

**REHABILITATION OUTCOME IN TRAUMATIC  
SPINAL CORD INJURY AT THORACIC AND LUMBAR REGION**

**DISSERTATION**

**Submitted to  
The Tamilnadu Dr.M.G.R. Medical University**

*For M.D.course  
in*

**Physical Medicine and Rehabilitation  
Branch X1X**



**THE TAMILNADU Dr.M.G.R. MEDICAL  
UNIVERSITY**

**Guindy, Chennai-32  
June 2011**

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**by**

**Dr.T. JAYAKUMAR  
Reg.no: 20109012**

*Government Institute of Rehabilitation Medicine, Chennai –83  
Madras Medical College & Research Institute, Chennai –3.*

**THE TAMILNADU Dr.M.G.R. MEDICAL**

**UNIVERSITY  
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# *Introduction*

## INTRODUCTION

SCI is one of the most severe of all disabling conditions. It commonly affects the young adult males, in their peak of the life. It causes emotional, social, financial, and physical disturbances to him and society disregards him as a non-productive person.

Earlier the life expectancy and outcome of persons with SCI continued to be poor for centuries. It was considered as an ailment not to be treated.

With the advances in the medicine, specialized centers were developed for care of persons with SCI and to improve the quality and longevity of their life. Guttman in England, and Munro in United States were the pioneers in their respective countries.

Outcome measurement scales like FIM, Asia Motor score, were designed to evaluate the efficacy of the treatment provided to the SCI patients.

The present concept is now shifted to comprehensive rehabilitation of the spinal cord injured patient and the ultimate goal is to integrate him into the society as functionally useful, productive person. The quality of life, environment barriers and family support are all playing a dominant role in determining the final outcome.

Presently, there is limited study in Indian subcontinent particularly in spinal cord injury rehabilitation.

The aim of this study is to find out the efficacy of the comprehensive rehabilitation on the final outcome of the SCI patient. Secondary, to study the demography statistics, mode of injury, commonly adopted Acute care management, social and environment barrier etc. and there role in final outcome.

# *Review of Literature*



## **REVIEW OF LITERATURE**

### **HISTORY**

“Edwin Smith Papyrus” an Egyptian physician, way back in 1700 BC has described a person with a spinal cord injury and he describes SCI as an ailment not be treated<sup>1</sup>. The life expectancy and outcome of patients with SCI continued to be poor.

Even the methods of reduction of the deformity due to SCI were described by Hippocrates, Vidus Visius a Greek surgeon etc which are at times violent and brutal<sup>2</sup>.

Guttmann in England and Munro in the United States, were the pioneers in SCI Rehabilitation. With the advent of newer medical technology in the 20<sup>th</sup> Century, SCI patient rehabilitation has become a reality.

Botterel of Toronto, showed ambulation possible with crutches. The concept of comprehensive Rehabilitation both medical and non-medical aspects like social, environmental factors play a major role in SCI rehabilitation. This has produced promising results for Guttmann in UK, Nakamura in Japan<sup>3</sup>.

Spinal Cord injury units in India were established by Dr. Mary Varghese 1968, Chahal's in New Delhi and Military Hospital Kirke etc. In Chennai a Paraplegia project was started in 1978 at Govt. General Hospital.<sup>4</sup>

Postural reduction by spinal extension is a common conservative line of management. Guttman used pillow and jacks for postural reduction. Paul of Aegina (690) performed first surgery for SCI. Harrington of Houston developed the successful spinal instrumentation followed by Steffee, Cotrel, Debouset etc who performed successful early surgical spinal stabilization to allow speedy recovery and early rehabilitation.<sup>5</sup>

## EPIDEMIOLOGY

Among the SCI admissions – in one study<sup>6</sup> 39% were non-traumatic in etiology.  
Among the traumatic causes – RTA and Gunshot injuries were to leading causes of SCI in United States.<sup>7</sup> This varies from place to place.

### In Fiji<sup>8</sup>

Annual incidence- 18.7 / million/yr.

Among total cases – 53% traumatic and 46% Non-traumatic.

Males to female ratio is 4:1

15-30 age group – 35% of cases,

Etiology →among – traumatic SCI – 38.7% falls, 25.3%

Motor Vehicle Accident. 20% sports,

8% shallow water diving, 4% deep sea diving and others.

### In Turkey (1997)<sup>9</sup>

Annual new incidence- 16.9 / million / year.

Male to Female ratio- 5.8:1

Mean age is 31.3 years (Males-31.25 Females-31.36)

Below 40yrs-70.7%

Causes – Falls- 37.3%, gunshot injuries-29.3%, car accident 25.3%,

Stab injuries-1.3%

41.3% were tetraplegic and 58.7% were paraplegic,

Commonest level – C5 for tetraplegic, L1 for paraplegic,

### In the Madras study<sup>4</sup>

Males-88%, Females- 11.2% and Males to Female- 8.09 Ratio

Age: Male 3<sup>rd</sup> & 4<sup>th</sup> decade, Female-2<sup>nd</sup> decade

Causes : 66% falls, RTA-14%

## **ANATOMY**

The vertebral column consists of 7 cervical, 12 Thoracic, 5 lumbar and united sacral vertebra and kyphotic at thoracic and lordotic at cervical and lumbar level. The anterior part of the vertebrae is formed by the body and posterior part by the arch. Vertebral body is cancellous with endplates made of cortical bone. The vertebra and intervertebral disc increase in size from above downwards ( except L5 S1 disc).

The neural arch consists of pedicle, lamina, superior and inferior articular processes, transverse processes and a spinous process. The facet joint is a diarthrodial joint and is in frontal plane in Thoracic vertebra and sagittal plane in Lumbar vertebra.

The disc consists of central avascular gelatinous nucleus pulposus which is surrounded by ligamentous annulus fibrosus, which is reinforced anteriorly by anterior longitudinal ligament and the major constituent of the disc is water and acts as a shock absorber.

The ligaments are anterior longitudinal ligament between two vertebra anteriorly and posterior longitudinal ligament posteriorly, the ligamentum flavum between the laminae and interspinous ligament between the spinous processes. The other ligaments are intertransverse ligament, supra spinous ligament etc.

The spinal cord in the spinal canal ends at lower border of L1. There is a localized bulge between T10 to T12 called Conus Medullaris that gives rise to lumbosacral plexus of nerves. Distal to the L1 Vertebra, the nerve bundle constitutes Cauda equina. The spinal meninges cover the spinal cord dural sleeve encloses each spinal root up to IV foramen. The spinal roots are separate within the spinal canal.<sup>10</sup>

### **Arterial Supply**

The arterial supply consists of one anterior and two posterior spinal arteries reinforced by 8 anterior<sup>12</sup> medullary feeders. Further, there are supplies from spinal twigs of posterior intercostals, lumbar and lateral sacral which join the arterial trunks anterior and posterior radicular arteries. The critical zone of spinal cord is between T4 and T9 where Reinforcement is sparse.

The artery of Adam-kiewicz arises from Aorta and enters the cord between T10 and L3 to supply the lower thoracic and lumbar cord via the anterior spinal artery. This area is the watershed area. The spinal artery branches are end arteries.

### **Cross Sectional Anatomy of the Spinal Cord**

It consists of central H-shaped grey matter surrounded by white matter. The intermediolateral grey column between T1-L2 segment gives pre-ganglionic sympathetic fibres, while S<sub>2</sub>S<sub>3</sub>S<sub>4</sub> segments give pre-ganglionic parasympathetic fibres. The white matter has

Ascending sensory tracts:

1. Fasciculus graciles and cuneatus – position, vibration, two point discrimination, pressure, stereognosis
2. Lateral spinothalamic tract – pain and temperature.
3. Ventral spinothalamic tract – Crude touch
4. Anterior and posterior spinocerebellar tracts- proprioception

Descending motor tracts: Corticospinal & Lateral reticulospinal – inhibitory.

Vestibulospinal & Medial reticulospinal – facilitatory.<sup>11</sup>

### Special Characteristics of Thorocolumbar Spine

	<b>Thoracic</b>	<b>Lumbar</b>
Transverse and AP Diameter	Equal	Transverse more than AP
Facet Joints	Frontal Plane	Sagittal Plane
Movements restricted	Flexion & Extension	Rotation
Costo-Vertebral joints	Present	Not-present
Special Features	70% rotation occur	Lumbo-pelvic rhythm

Activity of Lumbar flexion with anterior rotation of pelvis is Lumbo-pelvic rhythm.<sup>1</sup>

## **PATHOPHYSIOLOGY**

Traumatic SCI causes initial mechanical disruption of tissue leading to a complex secondary sequence of patho-physiological changes and neurological impairment. The sequels depend on the impact force delivered to the spinal cord at the time of injury. Animal models are developed to assess the efficacy of any therapeutic regimen<sup>13</sup>.

It is found that spinal cord compression, if exceeds 6 hours, lesions in the form of hemorrhage, central necrosis and edema within and around axons as well as destruction of myelin sheath are markedly present, suggesting early decompression within 6 hours can reduce the extent of morphological and vascular changes<sup>14</sup>.

Amyloid precursor protein, which is carried along the axon by fast axoplasmic transport, has been used extensively as a marker of traumatic axonal injury. Using immunostaining methods, lesions far from the site of focal injury have been demonstrated<sup>15</sup>. Cases are reported, ascending ischaemic injury as far as C2 from Traumatic T10 – T11 fracture.<sup>16</sup>

Profound disturbances of extra-cellular amino acid levels and energy metabolites were found in SCI. The elevation of glutamate and aspartate, correlated with previously recorded data on neurological outcome.<sup>17</sup>

The injury patterns are primary or secondary.

### **The primary neurological injury:**

- a. Contusion :** Transient compression resulting in intramedullary haemorrhage, and vascular injury.
  
- b. Compression :** The mechanical deformation interferes with axonal flow and causes ischaemia
  
- c. Laceration :** There is physical separation.

### **Secondary Injury:**

Results from Ischaemia, vasoactive substances, swelling and pressure effects. Late sequel include chronic pain, neurological deterioration due to scar and syringomyelia.<sup>18</sup>

### **NEUROLOGICAL LEVEL ON IMMUNE FUNCTION IN SCI**

Due to high rate of infection in SCI while assessing the immune status it is revealed that individuals sustaining complete cord injury at cervical cord level experience alterations in the immune function while those with lesions at T10 or below do not. The significance of this difference is though mild. The findings were impaired phagocytic activity and trend towards reduced neutral killer cell noticed in quadriplegic than controls but in paraplegics below T10.<sup>72</sup>



## BIO MECHANICS OF THORACOLUMBAR SPINE

Denis developed three column concept which was developed following a CT scan study of thoracolumbar injuries<sup>5</sup>. Now recently the sternum and ribs constitute the 4<sup>th</sup> column.

The thoracic spine is stiffer than lumbar spine due to the rib cage and has smaller and thinner discs. The movements at thoracic spine are rotation and lateral flexion, while flexion and extension are more at lumbar spine. This variation is due to the orientation of facets<sup>10</sup>.

The vertebral bodies and discs absorb compressive loads, while the tensile forces are absorbed by ligaments and processes.

Injury above T10 vertebra leads to cord damage, T10 L1 level vertebrae injury leads to cord and root damage while in injury below L1 vertebra cauda equina alone is damaged. The abundant space accounts for more early recovery in lumbar spine injury than thoracic spine.

Thoracolumbar Instability, as assessed by White and Punjabi provide a check list.

1. Anterior element disruption - 2 points
2. Posterior element disruption - 2 points
3. Sagittal plane translation – more than 2.5mm -2 points
4. Sagittal plane rotation –more than 5° -2 points
5. SCI or Cauda equina damage - 2 points
6. Disruption of costovertebral joint - 2 points
7. Anticipated loading -2 points

A total score of 5 points or more indicates instability<sup>5</sup>

## **PATTERNS OF INJURY**

Following trauma, according to Sherrington a stage of spinal shock develops which lasts for hours to days with complete loss of sensation, motor and reflex activity. Once spinal shock is over reflex activity returns, with onset of spontaneous reflex activity below the level of lesion leading to spasticity.

