	good	Average	Average	Average
12.	30	M	D12	RTA	Spasiticty	Spondylodesis	NIL	1	2	1	2	2	good	Average	Average	Average
13.	18	M	L1	RTA	_	Spondylodesis	NIL	1	2	1	2	3	good	good	good	

14.	18	M	D11	FARM		Spondy lodesis	NIL	1	4	1	4	1	good	over age	over age	over age
15.	30	M	LJ	FALL	-	NIL	NIL	1	1	1	1	1	aver-age	NIL	NIL	NIL.
16.	24	M	D6	RATA	Spasiticty	Decompression	Neurotory	1	2	1	2	2	good	Aver-age	Aver-age	Aver-age
17.	26	M	D10	BULLET	Bed Sore	NIL	NIL	1	2	1	2	2	good	Aver-age	Aver-age	Aver-age
18.	30	M	D8	RTA	Bed Sore	NIL	FLAP	2	3	2	3	2	NIL	NIL	NIL	NIL
19.	34	F	L1	RTA	_	Spondy lodesis	NIL	1	3	1	2	3	good	Aver-age	Aver-age	Aver-age
20.	45	M	D10	RTA	_	Spondy lodesis	NIL	1	2	1	2	1	good	good	good	good
21.	40	M	D6	BULLET	Bed Sore	NL	FLAP	1	1	1	2	2	good	Aver-age	NIL	NIL
22.	21	M	D9	RTA	_	Spondy lodesis	NIL	1	2	1	2	2	good	Aver-age	Aver-age	Aver-age
23.	24	M	D12	RTA	_	Spondy lodesis	NIL	2	2	1	2	2	good	Aver-age	NIL	NIL
24.	20	M	D12	RTA	Bed Sore	Spondy lodesis	Skin Grafting	1	2	1	2	2	good	good	good	good
25.	18	M	D11	Bullet	Bed Sore	NL	NIL	1	2	1	2	1	good	Aver-age	Aver-age	Aver-age
26.	16	M	D6	FALL	_	Spondy lodesis	NIL	1	1	1	2	2	Aver-age	NIL	NIL	NIL
27.	34	M	D8	RTA	Equinus Team	NL	TAL	2	2	1	2	2	good	Aver-age	Aver-age	NIL
28.	36	M	D8	RTA	_	Spondy lodesis	NIL	2	3	2	3	2	NIL	NIL age	NIL age	NIL age
29.	32	M	D12	RTA	Bed Sore	NIL	Flap	2	2	1	2	2	NIL	Aver-age	NIL	NIL
30.	18	M	L1	RTA	_	Spondy lodesis	NIL	1	2	1	2	1	NIL	NIL	NIL	NIL

Table. III Physical ambulatory abilities of the patients

Ability /Function	Nil	Average	Good	Total
Walk with Walker	2	4	24	30
Walk with crutches	7	20	3	30
Walk on ramp	10	17	3	30
Climb Stairs	12	16	2	30

28 (93 percent) of paraplegics could walk wearing KAFOs with the help of the walking frame. Only 3 (10 percent) could walk with KAFOs and Crutches.

Most of the cases aquired average ability to walk with crutches 20 (66 Percent), to move up and down the ramp 17 (56 percent) and to climb the stairs 16 (53 percent).

DISCUSSION

Ambulatory training of post traumatic paraplegic was considered, for many centuries, to be imposible till the second half of the 20th Century. The over all incidence of this problem in a developed European Country is 9.2 per million per year. We do not have epidimiological data regarding this problem in Pakistan. Even if the incidence of paraplegia is half of the Westeren World then we are having 540 new paraplegics every year in Pakistan.

The causes of paraplegia is our study are road traffic accidents 66.6 percent, bullet injury 16.6 percent, fall from height 13.3 percent and farm injury 3.3. percent. These statistics are different from those reported by Plama et al (1992) in which case the major cause is occupational activities. (32.2 percent) in USA. In Nigeria major cause is fall from the palm tree (Okonkwo, 1988). In Dermark road traffic accidents a the largest cause of the paraplegia (percent). It is interesting to note th although Pakistan is not very motoriz country it still has the highest incidence paraplegia produced by the road trafi accidents. Pakistan is largely an agricultur country. The causes for paraplegia related farming accidents are only 3.3.%

The mean age of paraplegic patien in present study is 28 years (range 16 yrs 45 years) and in study presented by Palma al (1992) the mean age has been 37 yea (range 7 to 74 years).

