Cervical spine injury outcome – a review of 101 cases treated in a tertiary referral unit

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Cervical spinal cord injury (SCI) is a devastating event for the patient and family. It has a huge impact on society because of the intensive resources required to manage the patient in both the acute and rehabilitation phases. Given the resource-limited setting in South Africa, questions are often raised regarding whether the outcome of this group of patients justifies the expense of their care. However local data have not been available to date.

Objective. To evaluate the mortality, morbidity and functional outcome of cervical SCI patients in the South African environment.

Material and methods. All cervical SCI patients managed in the acute spinal cord injury unit at Groote Schuur Hospital over a 12-month period were included. Epidemiological data, management, complications, neurological status and change were assessed. Those referred for rehabilitation were followed up in terms of mortality and ambulation status.

Results. There were 101 patients, with an average age of 34.7 years. Motor vehicle accidents were the commonest cause of injury, with violence contributing 21%. Fifty-nine patients required referral to a rehabilitation unit. Of these, 18 were functional walkers, and only 6 were care-dependent. By 1 year post injury all but 1 patient had been discharged from the health service. Fourteen patients died; in half of these cases injury was at C5 level and above.

Conclusion. Despite cervical SCI being a devastating event, aggressive early intervention yields a better-than-expected 1-year survival rate. Associated problems, such as pressure sores, remain a major problem both for the patient and in terms of health care costs.

It is difficult to predict prognosis on presentation because of spinal shock. It is recommended that all patients initially be treated aggressively, with exit strategies in place once all the information is available and a confident assessment of poor prognosis can be made.

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Cervical spinal cord injury (SCI) and the resultant quadriplegia is a devastating event for the patient and family. It has a huge impact on society because of the intensive resources required to manage the patient in both the acute and rehabilitation phases.

There is a tremendous financial burden to society because of the expensive and prolonged treatment required owing to the patient's lifelong dependence on medical care. South Africa has the ability to offer a high level of care, but there is a huge demand from poor, uninsured communities. After receiving First-World care many of these patients return to impoverished communities and face huge challenges in terms of survival.

This has led to questions being raised regarding whether the outcome of this group of patients justifies the expense of their care. Although uncomfortable, such questions need to be considered as appropriate resource allocation is essential in a resource-limited environment such as ours.

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Many consider that cervical SCI should not be treated, or at least that care rationing should be implemented, because of poor outcome. Statistics as bad as '95% dead in 1 year' are bandied about the trauma units, which influences the decisions made by the junior frontline staff manning these units.

To make rational decisions on this very sensitive and emotional topic, South African data are needed, but have not been available so far.

This study attempted to address the situation by reviewing 101 cervical SCI patients managed at the acute spinal cord injury (ASCI) unit at Groote Schuur Hospital (GSH). Cervical SCI patients admitted during the first year of the unit's existence were reviewed in terms of epidemiology, management and outcome.

Materials and methods

The ASCI unit was established at GSH in March 2003, after the service was relocated from Conradie Hospital as part of provincial restructuring. The Conradie functions were split, with acute care being offered at GSH and the rehabilitation component being relocated to a purpose-built Western Cape Rehabilitation Hospital in Mitchell's Plain.

The ASCI unit is a closed referral unit that provides acute physiological and orthopaedic stabilisation. Patients with unresolved head injuries and polytrauma are excluded from

the unit. The philosophy is one of urgent reduction and stabilisation, with rapid mobilisation and transfer to the rehabilitation unit.

A unit database is maintained. All cervical SCI patients admitted during the 12-month period March 2003 - February 2004 were reviewed. During this period 162 patients were admitted, of whom 101 had cervical injuries. Their database data, case notes and radiographs were reviewed. Those who were referred for rehabilitation were then followed up. Data collected were analysed for age, gender, employment, referral area, delay from injury to admission to unit, type of cervical injury, neurological level, associated injuries, management, need for ventilation, complications, length of stay, discharge destination, death and functional outcome.

Neurological status was recorded and classified using the American Spinal Injury Association (ASIA) guidelines. Motor and sensory examinations were performed on admission to the ASCI unit, after surgery and on discharge. SCIs are defined as complete when there is no motor or sensory function in the lowest sacral segment, whereas an incomplete injury is characterised by the presence of 'sacral sparing'. The neurological level of injury is defined according to the most caudal spinal cord segment with normal motor (> 3/5 muscle strength) and sensory function bilaterally.