### **Complete Lesion**

A complete lesion is present when there is no motor, sensory or voluntary bladder and bowel function exists distal to injury with a preserved bulbocavernous reflex.

### **Incomplete Lesion**

It exists when some function persists below the level of lesion, like sacral sparing, voluntary bladder or rectal function or great toe flexion activity. Prognosis for recovery in incomplete lesion is good.<sup>5</sup>

### **Spinal cord injury Syndromes**

There are some classical patterns of incomplete spinal cord injury as described by Schneider and Kahw.

### **1. Anterior cord syndrome**

It results in hyperreflexia, atrophy, and variable motor loss with the preservation of position sensation but impaired pin prick and temperature sensation. It occurs secondary to flexion rotation force resulting in dislocation. Recovery is poor.<sup>20</sup>

### **2. Central cord syndrome**

The features include weakness greater in arms than legs, lower extremity hyperreflexia, upper extremity mixed UMN & LMN weakness and preserved sacral sensation with potential for preservation of bowel and bladder control. It occurs secondary to Hyperextension injury on a cervical spondylotic spine. Recovery is good.

### **3. Brown – Sequard Syndrome**

This presents with hemi-or-monoplegia or paresis with contralateral pain and temperature deficit. There is a good prognosis for motor recovery progressing from the proximal extensors to distal flexors. This results from knife injuries and secondary to hemisection of the spinal cord.

### **4. Posterior cord syndrome**

Manifests as bilateral deficits in proprioception, resulting from Hyper-extension injury. Ataxia due to proprioception loss is the main feature<sup>21</sup>.

Injuries between T12 & L1 vertebra result in cord transection at S1 and damage to all the lumbar roots and paraplegia is of LMN type (mixed lesion ie. Conus & cauda involvement). If roots are spared then UMN paraplegia develops at S1. The severity of the primary injury determines these lesions<sup>3</sup>.

## **NEURONAL RECOVERY AFTER SCI**

Neural recovery occurs rapidly during first and second week. Then recovery continues at a slower pace for the first 4 months and the ability of the chronically injured axon to initiate a regeneration response is unexpected.<sup>22</sup>

### **Central Mechanisms**

Cortical reorganization such as recruitment of latent pathways, which are unused until injury, is one of major mechanism of recovery. At the site of injury, edema and haematomyelia may resolve reducing secondary injury. Recovery from neuropraxia and demyelination associated with Central Synaptogenesis which may occur in response to denervation Hypersensitivity of the anterior horn cell are the other mechanisms of recovery. Root impingement may resolve with decompression and spinal alignment<sup>18</sup>.

In a study the intensity of the lesion (incomplete) and vertebral displacement were statically associated with neuronal recovery. Age less than 30 years at the moment of injury in incomplete lesion is also associated with neuronal recovery. Degree of vertebral wedging, type of fracture, management (conservative or surgical) and neurological evolution do not have any association with recovery.<sup>23</sup>

## Classification of Injuries

Classification of injury is essential to understand the mechanism of injury and helps in decision making and predicting the prognosis of SCI.

There are many classification available, Nicoll, Holdsworth, Fergusson and Allen, McAfee et al.,<sup>24</sup> and the recently Denis classification are available. Of these, the one developed by Denis based on analysis of both plain X-ray and CT scan has achieved wide acceptance and is based on three column concepts. The column can fail individually or in combination by 4 mechanism – compression, distraction rotation and shear.<sup>5</sup>

1. Compression Fracture – anterior lateral wedge with failure of the anterior column – stable fracture.
2. Burst Fracture – Compressive loading leads to failure of anterior and middle columns. If posterior column, fails then it becomes unstable fracture.
3. Flexion distraction or Seat Belt Injury – all the three columns fail and are an unstable injury.
4. Chance fracture – horizontal avulsion fracture of the vertebral body caused by flexion about an axis anterior to anterior longitudinal ligament.
5. Translation Injury – due to shearing force, characterized by malalignment of spinal canal.

## **DIAGNOSIS**

### **History**

There is usually history of fall or Road Traffic Accident, suggesting a violent Trauma, following which patient has a severe low back pain and inability to move both lower limbs with loss of sensation in both lower limbs. Bladder and Bowel evaluation is also done to rule out retention.

### **Physical Examination**

If there is suspicion of a spinal column injury, undue movement of spine should be avoided. The localized point of tenderness of the spine with a palpable interspinous gap is looked for suggesting spinal injury. Other visceral injuries should be ruled out.

### **Neurological Evaluation**

Frenkel and colleagues have formulated a system of classifying SCI as complete and incomplete injuries. The complete injury is defined as the patient having no preservation of motor or sensory function more than 3 levels below the level of injury. The three levels distal to the neurological level of injury were formed as a zone of partial preservation.

Frenkel scale (1969) :

- A. Complete
- B. Motor Complete, sensory incomplete
- C. Motor useless
- D. Motor Useful
- E. Complete recovery

This classification was later modified by ASIA (American Spinal Injury Association) impairment scale (1992).<sup>25</sup> Here, the complete injury is defined as the absence of sensory or motor functions in the lowest sacral segments and incomplete injury as preservation of motor and sensation below the neurological level of injury with sacral sparing.

#### **Asia Impairments Scale.**

- A. Complete : No sensory or motor function in the sacral segments S4/S5.
- B. Incomplete : Preservation of sensory but not motor function below the level of injury extending through sacral segments S4/S5.
- C. Incomplete : Motor function is preserved below the neurological level and more than half of key muscles below the level have a muscle grade of less than 3.
- D. Incomplete : Motor function is preserved below the neurological level and more than half of key muscles below the level have a muscle grade greater than or equal to 3.
- E. Normal : Recovery of motor or sensory function.

(Data from American Spinal Injury Association).<sup>25</sup>

## Sensory Examination

28 key dermatomes each tested separately for pinprick and touch on a 3-point scale (0-absent, 1-impaired, 2-normal) is used with a face as the control point. Sensory index scoring is done by adding the scores for each dermatome. Maximum score is 112.<sup>26</sup>

## Motor Evaluation

Manual muscle testing grading system<sup>19</sup>

Score	Description
0	No movement
1	Palpable Contraction
2	Active movement with gravity elimination (Full range)
3	Active movement against gravity (Full range)
4	Active movement against moderate resistance (Full range)
5	Normal Strength



### Asia Motor Index Score

Is done on 10 key myotomes, by MMTG system and is calculated by adding the muscles scores for each key muscle group. Total possible score is 100.

<b>Myotome</b>	<b>Key Muscles</b>
C5	Biceps
C6	ECR
C7	Triceps
C8	Finger Flexors
T1	Abductor Pollicis Brevis
L2	Psoas
L3	Quadriceps
L4	Tibialis Anterior
L5	EHL
S1	Gastrosoleus

A muscle grades 3/5 and above is considered useful for A.D.L.

The Neurological level of injury on description takes in to account both motor and sensory levels, i.e. most caudal level at which both motor and sensory modalities are intact, for example if motor level is D7 and sensory level D8, the neurological level is D8.<sup>26</sup>

## **INVESTIGATIONS**

### **Radiographic evaluation**

Radiographic evaluation is most simple and specific for the diagnosis of spinal injury. Anteroposterior and lateral views of spinal column are minimal mandatory views essential for spinal column injury evaluation. Spinal movement during radiographic evaluation should be kept minimum with an attending physician supervising the examination.<sup>20</sup>

Normality AP and Lateral views give adequate insight to injury. Radiographs appear normal more commonly in children and in about 15-20% of adults with SCI. Posterior elements lesion is more seen in oblique views while lateral picture discloses stability of the spine.

### **CT Scan**

Declination of the bony structure is good with computerized tomography and three dimensional view of the vertebra can be reconstructed. Thus is not very useful in post-traumatic syringomyelia, root avulsion etc.

### **Myelography**

C.T. combined with myelogram with an intrathecal water soluble contrast like metrizamide provide better both soft tissue and bony contours. It can differentiate intra and extra medullary cord lesions and is very useful in post-traumatic syringomyelia, root avulsion etc.

## **MRI**

It is best modality for soft tissue imaging. It is useful in identifying the cause of compression, degree of damage to spinal cord and ligamentous disruptions. Recent advances include 3D imaging, MR angiography with gadolinium.

## **Evoked Potentials**

Peroneal and Tibial Nerve somatosensory evoked potentials elicited within 24 to 48 hrs after SCI was usually associated with some clinical improvement in the legs. ASIA scores and SSEP are also related to the outcome of ambulatory capacity of SCI patients.<sup>27</sup>

## **NERVE CONDUCTION STUDIES**

In contrast to patients with thoracic cord lesions, almost all patients with cauda and conus present a severe axonal neuropathy of the labial and peroneal nerves and pathological C-MAPs, develop as early as 1\_2 weeks after the acute onset of paraplegia. They allow, at early stage to differentiate between conus, cauda and epiconal lesion and C-MAP amplitude is also indicative of severity of the conus or cauda lesion. There after it becomes stable, secondary deterioration of C-MAP values suggests post-traumatic syringomyelia.

## **REHABILITATION OUTCOME EVALUATION**

Rehabilitation outcome evaluation involves assessment of individual functioning in various day today activities. Assessing the self-care activities assists in treatment, discharge planning, by documenting current abilities and monitors changes in functional status.

Impairment is a physical loss or abnormality, the result of such loss leads to disability and while the inability to fulfil a normal role in the society due to disability or impairment leads to handicap.

### **Self care assessment tools**

A number of functional assessment tools are available, for using in various conditions.

1. Purses profile:- by Moskowitz and Mc cann 1957,
2. Katz index of Independence in ADL – graded A-G
3. The Barthel's index by Mathoney & Barthel (1965) – which includes 10 items of ADL with a miximum score of 100, widely accepted.
4. The Kenny index of ADL (1960) – a five point scale from 0-4 with 17 ADL items.
5. Klien Bell ADL scale by Ronal klein, and Beverly Bell – 170 items in six categories and a percentage score is computed.

## **6. Functional Independent Measure**

In 1983 a task force supported by National Institute of Handicapped Research (NIHR) was established to develop a Uniform Data System for Medical Rehabilitation. The end result is FIM 'Functional Independent Measure'.

UDS MR includes admission, discharge and follow up FIM ratings. FIM consists of 18 items organized into six categories, patients are assessed by 7 point ranging from complete independence value 7, to complete dependence value-1 (self care, sphincter control, transfer, locomotion, communication, social cognition).

It is well documented and reliable, clinical observation requires only 20 minutes for screening. Is widely accepted and is a proven measure of ADL and social cognition.

1987- Wee FIM was developed as a modification and is used as a measure of functional abilities for children 6 months to 7 years of age. It uses the same items and rating scale as FIM.

Further, categories are subdivided into motor sub total score (self-care, sphincter control, transfer, locomotion) and cognitive subtotal score (communication, social cognition) as a two dimensional concept. The cognitive items are not informative for detecting changes overtime in SCI, but motor items appear to reflect well the functional status of the individual.<sup>60</sup>

This can be used in all disabling conditions like SCI, TBI, CVA, multiple sclerosis etc. Skinman and colleagues have developed Function Related Groups (FIM-FRG) which have the ability to predict more precisely the course of rehabilitation and the outcomes at discharge and followup.<sup>31</sup>

7. “Needs assessment check list”<sup>32</sup>

A new clinical approach to measuring outcome incorporating a behavior indicator rating scale to detail the individual progress and rehabilitation needs by Kennedy at Stoke Mandeville Hospital, United Kingdom.

