

THE PATTERN OF TRAUMATIC SPINAL CORD LESIONS IN SINGAPORE—AN ANALYSIS OF 70 PATIENTS ADMITTED TO THE SPINAL UNIT, DEPARTMENT OF REHABILITATION MEDICINE, TAN TOCK SENG HOSPITAL

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SYNOPSIS

Since 1973, the Department of Rehabilitation Medicine (DRM) has admitted patients with traumatic spinal cord lesions for management and rehabilitation. An analysis of 70 patients admitted over two years is presented to indicate the pattern of such spinal cord injuries, in particular the aetiology of spinal trauma—an unusually high incidence arising from Industrial Accidents. An analysis of Hyperextension Injuries of the cervical spine with acute central cord syndrome is also presented.

INTRODUCTION

The DRM admitted its first patient on 27.3.73. Presently, it comprises three wards, a large gymnasium for physical therapy and an occupational therapy section including facilities for assessment of activities of daily living (ADL). The Department is managed by a team of doctors trained in physical medicine and rehabilitation, nurses trained in spinal injuries management and rehabilitation, physical and occupational therapists, a full-time medical social worker and a part-time clinical psychologist. The team approach is supervised by a group of visiting consultants in orthopaedic surgery, neurology and urology. The Disablement Resettlement Officer (DRO) from the Ministry of Labour is involved in the vocational rehabilitation of the patients.

MATERIAL AND METHODS

The DRM admits about 350—400 patients a year from the four main general hospitals. The patients have suffered from spinal injuries with neurological deficit, stroke with hemiplegia, non-traumatic paraplegia and tetraplegia arising from transverse myelitis, spinal tumour etc., and arthropathies. In addition there are amputees and patients with head and multiple injuries of the locomotor system.

The vertebral column may be subjected to a wide variety or combination of stresses resulting in dis-

location, fracture or fracture-dislocation. In addition, Hyperextension Injuries in particular of the cervical spine may be associated with little or no apparent bony injury apart from facial and frontal injuries. These result in traumatic lesions of the spinal cord with varying degrees of neurological deficit ranging from incomplete to complete lesions.

In the following analysis of 70 patients with traumatic spinal cord lesions admitted to the DRM over a period of two years, the figures present a characteristic clinical pattern and thus establish a profile of typical lesions affecting various age groups.

RESULTS

Incidence (Table I)

The incidence of these lesions is calculated on a total of 30 patients who were injured in 1974. This year is chosen because it is the only complete year. The incidence does not take into account those patients who were not admitted to the DRM due to death or perhaps admission to private hospitals in the island but this can be assumed to be rare. Thus the calculated annual incidence per million population is 13.7 and is thus comparable to other highly industrialised and developed countries where it is generally 12—15 per million population per year. The lesions are more common in males—the ratio being nine males: one female. This is not surprising as will be seen on reviewing the aetiological factors. However, it should be noted that of the seven females, four had established mental illness prior to their injury. The Chinese, being the most populous in the island, account for 77 per cent of the injuries.

Admissions (Table II)

In the initial stages, only 23 per cent of the patients were admitted in the first week of injury and in a latter study on the effects of later admission on the state of the neurogenic bladder we found that significant problems were faced with in urological

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TABLE I

THE PATTERN OF *TRAUMATIC SPINAL CORD LESIONS* IN SINGAPORE
AN ANALYSIS OF 70 PATIENTS ADMITTED TO THE SPINAL UNIT,
DEPARTMENT OF REHABILITATION MEDICINE,
TAN TOCK SENG HOSPITAL

| | | | |
|------|---------|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Sex | Males | 63 | NOTE 4 Females with Mental Illness Annual Incidence Based on 30 Injuries Arising in 1974 = 13.7 Per Million Population [Population 1974 = 2.2 Million] |
| | Females | 7 | |
| Race | Chinese | 54 | |
| | Indian | 7 | |
| | Malay | 9 | |

TABLE II

| Duration of Lesion Prior to Admission to DRM | Number of Patients |
|----------------------------------------------|--------------------|
| Less than 1 week | 16 |
| Less than 2 weeks | 13 |
| Less than 4 weeks | 16 |
| Less than 8 weeks | 10 |
| Less than 6 months | 10 |
| More than 6 months | 5 |

| Duration of Stay in DRM | Number of Patients |
|----------------------------------------------|--------------------|
| Less than 1 month | 11 |
| Less than 2 months | 14 |
| Less than 3 months | 11 |
| Less than 6 months | 30 |
| More than 6 months | 4 |
| Transferred for Permanent Institutional Care | 4 |

NOTE 3 Patients C5 Level
1 Patient L1 Level
(Schizophrenia)

management. The policy of the DRM is not to keep patients longer than six months and in the analysis 50 per cent stayed up to three months and only four patients had to be finally transferred for permanent institutional care: of these, three patients were tetraplegics who also had associated diseases and one patient was a schizophrenic.