Results

Of the 101 cervical SCI patients in the study, 84 were males and 17 females. Twenty-seven regarded themselves as family breadwinners, and 52 were employed at time of injury.

The average age at time of injury was 34.69 years (range 13.89 - 73.05, SD 13.0 years), with no significant difference between the sexes. Sixty-nine patients had no dependants, with the rest having between 1 and 5 dependants.

The referral area was wide, with the commonest referral institutions being Groote Schuur and Tygerberg hospitals. Many other patients were accepted directly from secondary centres as far afield as Livingstone and Oudshoorn hospitals. The referral radius is shown in Table I.

Because of the distances involved and limited bed availability there was often a delay in admission. Half the patients were admitted on the day of injury or the subsequent day, with 67% admitted within 2 days of injury. Types of cervical injury are shown in Table II, with the commonest being distraction-flexion-type dislocations.

Table III shows the aetiology, with motor vehicle accidents being the commonest cause of SCI, and interpersonal violence contributing 21%.

There was no neurological deficit in 20 cases, 45 were motor and sensory incomplete, 35 were motor and sensory complete, and 1 patient had radiculopathy. The commonest neurological level of injury was C5, using the ASIA score.

Table I. Referral radius

Distance (km)	No. of patients
< 50	64
50 - 100	13
100 - 250	4
250 - 500	9
> 500	11
Total	101

Table II. Type of cervical injury

	No. of patients
Bifacet dislocation	19
Unifacet dislocation	19
Vertebral body fractures	18
Posterior elements fractures	13
Soft-tissue/disc injuries	17
Gunshot wounds (no fracture)	11
Stabs	4
Total	101

Table III. Aetiology

	No. of patients
Motor vehicle accident	56
Gunshot injury	11
Blunt assault	6
Stab wound	4
Rugby injury	3
Fall	16
Diving accident	5
Total	101

Despite the unit policy of excluding polytrauma cases, many patients had associated injuries. The commonest associated conditions were non-spinal fractures in 12, chest trauma in 5, gastrointestinal injuries in 3, non-contiguous fractures in 4 and scalp degloving in 4. Eleven cases arrived with established pressure sores.

Closed reductions were performed in 28 cases of cervical dislocation. Thirty-one cases were managed conservatively and the rest underwent surgical stabilisation. Anterior decompression and plating was the commonest procedure in 55 cases, with anterior Dens screw fixation in 5, laminectomy in 3 and posterior fusions in 7.

Twenty-three cases required ventilation. Thirteen cases were C3 or C4 neurological lesions. Two cases had normal neurological status but were entubated at the scene of the accident. Seven cases required more than 21 days of ventilation.

The average length of stay in the unit was 32.7 days (2 - 454 ± 55.1). Only 41 patients were discharged within 2 weeks.

Table IV shows the discharge destination.

The 59 patients referred from rehabilitation were followed up. All were a minimum of 1 year post injury. Four had died. Ambulatory status of patients alive at least 1 year after injury is shown in Table V.

Only 2 of above patients were in sheltered employment. There were 4 deaths in the rehabilitation period. As expected, 3 deaths were in the care-dependent group and the other was a wheelchair-independent patient.

Table VI demonstrates the breakdown according to neurological level. Many patients with incomplete injury became functional walkers, with the high-injury patients (C3 and C4) being care-dependent.

Table IV. Discharge destination

	No. of patients
Home (walking, no special care needed)	28
Western Cape Rehabilitation Centre	54
UCT Private Academic Hospital rehabilitation	5
Mossel Bay Hospital	1
Hermanus Hospital	1
Prison	1
Inpatient	1
Deceased	10

Table V. Ambulatory status of the 55 patients alive at least 1 year after injury

	No. of patients
Functional walkers (home)	18
Wheelchair-independent (home)	19
Wheelchair-independent (old-age home)	1
Wheelchair-independent (care home)	1
Wheelchair-dependent (home)	13
Wheelchair-dependent (old-age home)	1
Care-dependent	2

Table VII shows the mortality rate according to level of neurological injury. The numerator indicates the number of deaths, and the denominator the number of patients in the group. Although half the deaths occurred in the C5 and above level patients, this represents only a 33% mortality rate among the high cervical injury patients. Ten patients died in the acute phase while inpatients in the ASCI unit, and an additional 4 died during the follow-up period. Two deaths were due to pulmonary embolus and the rest to respiratory infection. Three patients had concomitant pulmonary tuberculosis and SCI. Two died and 1 required prolonged ventilation.