## **REHABILITATION IN ACUTE PHASE**

Manage of a patient with SCI starts at the site of injury. First and personnel, trained in dealing with SCI patient and unconscious patient have to adhere to the principles like, positioning of patient, avoiding twisting movement of the spine, co-ordination among the members in shifting the patient etc.

Unconscious patients should be treated as spinal cord injured unless otherwise proved. Spine may be immobilized with cervical collar for cervical spine injury and two lateral sandbags and the patient strapped to the spinal board in thoraco-lumbar spine injury. Transfers of SCI patient accomplished by means of Stryker frame.

Cardiopulmonary problems should be addressed first with maintenance of airway and circulation. Associated fluid and electrolyte imbalance and other visceral injuries if any, should be addressed concurrently.

Methyl prednisolone in high doses (25mgs/kg) within 8 hours act as a free radical scavenger to inhibit the secondary damage to the spinal cord. Gangliosides, complex acidic glycolipids, are believed to stimulate the repair of the damaged nerve cells, are under trial study. 3-strategy biological intervention for SCI patients is being planned.



- I. Neuroprotection:** Soon after injury, uses pharmacological tools to reduce secondary damage to the spinal cord. (methyl prednisolone)
- II.** Promoting axonal regeneration using either Pharmacologically (Gangliosides) or gene therapy.
- III.** Intense **Sensorimotor Stimulation** (Physiotherapeutic) or surgically supplying the key afferents like monoaminergic neuronal system will further enhance recovery .

A combination of these three will be more beneficial to the patient. The ability of the chronically injured neurons to initiate a regeneration response is also proved.<sup>35</sup>

### **Management of vertebral fracture**

The primary objective of vertebral fracture management is to restore the spinal alignment, and to avoid further injury to the spinal cord and finally to allow early recovery of the patient.

Conservative line of management is planned when patient is not medically stable or when patient is unwilling for surgery. Postural reduction with spontaneous decompression of spine needs 3 months to stabilize the spine. Madras method of log rolling uses a single large pillow as postural reduction pillow as well as to shift the patient in the bed in unison by a single person<sup>4</sup> . Another method as advised by Watson Jones<sup>24</sup> .

Once the period of rest (usually 8-10 weeks) is over in conservative line of management conventional thoraco-lumbar braces like Knight-Taylor, Jewetts hyperextension (ASH) braces are worn as an external spinal stabilization support.

Surgical management, within 6 hours<sup>36</sup>, like decompression will definitely be useful to avoid secondary injury factors, but when performed at a later time, it allows early mobilization and shortens the period of hospitalization. Motor recovery did not significantly improve between surgical and a non surgical line of management<sup>37</sup>.

### **Surgical Methods**

1. Methods for stabilizing spine.
2. Recent advances for neuronal recovery

### **Surgical Stabilization<sup>5,25</sup>**

Open reduction and internal stabilization is the accepted method.

### **Spinal instrumentation:**

#### **A. Anterior implants**

- a. Anterior plate and screws
- b. Dwyers
- c. Zielk

## **B. Posterior implants**

### **Standard fixation devices**

- a. Harrington distraction or compression
- b. Edwards instrumentation

### **Segmental fixation devices**

#### **1. Rod System**

- 1. Luque rod
- 2. Harrington Luque
- 3. Wisconsin.

#### **2. Plate and pedicle screw fixation**

- a. Steffe
- b. Luque
- c. Wiltse

#### **3. Internal Fixation**

AO instrumentation

## **C. Combined fixation devices**

- a. Dwyer
- b. Zielke
- c. Anterior plate and screws

### **Surgery to promote neuronal recovery**

Transplantation of monoaminergic neurons at SCI site<sup>38</sup> and olfactory ensheathing cell graft transplant<sup>39</sup> have been attempted but with little success. Recently the transplantation of syngeneic Schwann cells in medullary lesions has shown promising results.

Recently motor axon regeneration was demonstrated in the paraplegic rats. (Mammalian race), following transplantation of olfactory ensheathing glia and functional recovery to the extent of ambulation was demonstrated<sup>40</sup>. This is very promising for a future research in humans.

### **Goals of rehabilitation in acute care**

- Prevent pressure ulceration
- Maintain joint range of motion
- Begin bowel and bladder programs
- Begin sitting program
- Institute activities of daily living appropriate to medical conditions and level of management.

## **REHABILITATION CONCERNS IN SPINAL CORD INJURY**

### **1. Cardiovascular concerns in spinal cord injury**

Cardiac arrhythmias and hemodynamic abnormalities are seen commonly during acute period. Prevalence of cardiac arrhythmias in chronic SCI is low. Orthostatic hypotension seen early SCI is primarily due to sympathetic efferent pathway involvement particularly in spinal injuries above to T6 cord. Measures like gradually increase postural change, compression stockinet, along with pharmacological agents to increase fluid volume will be of useful.

The prevalence of hypertension and ischaemic heart disease has been reported to be greater among patients with SCI. Inactivity following SCI results in decrease in HDL cholesterol, increasing the risk of cardiovascular disease. Hence Exercise in persons with SCI can reduce this risk to greater extent.

Deep vein thrombosis and pulmonary embolism is a risk in SCI patient due the inactivity and flaccid paralysis. Unexplained fever and increasing girth of the calf are the indices for suspecting probable DVT. Early diagnosis and proper institution of pharmacotherapy and physiotherapy measures can prevent the fatal pulmonary infarction.

Autonomic dysreflexia is acute syndrome due to over activity of the sympathetic discharge that occurs as a result of noxious stimuli in persons with SCI above T6 level- (sympathetic splanchnic outflow level). This is a medical emergency in SCI that can lead to fatal cerebral hemorrhage if left untreated. Management includes, removal of the noxious stimuli like bladder distension etc, and intravenous antihypertensive agents like, Nifedipine, Hydralazine and Tetrazosin<sup>41</sup>.

## **2. Pulmonary concerns in spinal cord injury**

Pulmonary complications are secondary to impairment in ventilation and cough. Early in SCI, respiratory complications are the primary causes of death. Pulmonary complications include pneumonia, atelectasis & pleural effusion.

Paralysis of diaphragm and intercostals muscles are main cause of respiratory insufficiency in SCI. Defective expectoration can cause ventilation & perfusion mismatch. The maximum insufflations capacity (MIC) less than 500ml is an indication for tracheostomy. Vital capacity less than 50% of predicted normal, mean Sa O<sub>2</sub> less than 95% for atleast 1 hour during sleep, maximum PCO<sub>2</sub> greater than 50mm Hg requires treatment. But in traumatic paraplegia preservation of diaphragm function, main inspiratory muscle, maintains reasonable ventilation. 4 Aminopyridin per oral to patients with respiratory muscle, maintains reasonable ventilation. 4 Aminopyridin per oral to patients with respiratory dysfunction due to SCI has shown statistically significant improvement in lung function<sup>42</sup>.

## **3. Spasticity**

Spinal shock is a first response to a SCI, due to sudden loss of the supraspinal facilitation to the level below the lesion with suppression of spinal reflexes. Various neuronal mechanisms act to increase the reflex activity and hypertonic reflexes recover within a period of 3 week to 3 months.

Hypertonicity and spasticity may interface with selfcare, transfers, sleep, gait (adductor spasticity) and may even cause skin-breakdown, while the extensor spasticity at knee and ankle may in standing.

Pharmacological (baclofen), physiotherapeutic (cold, splints), chemical motor point blocks (Phenol, Botulinum toxin) and surgical ( Tendon lengthening, neurectomies, etc) are available and the selection of the most appropriate methods for each patient remains the challenge for the clinician.

#### **4. Bladder Management**

##### **Stage of Spinal shock:**

Bladder detrusor activity depressed soon after SCI as it happens in the skeletal muscles. Indwelling foley/ silicon rubber catheter drainage is done to avoid over distension of the bladder. Catheter has to be changed periodically once in 3 weeks (for silicon 6 weeks). Catheter has to be strapped to anterior abdominal wall in males to prevent periurethral fistula.

Acidification of urine (Vitamin C) and alkalization (citralka) alternatively every week will prevent colonization of both acidic/alkaline dependent bacteria and also prevents calculus formation, periodic inflation and deflation of the bulb of catheter also prevents calcification around the bulb.

Self clean intermittent catheterization<sup>43</sup> can also be attempted at during acute phase, with adequate fluid management so as to get urine out put of 1500 – 1800ml per day. Bladder distension should not be allowed to exceed 500ml.

## **UMN Bladder**

Depending upon the level and degree of involvement of the spinal cord, Cord bladder, Reflexes bladder, Spastic bladder or UMN bladder develops as evidenced by return of the spinal reflexes. The aim is induce reflex activity by tapping suprapubic area or stroking the medial wall of the thigh to initiate evacuation, assisted if necessary by abdominal compression. When the residual urine after reflex evacuation is less than 100ml, the bladder is called as a balanced bladder. For patients with detrusor over activity parasymphatholytic drugs like Probantheline and Oxybutyrin can be used in association with self clean intermittent catheterization. The surgical options are Limited sphincterotomy for significant external sphincter dyssynergia and in severe spastic case rhizotomy of S2-S5 roots will make a spastic to a flaccid bladder. Severe spastic contracted bladder's storage capacity can be increased by Augmentation cystoplasty.<sup>4</sup>

## **LMN Bladder**

Atonic bladder, Autonomous bladder, Flaccid bladder or LMN bladder develops due to either damage at conus or sacral roots (cauda). The aim is to evacuate the bladder by Crede's maneuver or Valsalva maneuver so that the residual urine is less than 100ml.

## **Detrusor Sphincter Dyssynergia**

It is seen at

1. At the bladder neck: in high quadriplegics with autonomic hyperactivity.
2. At the striated sphincter: Un-coordinated pelvic floor and striated sphincter contraction with detrusor contraction during attempts to void.



## Investigations for Bladder management in SCI.

- a) Blood urea, serum creatinine,
- b) Complete Haemogram
- c) Periodic urine culture and sensitivity
- d) Cystometrogram, with EMG studies of sphincter and bladder wall,
- e) Voiding Cystourethrogram
- f) Urography
- g) Ultrasound to rule out calculi, hydronephrosis and to calculate residual urine.

## Drug therapy in SCI bladder.

- |    |  |   |  |
|----|--|---|--|
| 1. | To reduce detrusor activity<br>(UMN bladder)       | → | Probantheline bromide<br>Hyoscyamine<br>Oxybutyini Hel<br>Imipramine     |
| 2. | To increase the detrusor activity<br>(LMN Bladder) | → | Carbachol<br>Bethanachol   |
| 3. | To reduce the bladder outflow<br>Resistance        | → | Prazosin<br>Tetrazosin<br>doxazosin<br>Phentolamine<br>Phenoxy benzamine |
| 4. | To increase the bladder<br>Outflow resistance      | - | Ephedrine<br>Phenyl phentolamine   |

## **BOWEL MANAGEMENT**

During spinal shock phase, due to loss of reflex gastro-intestinal function, paralytic ileus may develop. Fluid balance and nasogastric suction are the mainstay of treatment.

Once patient comes out of spinal shock, a UMN lesion leads of reflex bowel evacuation. Combination of high fibre diet, suppository, digital stimulation, usage of softeners like bisacodyl sodium to avoid hardening of stool and training the patient in commode chair will be useful.

In LMN bowel, due to patulous sphincter, stool consistency should be maintained firm to avoid accidents during gait training. Gravity, massage of abdomen from right to left may facilitate movement of faeces in the lower tract.

Complication of faecal mass impaction is to be prevented by constant monitoring of the bowel activities.<sup>45</sup>

## **6. PRESSURE ULCERS**

Pressure ulcers are the localized areas of tissue necrosis secondary to vascular ischaemia due to prolonged pressure that cuts off the capillary circulation.