In, study from Denmark publishe by Biering, S.(1990) the average age rang of SCI patients was 15 to 24 years. In ou study the mean age in male corrospond to th active phase of life of male population in ou society. It is also interesting to note that i our study 4 patients (13.3 percent) wer injured by fall from the height, belonged t younger side of range of age. The higl incidence of paraplegia due to bullet injur requires due consideration. This cause of SC leading to paraplegia is not as common i countries where socicty is properly regulated

Amongst the problems associatec with paraplegia, respiratorcy problems, urinary problems, traumatic shock, bed sore problems, osteoporosis, sexual dysfunction, oxygen supporting system and syringomyelia are discused extensively in the literature. In present study in contrast to wilmont and Hall (1986) and Reines and Haris (1987) we have not come accross many pulmonary problems. One reason which can justify the observations is that in our study most of the patients included had already passed through the early critical phase and had presented to us in otherwise compensated and stable

Fig 16: Photograph showing steps of Gait training

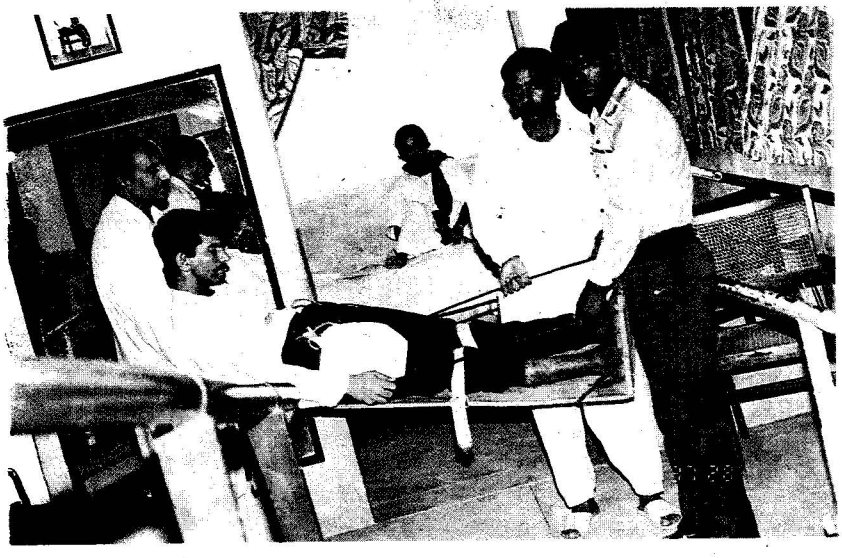

Fig 16 (a): Patient on the board, being carried to parallel bars walk way

Fig 16(b): Patient Standing in the L - Board.

Fig 16(c): Patient making Swinging movements in the parallel bars.

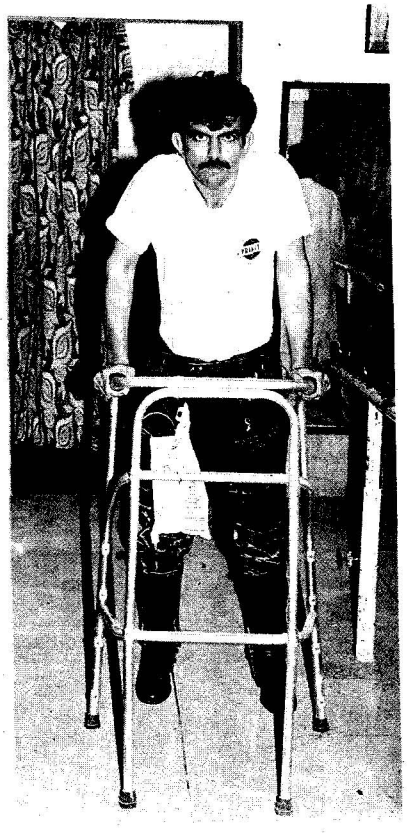

Fig 16(d): Patient Wearing bilateral KAFO Walking with Walking Frame

Fig 16(f): Patient Climbing the Stairs.

Fig 16(e): Patient C;imbing the ramp.