Table VII. Mortality rate according to level of neurological injury (the numerator is the number of deaths, and the denominator the number of patients in the group)

Level (ASIA)	Incomplete neurological deficit	Complete neurological deficit
C3	0/3	1/3
C4	2/3	2/9
C5	1/10	1/10
C6	0/3	1/3
C7	1/5	0/4

1 patient with normal neurological status died.

Discussion

SCI occurs predominately in young males, as shown in this study and substantiated by the literature.[1-3] As a consequence, most subjects had no dependants. Fifty per cent were employed at the time of injury, which is a surprisingly high percentage given the referral population.

As the ASCI unit is a regional service, patients come from a wide area. Given the nature of the injury (requiring prolonged stay and intensive resources), coupled with the perception

Table VI. Breakdown of ambulatory function at follow-up per neurological level (*N*)

	C2		C3		C4		C5		C6		C7	
	I	C	I	C	I	C	I	C	I	C	I	C
Functional walker	1		2		6		3		3		2	1
Wheelchair-independent							5	5		2	4	5
Wheelchair-dependent					2	3	2	4		2		
Care-dependent				2		4					1	
Total	1		2	2	8	7	10	9	3	4	7	6

I = incomplete injury; C = complete injury.

of poor outcome, tertiary hospitals will often not accept SCI patients from their referral centres. This results in the patients waiting in suboptimal conditions in secondary-level hospitals until a bed becomes available in the ASCI unit. This is evidenced by 23 patients being referred from Groote Schuur referral centres, and 27 from the Tygerberg drainage area, without going via the tertiary centres. As such there was a similar number of patients from the Groote Schuur ($N = 52$) and Tygerberg ($N = 46$) drainage areas, with an additional 3 from outside the area.

Motor vehicle accidents were the predominant cause of injury, with violence playing a lesser role. Gunshot injuries represented in excess of 20% of overall admissions, but there was a lower incidence among cervical SCI patients. This is possibly because the body offers a bigger surface area as a target than the neck, or because of the higher instantaneous mortality rate with cervical shootings, and such patients therefore not reaching hospital.

Sport was a small contributor. Rugby injuries were mostly from informal, poorly controlled games rather than from school sport. The South African Rugby Board has put enormous effort into education, and coupled with rule changes, this had led to a low incidence of injury, with only 1 case being a schoolboy, who was in fact playing in a league beyond his age and size. Diving accidents were generally associated with alcohol use.

Delay to admission is attributable to the large drainage area, with patients being transported over extensive distances. The number of ASCI high-care beds also remains inadequate. These issues impact on morbidity, as evidenced by the 11% incidence of pressure sores on admission to the unit.

The spectrum of neurological injury is typical for such a unit. Vaccaro *et al.*[3] reported 40% complete, 40% incomplete and 20% normal neurological status in his study. As the non-ASCI general trauma service at GSH is not well geared for the needs of SCI patients, the ASCI unit admits those with normal neurology if possible, to provide logrolling and pressure care. Secondary injury is prevented until stabilisation of the vertebral column can be achieved by surgery.

Because of the limited number of beds, an aggressive surgical approach is maintained. Seventy per cent of the patients were stabilised surgically. Historically, management at Conradie Hospital[4] was conservative, with a 2% operative rate. They generally practised closed reduction, and traction followed by orthosis. This approach requires a large number of beds and prolonged admission. There was also a reported in-hospital mortality rate of 22%, with a further 8% dying after discharge. With early surgical intervention we are able to increase the throughput of many patients and reduce morbidity and mortality.

Ventilation is a difficult issue in this scenario. Cervical SCI patients lose control of the intercostal muscles, and if C4 and C5 are compromised, they may lose diaphragmatic function. Those who still breathe spontaneously post injury often tire after a few hours, and go into respiratory failure. This, coupled with atelectasis, predisposes to chest infections, septicaemia and death.[5,6] Mechanical ventilation is often required, but there is the risk of prolonged ventilatory requirements and even dependence. There is much debate about this as such a patient may block a general ICU bed for weeks to months. However, many SCI patients require only a period of respiratory support to strengthen their diaphragms and avoid atelectasis. We believe that early intervention often allows shorter periods of support, as those who are left unsupported frequently develop atelectasis and infection by the time they are admitted to the ASCI unit, which prolongs their requirements. Twenty-three per cent of our patients required ventilation. As many patients improve by at least 1 neurological level, many who are initially ventilator-dependent will be weaned. Wicks and Menter[7] successfully weaned 28% of C2 level patients, 51% of C3 level patients and 78% of patients C4 and below.