The commonest sites are sacrum, trochanter and ischial region in paraplegic patients.

The primary factors involved in pressure ulcers are pressure, which is above the capillary pressure (13-32mm-Hg), friction, shear forces, moisture, local tissue viability, altered sensation etc.

The secondary factors are malnutrition, anemia, infection, edema, contractures, psychological depression etc.

The most widely accepted classification is,

National pressure ulcer advisory panel (NPUAP) Classification:

- Stage I: Non blanchable erythema not resolved in 30min
  
- Stage II: Partial – thickness loss of skin involving epidermis – possibly in to dermis
  
- Stage III: Full thickness destruction through dermis in to subcutaneous tissue
  
- Stage IV: Deep tissue destruction through subtraction tissue to fascia, muscle, bone or joint.

### **Management**

Prevention of pressure ulcer is by frequent turning over every 2 hours in the bed, lifting off from wheelchair once in 30 minutes and avoiding above mentioned primary and secondary factors.

Pressure distributing mattresses like foam bed, waterbeds, and air-filled or gel-filled cushions, alternating air filled beds, reduce the interfacial pressure and thus reduce the risk of pressure ulceration. Rehabilitation nurse plays a major rule in this condition. Pressure sores and UTI are negatively related to functional outcome.<sup>46</sup>. Platelet derived epidermal growth factors minimize scarring.<sup>47</sup>



Grade I ulcers need protection and relief of pressure, Grade II → Grade III ulcers are mainly complicated by infection. Antibiotics, slough excision and wound debridement, regular dressing are necessary. Grade II ulcer can heal by secondary intention. Grades III to IV require grafting and flap surgical procedures for earlier recovery. Bio-occlusive dressing is an advance in this field.

## **7. SEXUAL DYSFUNCTION**

Sexual sequelae of SCI like physical impairments of erection, ejaculation, orgasm, male fertility and vaginal lubrication have been well documented.

### **Sexuality in Men**

Sexual desire remains intact but libido dysfunction occurs as there is a social stigma attached to the physically handicapped person. Psychosocial support is more essential in overcoming this problem than a mere physical support.<sup>73</sup>

Erection is a function of the parasympathetic system. (S2,S3,S4). Reflexogenic erections are of a feature in higher lesions while psychogenic erections appear in lower lesions. The degree and sustainability varies and are better in incomplete lesions. The erectile dysfunction can be overcome by a) placement of rings at the base of penis to obstruct venous drainage 2) non invasive vacuum tumescence, 3) Implantation of penile prosthesis, semirigid and inflatable type (infection and erosion are complications).<sup>48</sup> 5) sacral anterior nerve root stimulators, 6) pharmacological drugs for erection like adrenergic blockers, 7) Intracavernosal<sup>49</sup> injection with papavarine, phenoxybenzamine, prostaglandins – complication include priapism and fibrosis. 8) stuffing the non-erect penis into the vagina.

Ejaculation is a function of sympathetic system (T11-T12). Most men do not achieve ejaculation. Retrograde ejaculation is common. Ejaculation dysfunction is main problem when concerned about fertility. It is managed by,

- a) Vibroejaculation with 80hz of vibration stimulating penis provoking ejaculation
- b) Eletroejaculation with probes.<sup>50</sup>
- c) Finally, hypogastric plexus stimulation may also be used.

Orgasm does not invariably associate with ejaculation. A sensation of pleasurable release (paraorgasm) is possible.

### **Sexuality in Women**

The main concern is lubrication particularly in lower lesions. Vagianl lubricants can be of use in this situation. Sensations above the level of lesion can be 'neoerotic' area producing paraorgasm.

Alternatively, orogenital contact, vibrators, manual erotic pleasuring of genital and nongenital areas are used in attaining sexual satisfaction.

## **REHABILITATION TEAM AND THEIR ROLES**

### **Rehabilitation Nurse**

During the acute phase proper positioning, avoidance of pressure ulceration, bladder and bowel care and indentifying the needs of the patient is all the mainstay.

Nurse are people who spend more time with the patient than any other member of the rehabilitations. In this context, she has a more role as representing each member to some extent. Her role extends from nutrition to helping the patient and their relatives to adjust to the psychological trauma of the injury & to give suggestions to vocational evaluator about his or her interests in jobs and to occupational therapist about the usefulness or devices in her absentia.<sup>62</sup>

### **Psyiotherapist**

Their services are also required from acute stage.

**Acute stage:-** or immobilization stage:

Passive or active range of motion exercises, conditioning exercise to upper limbs to avoid the negative effects of immobilization, and chest physiotherapy to avoid stasis are earlier management principles in Physiotherapy.

## **Convalescent stage**

Physiotherapist now encounters complications like pressure ulceration, spasticity, orthostatic hypotension and occasionally autonomous dysreflexia, Relaxation exercises, tilt tabling and associated upper limb and trunk crutch muscles strengthening program are given.

Assessment in the form of regular muscle power chart will be of immense help to plan about the transfer or ambulation.

Bed mobility, transfers, wheel chair mobility, ambulation including climbing stairs and negotiating uneven surfaces is assessed.

Depending upon the level of lesion, the following gait expectations are possible in complete paraplegia.

Cervical cord lesions – Wheel chair ambulation

T1 →T10 cord lesions – Therapeutic standing

T11 →L1 cord lesions – Household ambulation

Below L1→ lesions - Community ambulation

During chronic stage – physiotherapist teaches a home program regarding skin care, prevention of contractures. ROM exercises, strengthening exercises and reviews the patient periodically once a month.



## **Orthotic and Prosthetic Technician**

Ambulation in paraplegics is either wheel chair or walking braces depending upon the level.

For lesions from T1 to T10 bracing the patient completely – long leg braces with spinal extension allows him to stand, which avoids the complications of recumbence as well as psychologically boosts the patient.

For lesion from T11 to L1 where there is truncal stability and partial preservation of ability to hike and rotate pelvis – long leg braces with pelvis support (if no sensory loss) can be prescribed. Gait will be initially ‘swing to’ gait and later ‘swing through’ gait using upper limb musculature.

Lesion below L2 with preservation of the quadratus lumborum and ability to swing forward, bracing now depends on the residual power of the limb.

At Govt. Inst. of Rehabilitation medicine, the prescription for long leg braces in complete paraplegia is as follows.

“Bilateral KAFO, Knee joint with drop lock with no knee cap but with upper and lower knee pad, with 10° fixed dorsiflexion ankle with boot with microcellular rubber insole with shoe upper lined by soft sewn leather.”

Prescribed for a paraplegic patient who has a potential to walk – L1 and below.

Pelvic band and knee-cap are not prescribed so as to avoid pressure points.

Truncal stability is achieved in these patients by voluntary muscular control supplemented by crutches.

Hip control → by virtue of 10° fixed dorsiflexion, during foot flat stage body leans forward, and patient volitionally arches spine backward to adjust his centre of gravity. In this process the stronger ileo-femoral ligament prevents hyperextension by supporting the Hip and hence patient does not fall backwards.

Knee and ankle supported by braces.

MCR and other modifications in the shoes are for the sensory deficit to avoid subtle injury.

## **Newer Advances**

Reciprocating gait orthosis is advancement in the gait management, but again the cost of energy expenditure is the reason for low utility of the orthosis on long term follow-up<sup>52</sup>. ORLAW parawalker is also utilized for this purpose.<sup>53</sup> Wheelchair is still the fastest medium of transport compared to the above.<sup>54</sup>

Functional electrical stimulation is still in a budding stage with lots of promises for ambulation in paraplegics particularly UMN lesions.

A new walking index for spinal cord injured patients was developed which has an interrater reliability of 100 percent recently but yet to assessed in clinical setting for responsiveness.<sup>63</sup>

## **Psychosocial Concerns**

Suicide rates are more in marginally disabling persons (nearly twice) than the functionally complete individuals<sup>55</sup>. This fact gives insight to the psychosocial concerns in SCI patients.

As soon as patient sustains SCI, predominantly a young adult male, his initial adjustment and adaptation to this non-fatal, severe injury depends on various factors like his previous psychological state, vocation, his commitments to his family and friends etc. Here the clinical psychologist helps the patient, his family and rehabilitation team so that he reasonably comes out of this catastrophic event in his life. Patients go through denial, anger, bargaining, depression and finally acceptance.

Social issue like, family financial commitments, insurance, alternate job suggestions are being dealt by the social welfare officers, particularly when the patient is the bread winner of the family additional expenditure will be incurred for transport and environmental modifications. Women with SCI are most severely affected in our society due to dominant nature of family and their betterhalves.<sup>56</sup>

### **Vocational Concerns**

Vocational development was markedly depressed during initial inpatient rehabilitation and 6 months after injury. Gradual improvement occurred after 6 months. But 2 years after discharge the level of development remained lower than before injury. The changes in vocational development overtime did not differ significantly by the level of functional independence. Goldberg scale of vocational development was used to measure the changes in the vocational development overtime.<sup>59</sup>

People with disability act 1996 gives due importance to the disabled people. In the state of TamilNadu, Commissioner for disabled a department under social welfare ministry headed by IAS officer deals with problems including vocational aspect. In Chennai, at Guindy a special centre 'Vocational Rehabilitation Centre'exclusively for locomotor handicapped is rendering its services.

In this hospital also, a vocational training, drawing, and radiomechanics are available. Discriminatory hiring practices, architectural and attitudinal barriers and transportation difficulties are the the barriers of successful employment.<sup>57</sup>

## **Environmental and Architectural Barriers**

Common barriers that hinder mobility include accessibility from road, to entrance of the house, inside the house, toilet seating and access of objects required for ADL.

Adaptation include modification inside the house like widening the door ways, raising the toilet seat with hand rails tor support, ramp in the entrance for wheel chair, electric switches within the reach of hand.

Modifications in the society lide ramps in building, separate parking space for disabled persons depends on Government policies.

Strict adherence to building infra-structural facilities for locomotor handicapped has to be in forced so that they can have successful community integration.<sup>58</sup>

Escrow Assessment Instrument helps to classify these barriers.<sup>74</sup>

# *Objectives*

## **OBJECTIVES**

The primary of the study is to understand the role of comprehensive rehabilitation on the functional outcome of the traumatic paraplegia patients at thoracic and lumbar Region. The factors considered are the degree of neurological injury, age and effect of rehabilitation, social and vocational factors. The secondary objectives are to study the demographic patterns like age, sex, cause etc.

# *Materials & Methods*



## **MATERIALS AND METHODS**

### **POPULATION**

Government Institute of Rehabilitation Medicine, is a main Catering Institute for the disabled persons not only from northern part of Tamilnadu, also from Pondicherry, border areas of Andhra Pradesh and Karnataka. Even from southern part of Tamilnadu patients are referred here for management.

About 50 consecutive patients of spinal admitted in this Institute at Chennai-83 were included in the study.

### **SETTING**

Tertiary Care Centre, Government Institute of Rehabilitation Medicines, Chennai-83 under Madras Medical College and Research Institute.

### **PERIOD OF STUDY**

Two years, from February 2009 to January 2011.

## **CRITERIA FOR STUDY**

1. Only pure traumatic cases of SCI were included in the study.
2. All patients at the time of admission have a definite neurological injury.
3. Age above 11 years and below 50 years were included.
4. Only the thoracic and thoracolumbar level injuries were included.
5. Patients within 18 months of injury were included.

## **EXCLUSION CRITERIA**

1. Age less 11 years and above 50 years were excluded.
- 2.. Spinal cord injuries above D6 were excluded.
3. Non-traumatic causes of SCI tumours, osteoporosis, pathological fracture dislocations etc., were excluded.
4. Patients with mental retardation or other debilitating diseases were excluded
5. Associated severe injuries of brain, chest, abdomen were excluded.
6. Post injury period of 18 months was excluded.
7. Patients treated with other system of medicines were excluded.