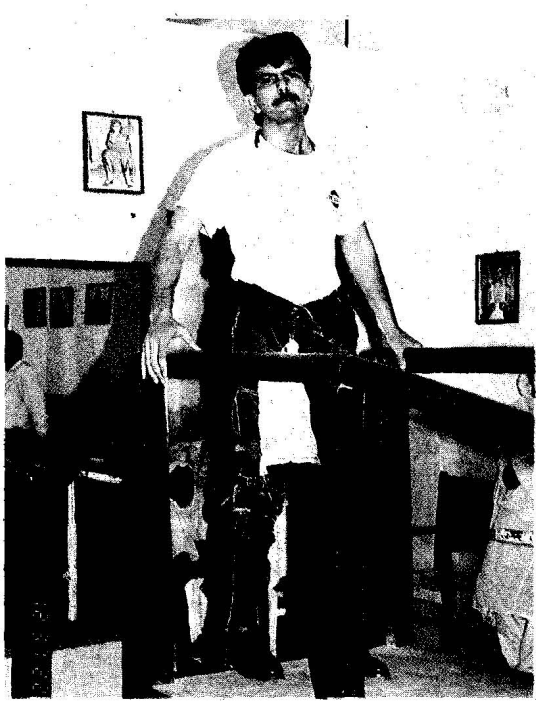

Fig 16 (g): Patient Practcing to Stand without Support of Walking Frame

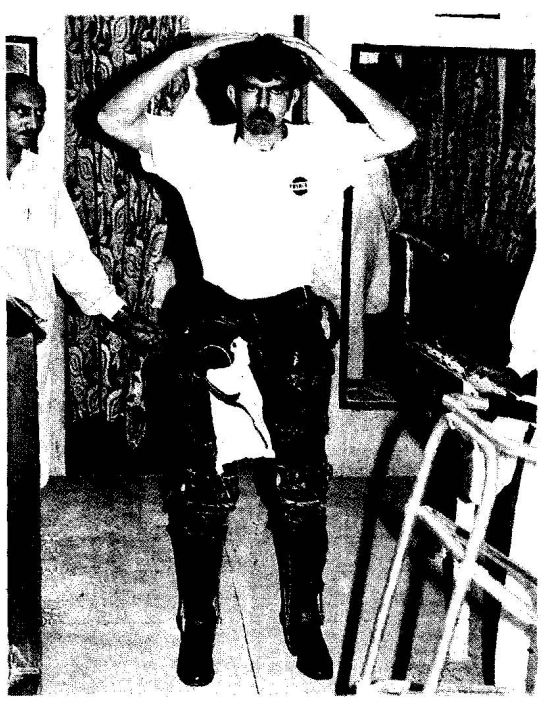

Fig 16(h): Patient Standing with Support of the Walker

situation. Similarly the incidence of traumatic shock in SCI patients, as high as 20 percent as reported by Meinecke (1984) does not coincide with our observations.

The measurement of skin blood cell flux, serum levels of osteocalcin, core temperature, oxygen supporting system and other autonomic dysfunctions as reported by Schubert and Fagrell (1991), Oietsehmark et al (1992) , Essiet and Oniuba (1992), Hjeltness (1986) and Rossier et al (1985); could not be investigated in our patients because of unavailability of required technology.

In present study sexual dysfunction was not investigated, however, the authors did recieve letters from two patients who wanted treatment for loss of erection both were facing a threat for divorce. We also have been informed by very small number of patients that erection improved during the course of rehabilitation.

The major principles of ambulations of paraplegics in our study largely coincide with those laid down by Guttman during 1940 - 1945.

For present study our major accomplishment have been to design and manufacture a wooden L-shaped board which functions in several ways:

1. It facilitates standing of paraplegic in erect posture.
2. While standing the autonomic imbalances are compensated.
3. It adds weight to lower part of the body when swinging exercises are performed in the parallel bars. This helps in developing the muscles of the upper limbs so that upper limbs are in better position to function as actual units of ambulation.

In present study all 30 patients were fitted with KAFOs bilaterally. In majority of cases these were made up of polypropylene sheet, only few were made up of bilateral uprights of mild steel and special shoes.

The reciprocating gait training with Oswestry para walker and its use along with the functional electrical stimulation of muscles although appear a superior method of rehabilitation of paraplegics, are not applicable to a Pakistani paraplegic due to lack of know how and technology.

24 Patients (80 percent) of patients in present study showed good ability and 4 patients (13.4 percent) showed averge ability to walk with KAFOs and w alking frame. It is important to note that some patients were not equally successful in walking with the crutches. Our observation is that walking frame, because of its design is more stable and friendly to use. Climbing up and down the ramp and stairs was easily possible for only small number of patients. Most of our patients when started walking with frame, did not show enough entheusiasm to continue learning.more.

The concept of L.Board and steps of training applied in this study are orignal and have not been reported before in the literature (Fig 16 a-h)

CONCLUSIONS

A simple cheep and orignal method of gait training has been reported. It is very clear that the whole training programme has been possible because of designing and manufacture of the wooden L-Board.

Although initial results are encouraging, authors have clear impression that this field could be further developed extensively by carring out scientific investigations in paraplegics mainly in the areas of exercise physiology, cardiopulmonary function and oxygen tension, stabilizing techniques of unstable fractures/dislocations of spine, new designs of KAFOs and walking aids and functional electrical stimulation.

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