Age Groups (Fig. 3)

The age group 15—35 years accounts for more than 50 per cent of the total. These figures are comparable to those quoted in the U.K. Of particular interest are the increasing numbers of cervical spinal cord injuries in the older age groups. There seems to be three notable "spikes" of this type of injury arising in the following age groups: 15—25 years; 46—55 years; 66—75 years. The high incidence in the two older groups could be accounted for by an underlying factor probably cervical spondylosis coupled with the fact that the cervical spinal (neural) canal seems to be narrower in the Chinese.

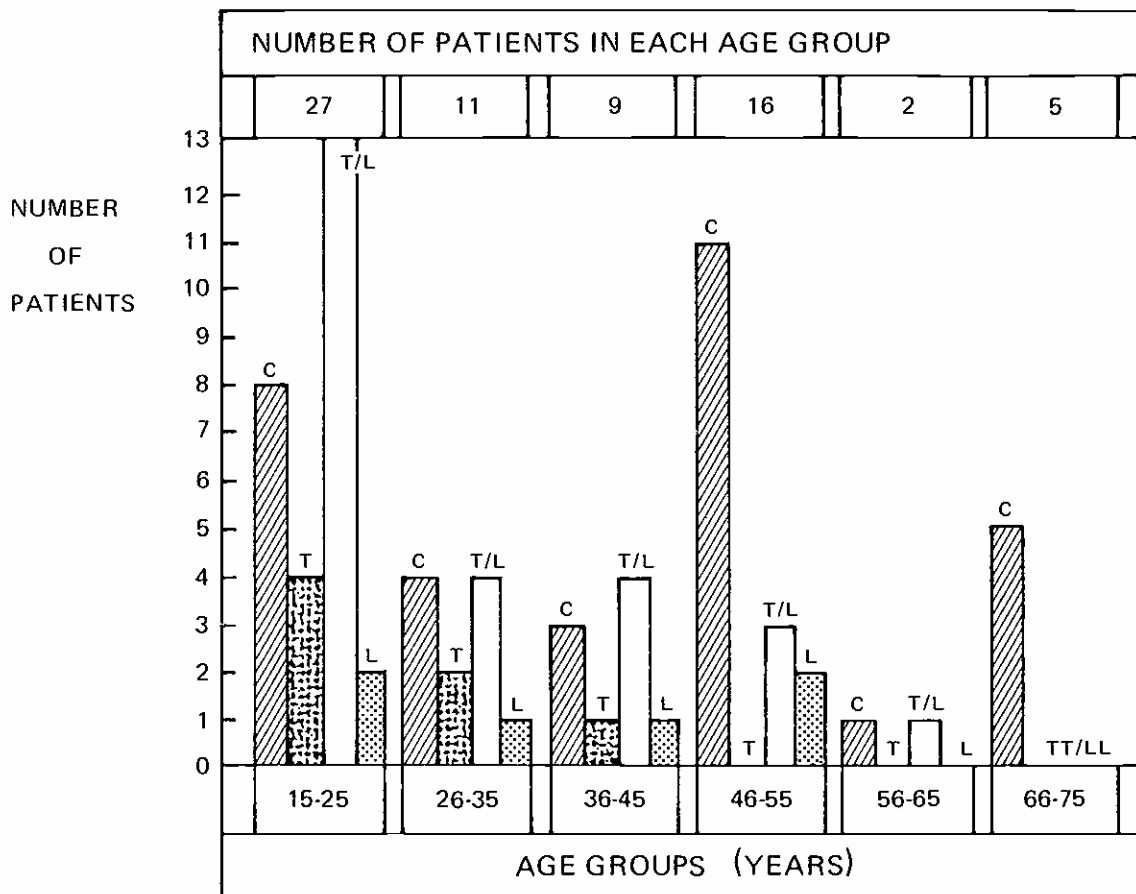
Thoracolumbar injuries are commonest in the younger age groups particularly 15—25 years group and practically non-existent in the older groups. A declining incidence as age progresses is also noted for the upper thoracic lesions.

Clinical (Neurological) Patterns (Fig. 4)

This table depicts the clinical pattern of spinal cord lesions at different spinal levels. Each dot represents one patient and the encircled dots denote complete lesions. Notably, the incidence of cervical lesions is the highest accounting for nearly 50 per cent of the lesions but complete lesions are very uncommon. On the contrary, all the seven patients in the upper thoracic lesion group had complete lesions. In the thoracolumbar region, a mixture of complete and incomplete lesions is seen and below L1 level all six patients were incomplete lesions i.e. Cauda Equina lesions.