Patients satisfying these criteria were included in the study and all patients were assessed according to the proforma (Appendix).

## **SAMPLE SIZE**

Only 50 patients conformed to the above criteria during the period. About 18 patients were lost to follow-up.

## **OUTCOME MEASUREMENTS**

Each patient was assessed according to the proforma (Appendix) covering various aspects like age, sex, occupation, income, education, family status, mode and type of injury, transportation time lag to the primary level admission, duration or rehabilitation management, treatment, neurological status, mobility status etc.

The neurological level of injury and Motor Asia Scores were delineated according to the American Spinal Injury Association.

The functional assessment was done according to functional Independent Measure which includes 13 Motor and ADL Functional and 5 cognitive and social factors and measured on a 7 level scale from totally independent to totally dependent.

The interview with patient and patient relatives and other interactions with each other in the wards were utilized to assess the family support.

### **To modify support was stratified into:**

1. Sitting with / without support.
2. Standing with / without support.
3. Walking with calipers and aids.
4. Walking without aids.
5. Step climbing.

Each patient was assessed at admission, discharge and follow-up and time at which these abilities were achieved were notified. The average period of inpatient rehabilitation is 70 days. The data collected from above proforma was subjected to statistical analysis like mean, median, standard deviation, percentage, tables and tests of significance. Due to the strict protocol and consequencing of cases, have reduced bias.

## *Observation and Results*

## **OBSERVATION AND RESULTS**

The number of spinal cord injury patient taken up consecutively for the study is 50.

### **1. AGE**

The youngest is 14 years and oldest is 45 years, and the mean age of the patient in this study is 25 years 64% of the patients were in the age groups (6-30 years ). (bar diagram)

### **2. SEX**

Among the 50 patients in the study 44 were males and 6 females.

Males: 88%

Females: 12%

### **3. CAUSE OF SPINAL CORD INJURY**

Spinal cord injury secondary to falls constitute 92% (54 cases) SCI following road traffic accident were only 8% (5 cases).

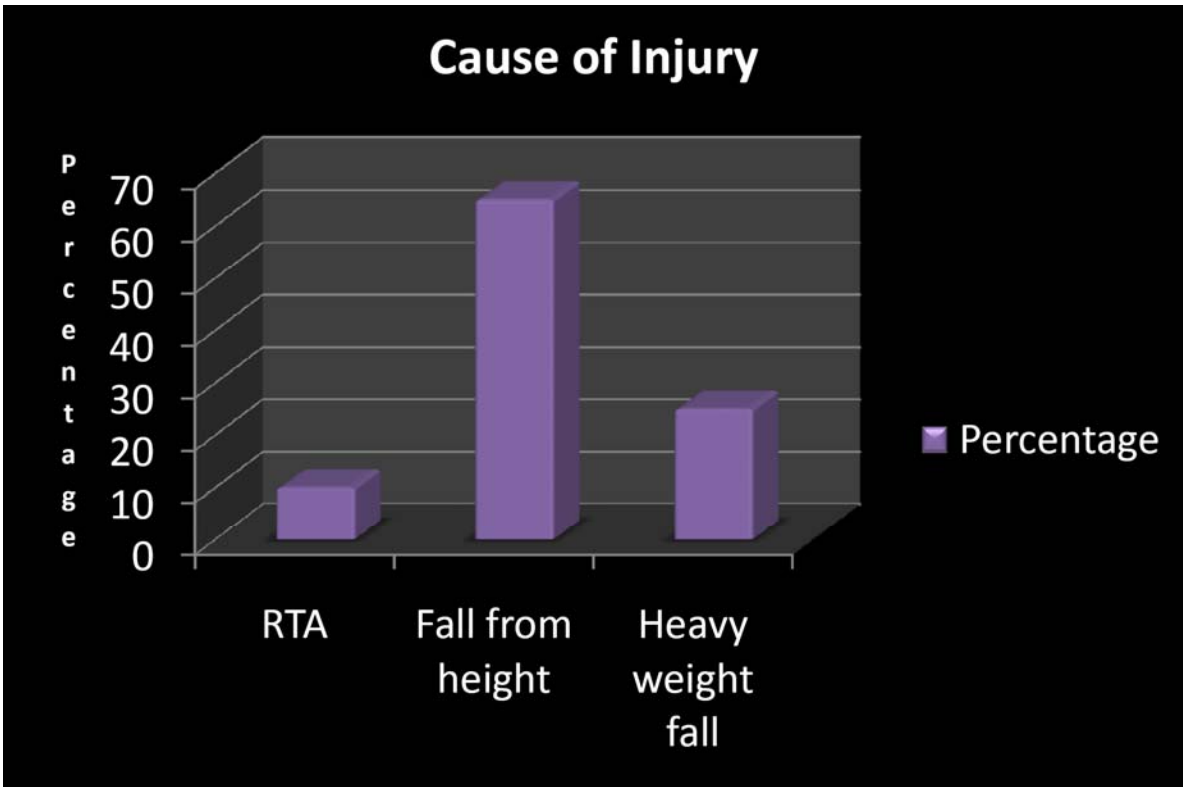
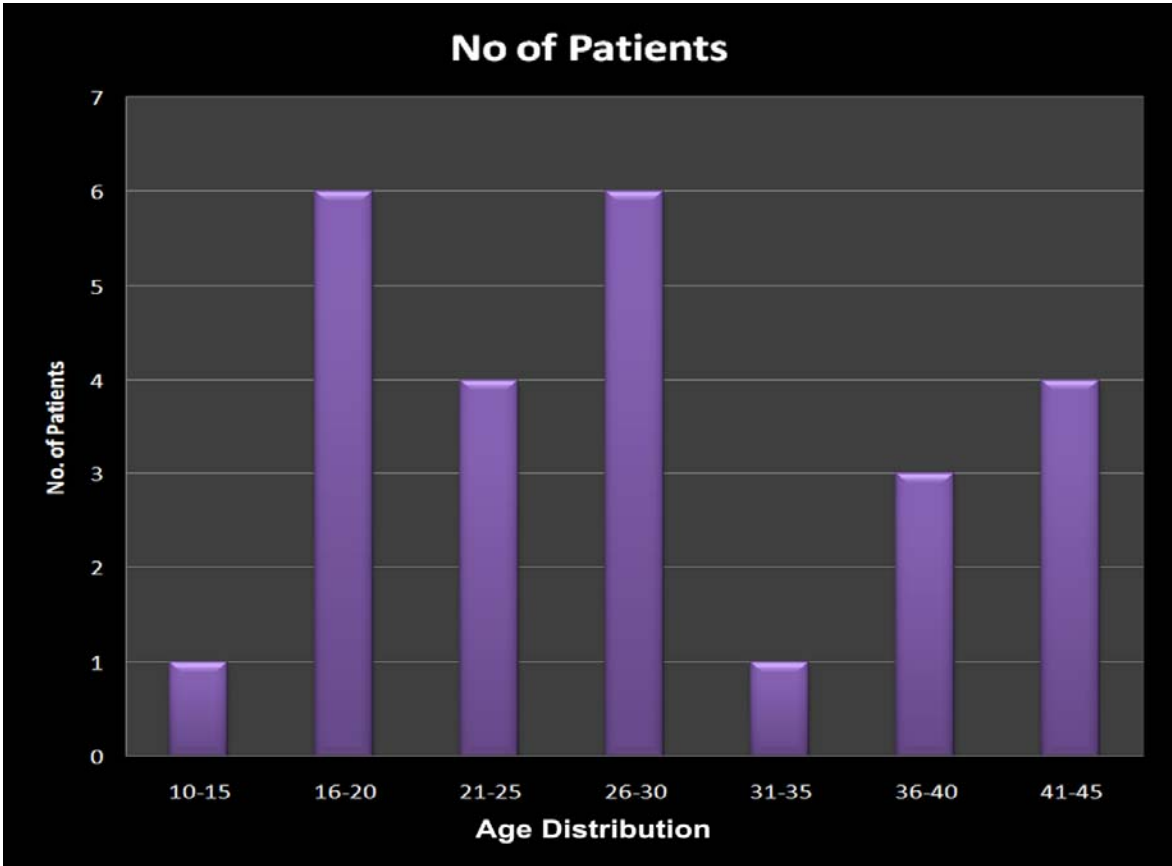
Among the SCI following falls (46 cases), 73.91% sustained injury due to a fall from height while in 26.08% it is due to fall of a heavy object on the back. (bar diagram)

### **4. MODE OF TRANSPORTATION**

Among all the patients in the study, only one patients was transported ideally in an Ambulance from the site of injury, 36% patients (18 patients) were actually carried manually to the Hospital. Rest of the patient used different other modes of transport like car, van bullock cart.

### **5. PLACE OF INJURY**

64% patients (32 cases) sustained SCI in rural and semi urban areas while 36% (18 cases) were from urban areas. Even among the urban areas 77% cases (14 cases) due to falls.



## **6. TIME LAG BETWEEN INJURY AND FIRST REFERRAL ADMISSION**

72% of cases (36 cases) reported to hospital within 12 hours (64% within 6 hours). The total mean value duration is 24.12 hours, while four patients was referred to first referral hospital after 1 week

## **7. SITE OF FRACTURE**

T12 LI junction was the most common site of fracture together comprising more than half the cases (56%). 36% of cases at T6-T11 while 8% occurred below L1.

## **8. MANAGEMENT OF VERTEBRAL INJURY**

30% of cases (15 cases) were managed conservatively while 70% (35 cases) were treated by surgical stabilization.

## **9. DURATION OF REHABILITATION MANAGEMENT**

The mean value of the length of stay at Hospital for Rehabilitation - management is 71.08 days.

## **10. ASIA SCALE CLASSIFICATION**

Among the 32 patients, (follow-up)

ASIA - A	22 patients on admission – none changed their Grade at follow – up.
ASIA - B	6 patients, only on patient moved to next grade at follow –up
ASIA- D	4 patients – both patients moved to grade E At follow – up





**Paraplegia patient walking on a parallel bar**



**Paraplegia patient walking with a pair of elbow crutches**



## **11. MOBILITY STATUS AT DISCHARGE**

n = 50    32% were wheel chair bound (14case)

56% were household ambulators (28case)

12% were community ambulators (6case)

On Follow-up 18.75% were wheel chair bound – 6 cases

n = 32            62.5% were household ambulatory – 20 cases

18.75% were community ambulatory – 6 cases

## **12. COMPLICATIONS**

About 48% of patient did not develop any significant complication during the rehabilitation management.

Among the complication pressure sores (61%) were the main complication while the urinary tract infection developed in about 46.15% of the patients.