Ventilation requirement still remains a predictor of poor outcome. De Vivo[8] reported that 75% of ventilator-dependent patients die within the first year of injury. In our study, 6 ventilated patients died in the unit and an additional 4 died within the first year. Therefore 43% of our ventilated cases died. Concomitant pulmonary tuberculosis patients had a high mortality rate. In the South African environment, tuberculosis is endemic, and this should be looked for and aggressively treated.

In addition to the 6 inpatient ventilated deaths, there were a further 4 deaths. One of these patients had pneumonia, and the other 2 had pulmonary emboli. This is despite the unit policy of thrombo-embolic stockings and low-molecular-weight heparin. Including the 4 deaths noted on follow-up, there was a 14% mortality rate in the first year. One of these patients was neurologically normal, but had severe co-morbid factors. Thus there was a 16% mortality rate among the neurologically impaired patients, which compares favourably with rates in the rest of the world.[9] Sneddon[10] reports a 20% 1-year mortality rate among C5 and above patients younger than 45 years, and 75% among those older than 45. The mortality rate for patients with a neurological level below C5 was 8% if younger than 45 years and 66% if older than 45 years. The Frankel[1] data reporting on 50 years' experience did not show a significant difference in mortality between patients with neurological levels of C1-4 compared with C5-8. Patient deaths before reaching the ASCI unit were not considered, and the selection process depending on the unit bed status may have led to patients with better prognosis being admitted.

Although the philosophy of the unit is one of early aggressive intervention and discharge to the rehabilitation hospital, the average stay was 32.7 days. Only 40% of patients were moved on in the planned 2-week period. This is because of the unacceptably high complication rate. A major factor is

pressure sores, as the rehabilitation hospital will not accept patients with open sores. As 11% arrive with such sores and a further 11% develop them, transfer is slowed. This has been recognised, and major steps have been taken with regard to education both within the unit and in the paramedical transport service. The continued use of hard fracture boards is being targeted, as patients may lie for hours in an ambulance or casualty awaiting transfer, and develop sores that take months to heal. Air-cell mattresses have been purchased based on those data, with subsequent reduction in incidence of bed sores.

At 1 year, only 1 patient remained either in the unit or in the rehabilitation service. The 20 neurologically normal patients went home from the ASCI unit, together with an additional 8 patients who had recovered adequately. The majority went on to either the state rehabilitation centre (Western Cape Rehabilitation Hospital) or the University of Cape Town Private Academic Hospital for rehabilitation. This group of 59 patients were followed up. Four died within the year, leaving 55 patients. All these patients had left the care of the rehabilitation hospital and had been placed in the community by 1 year.

With increased supportive care, life expectancy of the quadriplegic is increasing. This is evidenced in the 50-year review by Frankel *et al.*[1] Yeo *et al.*[11] confirmed that a quadriplegic can expect 70% of normal life expectancy. Hall *et al.*[12] followed a group of quadriplegics for 14 - 24 years postoperatively. The majority were ventilator-independent. Quality of life and self-esteem were reported to be high, and 95% reported being 'glad to be alive'. More than 90% lived in private homes, but only 25% were employed. Mersey Regional Spinal Injuries Centre confirmed this sentiment among those who were ventilator-dependent.[13]

Conclusion

This study demonstrates that although cervical SCI is a devastating event, early aggressive care in an appropriate centre yields reasonable survival rates at 1 year.

Pressure sores remain a difficult problem. They prolong hospital stay and add enormously to the cost. Resources must therefore be allocated to reduce their incidence. The solution involves a holistic approach to streamlining spinal injury care, from the scene of accident to discharge from rehabilitation.

Although neurological level and ventilatory requirement are negative predictors of outcome,[14,15] it is difficult to rationalise care at the outset. These patients often have evolving neurological deficit.[2,16] This situation, combined with the fact that most emergency centres are managed by junior members of staff, means that confident evaluation and ethical decisions are difficult, if not impossible, to make at the outset. These patients need to be managed actively; once out of spinal shock, definite assessments can be made and decisions taken regarding continuation of care. This of course also brings its problems, as withdrawal of care is also difficult. A suitable exit strategy needs to be developed.

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