Aetiology of Spinal Trauma (Table V)

In most industrialised and developed countries, road traffic accidents (RTA) account for the large majority of spinal cord trauma. In New South Wales (Australia) 44 per cent were due to RTA with sports (particularly diving) injuries accounting for 23 per cent. In the U.K. series 40 per cent were due to RTA, 20 per cent due to sports injuries and 8 per cent due



| | | | |
|-----|-----|---------------------------------|--|
| KEY | C | CERVICAL LESIONS C1 – C8 | |
| | T | THORACIC LESIONS T1 – T9 | |
| | T/L | THORACO/LUMBAR LESIONS T10 – L1 | |
| | L | LUMBAR LESIONS L2 – L5 | |

| | |
|------|---------------------------------------------------------------|
| NOTE | AGE GROUP 15-35 YEARS ACCOUNTS FOR MORE THAN 50% OF PATIENTS. |
|------|---------------------------------------------------------------|

Fig. 3

to industrial accidents. The pattern in Singapore is quite different. The incidence of these lesions arising from Industrial accidents is significantly high i.e. 34 per cent and comparable to those caused by RTA i.e. 34 per cent.

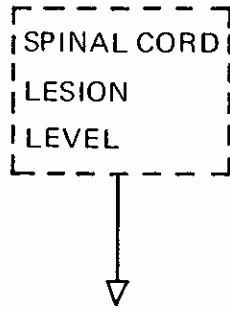
Results of Medical Rehabilitation (Table VI)

This table presents results of an intensive rehabilitation programme geared mainly to achieve restoration of independence in mobility and self-care activities (ADL). The assessment is made on a system of functional grading and is conducted by the whole team on admission and on discharge. Again only four patients (mentioned before in Table I) could not achieve the rehabilitation goals.

Hyperextension Cervical Injuries (Table VII)

The clinical pattern of Hyperextension Injuries with central cord involvement is presented and the following may be noted:

1. 50 per cent of all cervical spinal cord lesions were Hyperextension Injuries.
2. All the patients were males above the age of 35 years particularly 45—54 years.
3. The incidence in Chinese is slightly higher than the overall incidence i.e. 90 per cent compared with 77 per cent in Table I.
4. The commonest level seems to be around C5.
5. 75 per cent were due to Road Traffic Accidents, Industrial accidents accounting for much less.



| KEY | |
|------------------------|------|
| INCOMPLETE LESIONS | • |
| COMPLETE LESIONS | ⊙ |
| BROWN – SEQUARD LESION | ⊙ BS |

• EACH MARK REPRESENTS ONE PATIENT.

| | | |
|-----|--------------------|----|
| C1 | | 32 |
| C2 | • • | |
| C3 | | |
| C4 | • • • • | |
| C5 | ••••••••••⊙⊙ BS | |
| C6 | • • • • • • | |
| C7 | • • • • • | |
| C8 | ⊙ | |
| T1 | | |
| T2 | | |
| T3 | ⊙ BS | |
| T4 | ⊙ | |
| T5 | ⊙⊙ | |
| T6 | ⊙⊙ | |
| T7 | ⊙ | |
| T8 | | |
| T9 | | |
| T10 | ⊙⊙⊙ | 25 |
| T11 | ⊙⊙⊙ | |
| T12 | ⊙⊙⊙⊙••••• | |
| L1 | ⊙⊙⊙••••• | |
| L2 | • • • • • | 6 |
| L3 | • | |
| L4 | | |
| L5 | | |
| S1 | | |
| S2 | | |
| S3 | | |
| S4 | | |
| S5 | | |
| | | 70 |

TABLE V
AETIOLOGY OF SPINAL CORD TRAUMA

| Aetiology of Spinal Trauma | Type of Accident | Spinal Lesion | | Cord Level | | Total Number of Patients | |
|----------------------------|--------------------------------------------------------------------------------------------------|---------------|----------|----------------|--------|--------------------------|----|
| | | Cervical | Thoracic | Thoraco Lumbar | Lumbar | | |
| Road-Traffic Accident | Moving Vehicle (Motor) Passenger/Driver | 8 | — | 4 | — | 12 | 24 |
| | Moving Vehicle (Bicycle or Motor Cycle) | 6 | 2 | — | — | 8 | |
| | Pedestrian Knocked Down by Moving Vehicle | 4 | — | — | — | 4 | |
| Industrial Accident | Injured By Heavy Object | 5 | — | 6 | 2 | 13 | 24 |
| | Fall from Height | — | — | 9 | 2 | 11 | |
| Domestic Accident | Fall from Height | — | 2 | 5 | 2 | 9 | 13 |
| | Injured By Heavy Object | 1 | — | — | — | 1 | |
| | Slipped and Fell Low or Ground Level | 3 | — | — | — | 3 | |
| Crime | Penetrating Injury | 1 | 3 | 1 | — | 5 | 5 |
| Sports Injury | Diving Accident | 4 | — | — | — | 4 | 4 |
| | | 32 | 7 | 25 | 6 | 70 | 70 |

NOTE 5 Domestic Accidents (4 Females, 1 Male) were Patients with *Mental Illness* Diagnosed before the Injury.