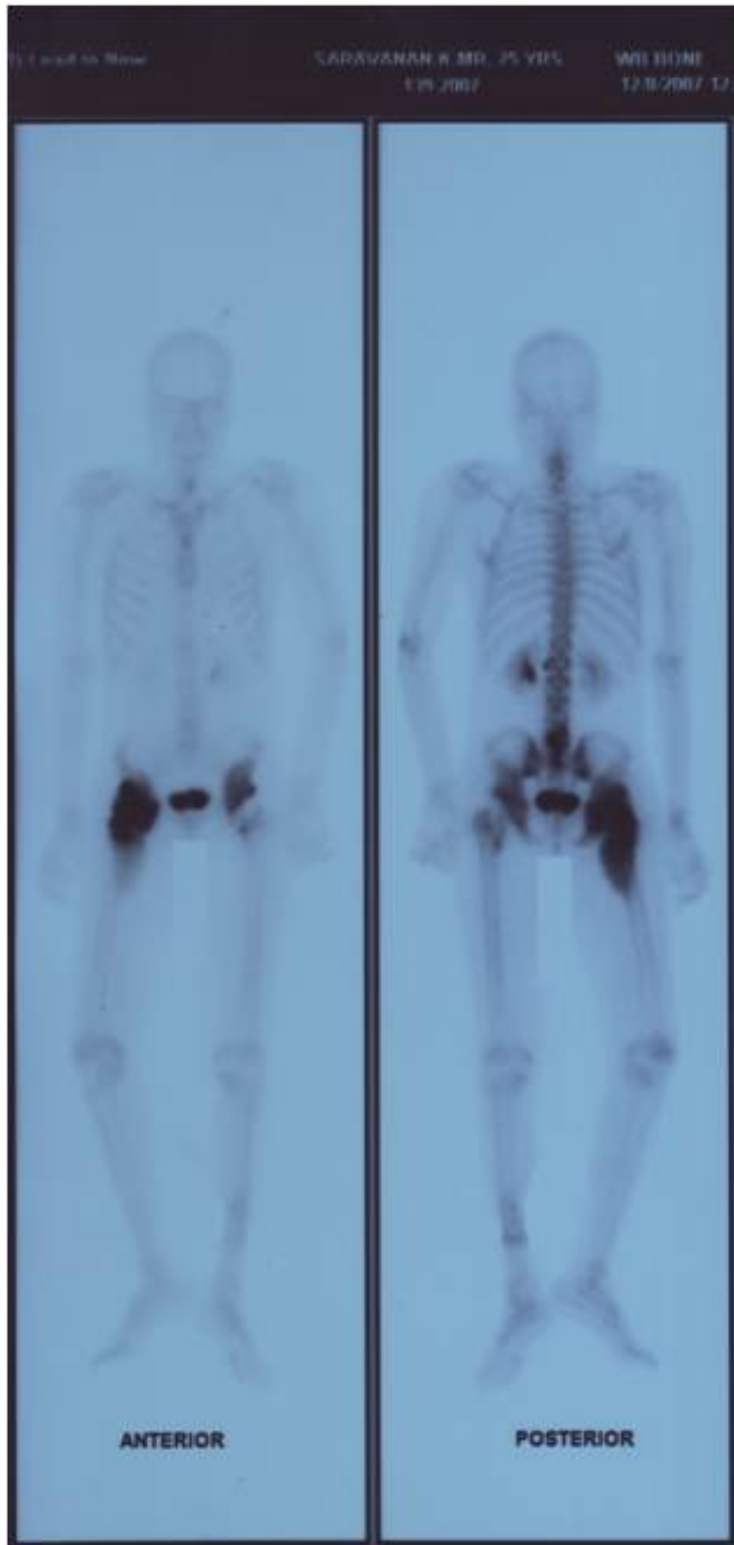
28% of patients developed other complications like penoscortal fistula stricture urethra, pain due to flexor spasms, bleeding from pressure ulceration leading to hypovolemia etc.

2 Patients developed heterotopic ossification and 4 patients developed deep vein thrombosis.



X-Ray of the right hip shows Heterotopic Ossification





**Tri-Phosphate Bone Scan-Heterotopic Ossification**

### 13. LEVEL OF EDUCATION

48% of patients on the study were either illiterate or just have primary level of education, while 52% of patients have high school or higher level of education. (diagram)

### 14. OCCUPATION

Agricultural laborers 36% and skilled laborers (32%) constitute the major occupation of the patients in the study. (diagram)

### 15. INCOME

Already 60% patients were earning an income less than Rs.1000/- per month prior to the spinal cord injury.

At follow-up, among 32 patients, about 68.75% were not earning any livelihood and they are completely dependent financially.

### 16. MARITAL STATUS

48% of patients were married and supported by their spouse.

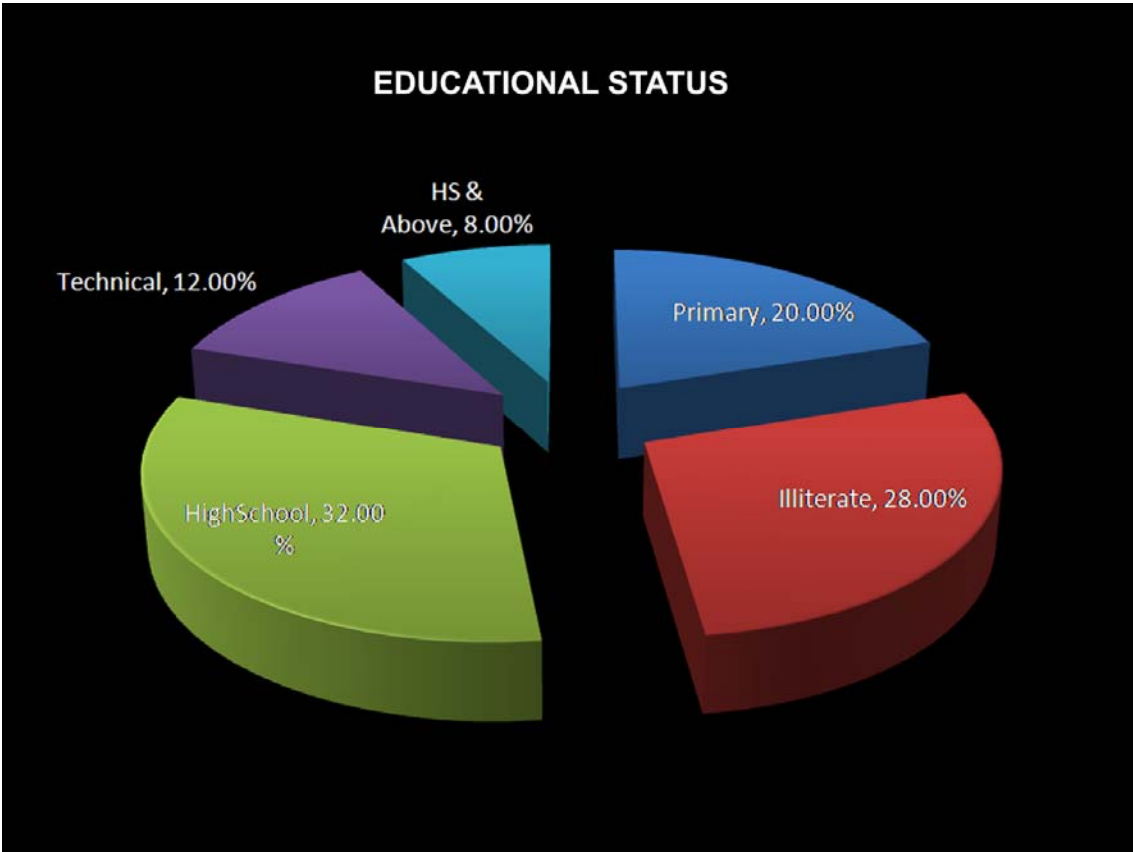
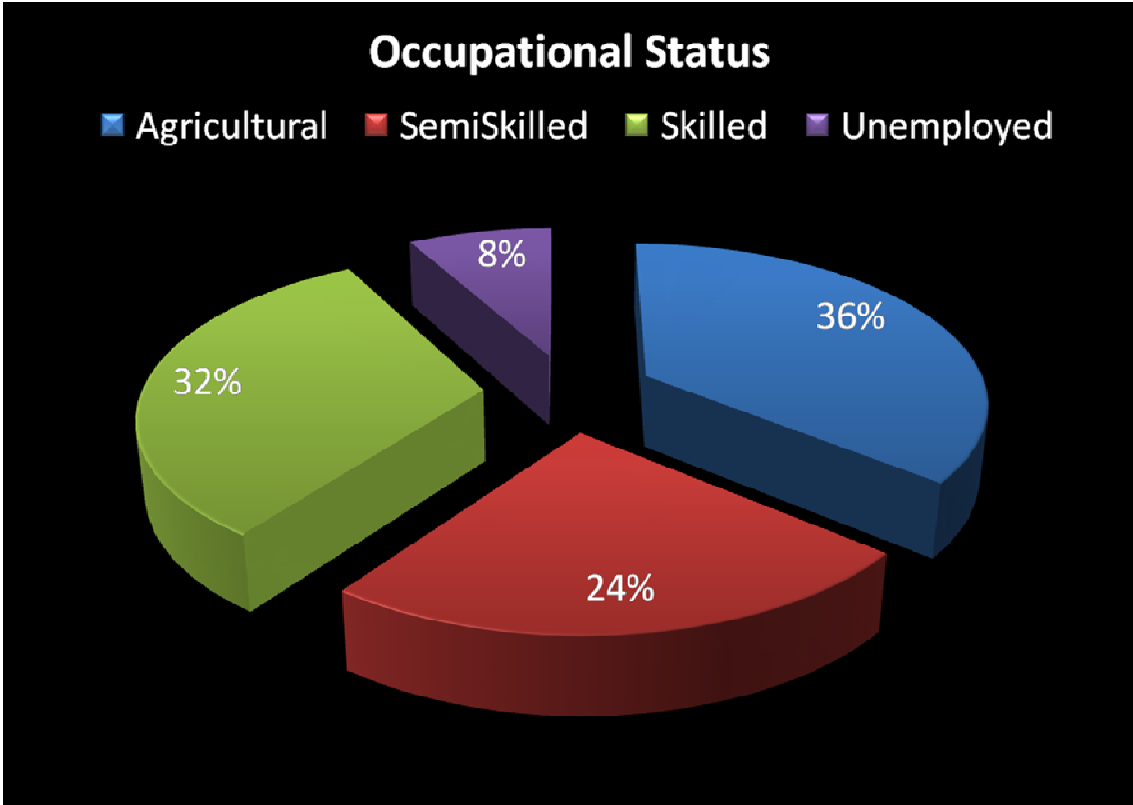
**TABLE 1**

### FIM SCORES

	<b>N</b>	<b>Mean</b>	<b>SD</b>	<b>'t' Value</b>	<b>Significant at 0.01 Level</b>
Admission	50	77.20	22.79	4.64	Significant
Discharge	50	101.6	13.01		

The above table shows the mean, SD and 't' value of the Functional Independent

Measures of the spinal cord injured patients during admission and discharge and the 't' value of 4.64 is significant at 0.01 level indicating the mean difference between admission and discharge scores of FIM is significantly different.



**TABLE 2**

**FIM SCORES**

	<b>N</b>	<b>Mean</b>	<b>SD</b>	<b>'t' Value</b>	<b>Significant at 0.01 Level</b>
Admission	50	77.20	22.79	4.84	Significant
Follow-up	32	105.43	14.57		

The above table shows the mean, SD and 't' value of the Functional Independent measures of the spinal cord injured patients during admission and follow-up and the 't' values of 4.84 at 0.01 level indicating the mean difference between admission and follow-up scores of FIM is significantly different.

**TABLE 3**

<b>Neurological Injury Status</b>	<b>N</b>	<b>N</b>
Complete cord injury	36	72%
Incomplete and injury	14	28%

The above table shows the neurological injury status of the patients in the study in percentage and it is evident from the table that nearly 3/4th of the patients sustained complete cord injury.

**TABLE 4****ASIA MOTOR SCORES**

	<b>N</b>	<b>Mean</b>	<b>SD</b>	<b>'t' Value</b>	<b>Significant at 0.01 Level</b>
Admission	50	59.2	13.07	0.34	Not Significant
Follow-up	50	60.5	14.6		

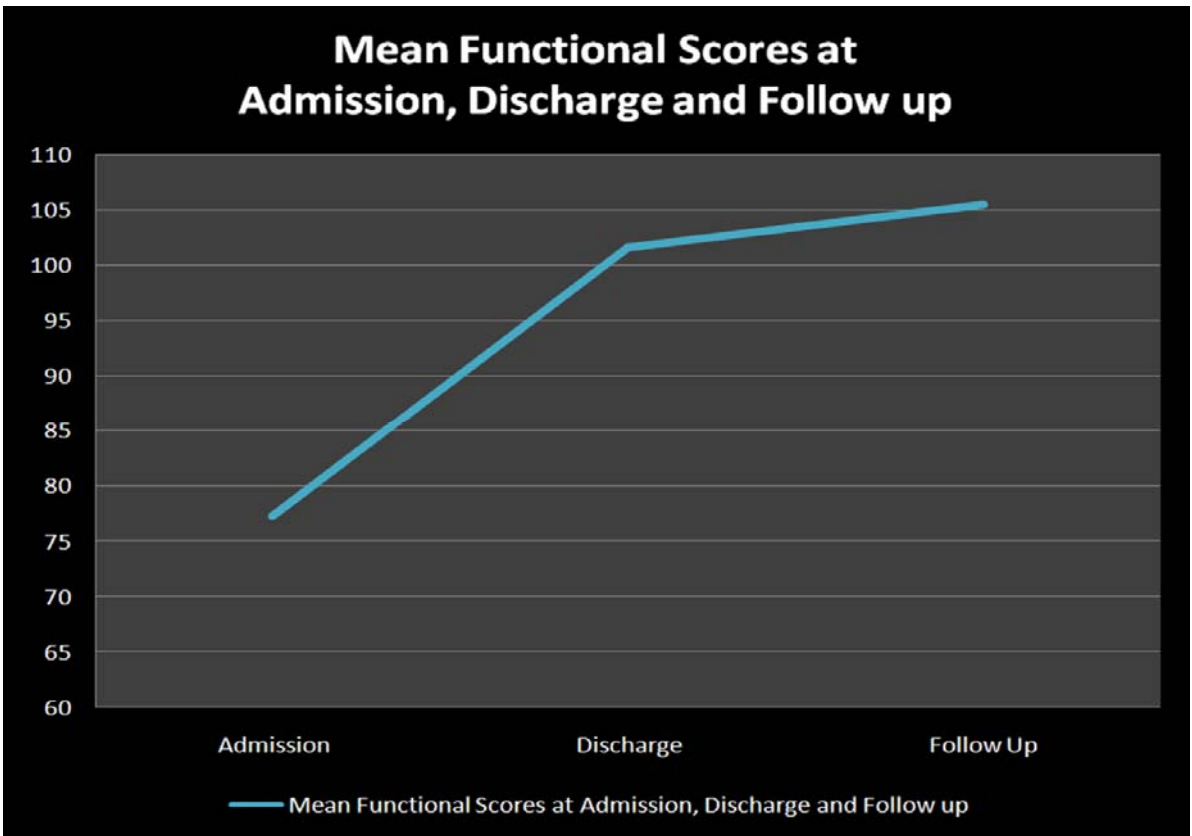
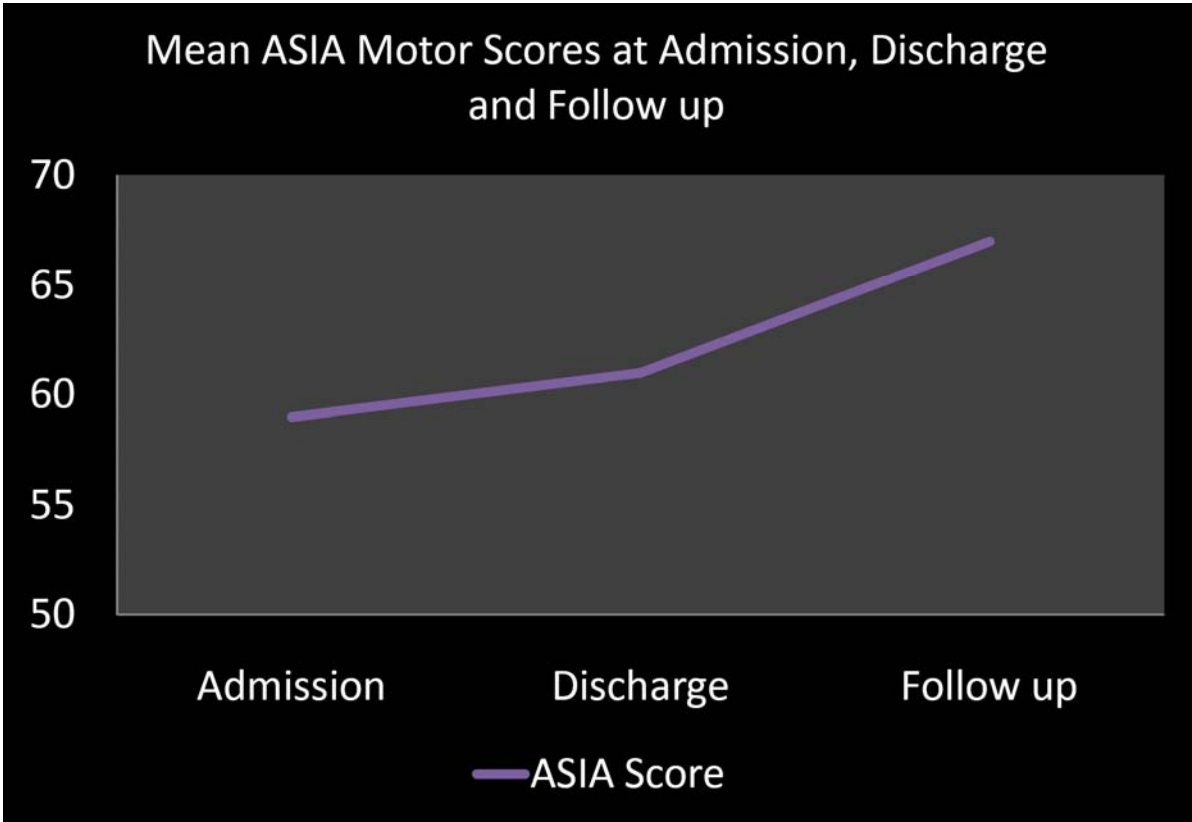
The above table shows the mean, SD and 't' value of the Asia Motor scores the patients during admission and discharge and the 't' value of 0.34 is insignificant at 0.01 level indicating the mean difference between admission and discharge scores of AMS is not significantly different.

**TABLE 5****ASIA MOTOR SCORES**

	<b>N</b>	<b>Mean</b>	<b>SD</b>	<b>'t' Value</b>	<b>Significant at 0.01 Level</b>
Admission	50	59.2	13.07	1.63	Not Significant
Follow-up	32	67.5	16.64		

The above table shows the mean, SD and 't' value of the Asia Motor scores the patients during admission and follow-up and the 't' value of 1.63 is insignificant at 0.01 level indicating the mean difference between the admission and follow-up scores of AMS is not significantly different.





**TABLE 6**

**FIM SCORES AND NEUROLOGICAL LEVEL**

<b>Neurological Level</b>	<b>Admission</b>	<b>Discharge</b>	<b>Followup</b>
Complete Cord Injury	53% (n = 36)	77% (n = 36)	77% (n = 18)
Incomplete Cord Injury	82% (n = 14)	91% (n = 14)	95% (n = 14)

The above table shows the functional independence measures of spinal cord injured patients during admission, discharge and follow-up among the patients who sustained complete cord injury when compared to incomplete cord injury.

**TABLE 7**

**Asia Motor Score and Neurological Level**

<b>Neurological Level</b>	<b>Admission</b>	<b>Discharge</b>	<b>Follow up</b>
Complete Cord Injury	53% (n = 36)	53% (n = 36)	53% (n = 18)
Incomplete Cord Injury	75% (n = 14)	79% (n = 14)	81% (n = 14)

The above table shows the Asia Motor Score of spinal and injured patients during admission, discharge and follow-up among the patients who sustained complete cord injury when compared to incomplete cord injury.

**TABLE 8****Age and FIM Scores**

<b>Age</b>	<b>Admission</b>	<b>Discharge</b>	<b>Follow up</b>
Below 15 Years	53% (n = 2)	68% (n = 2)	-
15-30 Years	60% (n = 32)	78% (n = 32)	80% (n = 24)
30-45 Years	57% (n = 16)	78% (n = 16)	78% (n = 8)

Table 8 shows the FIM scores of the patients during admission discharge, and follow-up among the patients with various age groups in percentage.

**TABLE 9****Level of Injury & FIM Scores**

<b>Level of Injury &amp; FIM Scores</b>	<b>Admission</b>	<b>Discharge</b>	<b>Follow up</b>
T12 and above	54% (n = 26)	68% (n = 26)	75% (n = 10)
L1 and below	75% (n = 24)	87% (n = 24)	88% (n = 22)

Table 9 shows the FIM scores of the patients during admission discharge, and follow-up among the patients with different level of injury in percentage

# *Discussion*

## DISCUSSION

This is a study of 50 patients of consecutive traumatic spinal cord injured patients at the thoracolumbar segments. Of the 50 patients included in the study during one year only 64% patients turned up for follow-up study.

The mean age of the patient in the study is 28years, comparable to a study from similar developing country Turkey<sup>9</sup> where it is 31.3 years. Irrespective of the age of the patient, all patients have shown significant functional independence when comparing FIM scores of admission, discharge and follow-up (Table 8). This is comparable to a study on exclusively Paediatric<sup>64</sup> and Geriatric<sup>65</sup> SCI rehabilitation where both groups have shown satisfactory improvement in function following rehabilitation.

There is male preponderance in this study with 88% of the patients are male, (8:33:1) comparable with the previous studies Madras<sup>4</sup>, Turkey<sup>9</sup>, Fiji<sup>8</sup>, etc.

About 92% of cases in this study caused by falls, in contrast to Western Studies, Turkey 37.3%, Fiji 38.7% while Road Traffic Accidents as a cause of Injury in only 2% of cases in this study.

Only 4% of the patient (two cases) was transported ideally in an ambulance from the site of injury and 36% of patients (18 patients) were actually carried manually to the Hospital, which indicates the very poor awareness of the patients about the initial first aid management of SCI patient. This may be due to the fact that 64% of patients sustained injury in Rural / Semi-urban areas and 48% patients were either illiterate or just had primary level of education (diagram).

The same above factors may also be the cause of the higher percentage as high as 72% of complete cord injury compared to 28% of incomplete cord injury patient. (Table 3) There is an inverse relationship between the FIM score and the severity of the spinal cord lesion as revealed by the table 6, which is consistent with previous studies Drewes AM et al study from Netherlands. Asia Motor Scores of these patients also confirms the neurological degree of lesion evidenced by failure of recovery at the follow-up (Table 7).

Even though 72% of cases were shifted to the Tertiary care hospital within 12 hours the higher degree of complete cord injury as high as 72% could be due to the poor educational level, lack of awareness about the first aid management and occurrence of majority (64%) of injuries at Rural/semi-urban areas. Associated with these, higher level of conservative line of management adopted in the tertiary care centers as high as 84% overlooking possible secondary causes of the SCI, as 64% cases reported to the hospital within 6 hours may be an additional factor. The degree of initial impact leading to primary injury may be above all the most important factor in deciding degree of neurological injury in above cases, which is under a primary prevention strategy of the spinal cord injury. If all above factors are considered the degree of spinal cord injury can be curtailed to a lesser extent.

Frenkel classification of SCI and ASIA Modification of the cases in the study also reemphasizes the above fact as evidenced in the observation No.18.