TABLE VI

| M | Mobility Status | Number of Patients |
|----|---------------------------------------------------|--------------------|
| M1 | Independent Ambulation | 23 |
| M2 | Independent Ambulation with Aids/ Appliances | 18 |
| M3 | Independent Mobility in a Wheelchair | 25 |
| M4 | Bedridden or Dependent Mobility in a Wheelchair | 4 |
| S | ADL Status (Independence in Self Care Activities) | Number of Patients |
| S1 | Total Independence | 57 |
| S2 | Partial Dependence | 9 |
| S3 | Total Dependence | 4 |

TABLE VII
HYPEREXTENSION INJURIES (HEI) OF THE CERVICAL SPINE
WITH SPINAL CORD LESIONS

| Number of Patients With HEI | | | Total Number of Cervical Injuries | | | | Note |
|------------------------------|-------------------------------------------|--------------------|-----------------------------------|---------------------------|-----------------------------------------|-------|---------------------------------------------|
| 16 | | | 32 | | | | 50% of Cervical Spinal Cord Lesions are Hei |
| All Males | | | Age Groups | | | | |
| Chinese | Malay | Indian | 35-44 | 45-54 | 55-64 | 65-74 | |
| 14 | 1 | 1 | 3 | 9 | 1 | 3 | |
| Cervical Spinal Lesion Level | | Number of Patients | | Commonest Lesion Level C5 | | | |
| C4 | | 3 | | | | | |
| C5 | | 9 | | | | | |
| C6 | | 3 | | | | | |
| C7 | | 1 | | | | | |
| Aetiology | Type of Injury | | Number of Patients | | 75% Arise Out of Road Traffic Accidents | | |
| Road Traffic Accidents | Moving Vehicle (Motor) (Passenger/Driver) | | 5 | | | | |
| | Moving Vehicle (Bicycle or Motor Cycle) | | 4 | | | | |
| | Pedestrian Knocked Down By Moving Vehicle | | 2 | | | | |
| Industrial Accident | Injured By Heavy Object | | 1 | | | | |
| | Fall from Height | | 2 | | | | |
| Domestic Accidents | Fall from Height | | — | | | | |
| | Injured By Heavy Object | | 1 | | | | |
| | Slipped and Fell (Ground Level) | | 1 | | | | |

DISCUSSION (Table VIII)

The characteristic spinal cord lesion arising from Hyperextension Injuries of the cervical spine is an acute central cord lesion where the upper limbs are relatively more involved neurologically than the lower limbs. This is due to the lamellar arrangement of the fibres within the pyramidal tracts i.e. somato-

tropic division, which accounts for the variation in the extent of supranuclear paralysis affecting individual areas of the body. This is particularly conspicuous in incomplete lesions of the cervical cord where the pyramidal fibres for the upper limbs are situated medially within the pyramidal tract area while the fibres for the lower limbs are laid eccentrically and laterally.

TABLE VIII

HYPEREXTENSION INJURIES OF THE CERVICAL SPINE WITH SPINAL CORD LESIONS—
LOCOMOTOR FUNCTION ON DISCHARGE

| | Locomotor Function | Number of Patients |
|------------|--------------------------------------------------------|--------------------|
| Upper Limb | Gross Impairment | 10 |
| | Impairment of Fine Movements only | 4 |
| | Little or no Impairment | 2 |
| Lower Limb | Wheelchair Bound or Gross Impairment | 2 |
| | Ambulant with Aids or Appliances | 4 |
| | No Impairment (or Ambulant without Aids or Appliances) | 10 |

Schneider *et al* (1958) have drawn the attention to a syndrome of acute central cervical cord injury caused by simultaneous squeezing of the cord antero-posteriorly resulting from hyperextension cervical injuries. This central damage may occur without apparent damage to the vertebrae and is caused by the inward bulge of the ligamentum flavum during hyperextension. The end result is a dissociation of motor paralysis/paresis between the

upper and lower limbs—the upper limbs being more affected, with varying degrees of sensory disturbances below the level of the lesion as well as bowel, bladder and sexual disturbances. In Table VIII, this characteristic dissociated motor pattern is seen.

CONCLUSION

The importance of establishing clinical patterns of traumatic spinal cord lesions lies in diagnostic implications. In addition, preventive measures may then be justified on the aetiological factors involved so as to reduce these crippling deformities of paraplegia and tetraplegia arising from unnecessary accidents.

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