T12 L1 junction was the most common site of fracture together comprising more than half the cases in the study (56%). There is an inverse relationship between the FIM score and the neurological level supports the clinical observation that functional independence in SCI is reduced in individuals with higher neurological impairment as evidenced in the table 9. Middleton J.W and Truman G of Sydney also emphasized the same fact.<sup>68</sup>

The severe disease effect of SCI particularly in Thoracic and Thoracolumbar segment is the decreased efficiency of independent ambulation as revealed by 88% of the patients are either wheel chair bound or house hold ambulators with calipers and crutches (56%). This fact may be due to the lesser number of patients (8%) with lesions below L1 and as high as 72% of patients (36 cases of complete cord injury) with Asia scale A. But Wheel chair mobility as mode of ambulation if considered all 100% patients are independent in ambulation. Again the degree of neurological impairment and level of lesion determines the ambulatory outcomes of the patient as also observed by Drewes AM<sup>66</sup>, Middleton JW<sup>68</sup>

The duration of Rehabilitation is about 71.08 days, which is comparable to a study from Hongkong<sup>69</sup> where the duration of Rehabilitation period is about 84 days. The pressure ulcers were the main complication compared to Urinary tract infection (46%) comparable, to study made by MeKinley WO and Jackson of Virginia University, USA.<sup>70</sup>

Functional Independent Measure, measure that is useful particularly motor items<sup>60</sup> in SCI. The mean, (Mean Functional Score-graph) Standard deviation and 't' value of FIM scores of the SCI patients during admission, discharge and is shown in Table 1. Admission and follow-up is shown in table 2. The 't' value of 4.64 and 4.84 of the above is significant at 0.01 level indicating the mean difference between admission and discharge and admission and follow-up scores of FIM is significantly different. Comprehensive rehabilitation program instituted by the Rehabilitation team is one of the important cause of this result. This is in comparison with many such studies like Hall KM, USA (1999)<sup>60</sup>, Middleton JW<sup>68</sup>, Australia (1998), Yarkony GM USA (1990)<sup>69</sup> where FIM was used as a tool and also in studies like Drewes AM, Denmark (1989)<sup>66</sup>, where modified Barthel Index was used as a tool.

In this study the mean, Standard deviation and 't' value of Asia Motor scores of the SCI patients during admission, discharge and is shown in Table 4. Admission and follow-up is shown in table 5. The 't' value of 0.34 and 1.63 of the above is insignificant at 0.01 level indicating the mean difference between admission and discharge and admission and follow-up scores of AMS is not significantly different. This is due to the fact the majority of patients (72%) sustained complete cord injury where the potential for recovery is poor (Table 3). During the follow-up all incomplete cord injury patients (14 patients, Table 4) reported and hence an increase in Asia Motor Scores is noticed in the graph.



As such 60% a patients are earning income of 1000/- or less and about 88% patients are male patients. Almost all patients in their peak of their youth expect one. 36% of the patients are agricultural laborers where only 32% constituted skilled, rest one and unskilled personal (diagram). As high as 69% in the follow-up patients are not earning any livelihood, eventhough majority of patients is in the peak of their youth. The level of vocational development remained lower than that before injury as compared to by Alfred WG et al 1987.<sup>59</sup> District rehabilitation centers and the social welfare officer should interact with one another to get a better result.

Nearly 48% patients were married and are well supported by their spouse and family members. Compared to western culture, our cultural factor play a major role, there is no reports of marital disharmony in our study. Even where spouses not present, mother takes care of their injured children.

Autonomy of the patient is mainly blocked by architectural barriers in and around the house of the patient. (60% - uneven terrain, 60% open ground for toilet; 56% steps at the entrance, etc.). Modification in the architectural barrier puts further financial constraints on the patient as 60% of patient earning a pre injury livelihood of Rs.1000 or less and about 69% has no post injury income.

The objective of the study i.e. Rehabilitation Out come study reveals inpatient rehabilitation has significant functional gains in terms of self-care & wheel chair mobility avoiding complications of spinal cord injury like pressure sores & UTI as evidenced by FIM scores. (FIM Graph).

The overall Rehabilitation outcome of SCI patient is affected by multiple factors like family, level of education, occupation and the social environment. SCI Rehabilitation should be concentrated on these aspects to have much better outcome.

District Rehabilitation centers in each districts, Vocational Rehabilitation centers in head quarters, vocational evaluators and social welfare officers of the tertiary care hospitals in association with non – governmental social welfare organizations like Rotary, Ability foundation etc. should be able to give more meaningful life to SCI patients in terms of vocation and financial independence and will reintegrate these persons into the society. Community based Rehabilitation programmers with patient, family members, local village level health care providers is another alternative.

This Rehabilitation out come study is limited by small sample size cross sectional nature, data from a single Rehabilitation sitting and there is lack of community based controls.

# *Conclusion*

## CONCLUSION

1. The spinal cord injury has a high male dominance with an average age of 28 years.
2. Fall from a height constitute a major cause of spinal cord injury. The lack of awareness of first aid management of the spinal cord injured patient and transportation method has worsened the degree of injury.
3. Early surgical decompression and stabilization at tertiary care hospitals is needed to further improve the Rehabilitation outcome of the SCI patients as there is advanced surgical treatment is available in most of our centers.
4. The incidence of complications can be reduced minimum by Rehabilitation.
5. Functional improvement is significant in all patient despite majority of patients had complete spinal cord injury.
6. Education has an important role in outcome of the spinal cord injury patients.
7. Loss of vocation, unable to adapt to newer vocation and subsequent financial loss burdens the SCI patient and vocational evaluation and counseling is important in SCI Rehabilitation.

8. Environmental barriers at home and family support play an important role and this needs counseling in aspects of social security and environmental modifications.

9. Integrated services of DRC, VRC, NGO and tertiary care hospitals will enhance quality of life for SCI patients.

10. Comprehensive Rehabilitation centers integrated with community based Rehabilitation will further improve the quality of life in the long run, and will integrate SCI patients as productive members of the society.

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# *Appendix*

**PROFORMA FOR DISSERTATION  
TRAUMATIC PARAPLEGIA-REHABILITATION OUTCOME STUDY**

CASE NUMBER:-

**PRIMARY DATA:-**

1) Name:-

2) Age:-

3) Address:

4) Sex:-

5) Place of Injury:-

- Rural
- Semi urban
- Urban

6) Mode of Injury:-

- Fall
- R.T.A
- Other

7) Mode of Transport:-

- Manual
- Rickshaw
- Auto
- Car
- Ambulance
- Other



8) Number of persons involved in Transport:-

1(one)

2(two)

3(three)

3 or more than three

9) Time lag between onset of neurological deficit and injury:-

Immediate

Delayed

10) Time lag between injury and first referral admission:

Hours

Days

11) Duration of Acute care Management:-

Date of admission :

Date of discharge :

12) Duration of Rehab care Management:-

Date of admission :

Date of discharge :

13) Associated injuries:-

Head injury

Chest injury

Visceral injury

Appendicular injury

14) Co-morbid conditions:-

Diabetes mellitus

Hypertension

Ischaemic Heart Disease

Other

15) Acute care management of vertebral injury:-

A) Conservative 1) postural reduction

2) only bed rest

3) Traction

Period of immobilization:-

B) Surgical 1) Decompression Laminectomy alone

2) Harrington rod

3) Leuke rods

4) Hartshell rectangle

5) Steffi plate

17) Duration between onset of traumatic paraplegia and time of surgery:-

18) Role of Investigation:

1) Plain x ray only

2) CT scan

3) MRI

19) Role of methyl prednisolone/steroids in Acute care management,  
Administered or Not

20) Vertebra involved:-

**DATA PERTAINING TO SOCIAL, VOCATIONAL AND PSYCHOLOGICAL ASPECTS:-**

21) Educational status:-

Illiterate

Primary

High school

Higher secondary

Graduate

Post graduate

Technical

22) Family status:-

1) Marital status

- a) Married
- b) Unmarried
- c) Widower

2) Type of Family :- Nuclear

Joint Family

23) Occupation:-

- White collar
- Agriculturer
- House wife
- Business
- Student
- Seasonal workers
- Unemployed
- Others

24) Income per month:-

- Below 500,
- 501 – 1000
- 1001 – 1500,
- 1501 – 2000
- Above 2000

25) Housing Details:-

- 1) Type of house-
  - Thatched
  - Tiled
  - Terrace
- 2) No of Rooms;
- 3) Geographical location-
  - Urban
  - Semi urban
  - Rural

## 26) ARCHITECTURAL BARRIERS

1) Distance from Bus stop / Railway station to the House

2) En route to House from Bus stop

Tarred Road

Mud Road

Through paddy fields

3) Entrance to House :-

a) steps

b) Ramp

c) Lift

4) Width of door:

72 inches : adequate or not

5) Adequate space for mobility in the room: Yes or No

6) Flooring

Mud

Cemented

Mosaic

7) Toilet facilities

a) Inside the house

Outside the house

b)Type:-

1)Indian type squatting

2)Western type

3)Open ground

**PROGRESS CHART**

27) Higher mental functions:            Admission    Discharge    Follow up

28) Upper Limbs:

29) Motor level:-

- a) Level of total preservation
- b) Level of partial preservation
- c) Level of total loss

30) Motor Index Score:

Right	Right		Left	Left
Discharge	Admission		Admission	Discharge
		C 5 Biceps		
		C 6 E.C.R.		
		C 7 Triceps		
		C 8 Ext.Indices		
		T1 Abd.Pol.Br		
		L2 Psoas		
		L3 Quadriceps		
		L4 Tib.Antr.		
		L5 E.H.L.		
		S 1 Soles		
		Total Score		

31)Sensory Evaluation:-

- a)Level of total preservation
- b)Level of partial preservation
- c)Level of total loss
- d)Sacral sensation

32)Reflexes:-

- a)Abdominal
  - Uppers
  - Lower
- b)Cremasteric reflex
- c)Anal Reflex
- d)Bulbo cavernous reflex
- e)Plantar reflex
- f)Knee jerk
- g)Ankle jerk

33) Neurological Status:-

- Complete
- Incomplete

34)Neurological Level Injury:

35) ASIA – Scale classification:

36) Bladder Evaluation:-

- 1)On indwelling catheter
- 2)On supra public catheter
- 3)On intermittent catheterization
- 4)Reflex evacuation (UMN)
- 5)Normal voiding

37) Bowel Assessment:-

- 1) Incontinent
- 2) Continent
- 3) Constipation
- Digital evacuation
- Enema

38) Sexual function:

- 1) Normal
- 2) Reflex erection
- 3) Voluntary erection
- 4) Ejaculation
- 5) Neoerotic areas

39) Psychological status:

- 1) Anxiety
- 2) Depression
- 3) Normal

40) Mobility status:-

- 1) Bed mobility
- 2) Wheel chair transfer and self propulsion
- 3) Standing with calipers and axillary crutches
- 4) Walking with calipers and axillary crutches
- 5) Walking with axillary crutches but with calipers.
- 6) Walking without calipers- independently
- 7) Step climbing

Community ambulation – Tricycle

#### 4) COMPLICATIONS:

1)Urinary tract infection

2)Pressure sores:

Site

Number

Grade

3)Spasticity:

4)Contractures:

5)Others:



**FUNCTIONAL INDEPENDENT MEASURE**

**Score sheet**

- 7 – Complete Independence (Timely, Sagely) **NO HELPER**
- 6- Modified Independence (Device) **NO HELPER**
- Modified Dependence
- 5-Superviseion **HELPER**
- 4-Minimal Assist (Subject = 75% +) **HELPER**
- 3-Moderate Assist (Subject =50%+)**HELPER**
- Complete Dependence **HELPER**
- 2-Maximal Assist (Subject = 25%+)
- 1-Total Assist (Subject = 0%+)

Self care      Admission      Discharge      Follow-up      69

- A.Feeding
- B.Grooming
- C.Bathing
- D.Dressing-Upper body
- E.Dressing-Lower body
- F.Toileting

Sphincter control

G.Bladder management

H.Bowel management

Mobility

Transfer

I.Bed, Chair, Wheel chair

J. Toilet

K.Tub, Shower

Locomotion

L.Walk/Wheel chair

M.stairs

Communication

N.Comprehension

O.Expression

Social Cognition

P.Social Interaction

Q.Problem Solving

R.Memory

**TOTAL**