

Acute cervical spine injuries in adults: initial management

Pete Ford* and Abrie Theron

*Correspondence Email: peteford@nhs.net

INTRODUCTION

Spinal cord injury is a catastrophic consequence of cervical spine injury and is a challenging condition to manage, with global pathophysiological changes occurring following injury. Although respiratory complications are the leading cause of morbidity and mortality the condition calls for a multisystem approach and often involves several disciplines. Correct early management of acute cervical spinal cord injuries can improve longterm outcome.

Between 2 and 5% of patients suffering from blunt polytrauma have a cervical spine injury. Cervical spine injuries tend to occur between 15 and 45 years and are seen more commonly in males (7:3). The most common level of fracture is C2 whereas dislocations occur most commonly at the C5/6 and C6/7 levels.¹

The initial management of the polytrauma patient follows the Advanced Trauma Life Support (ATLS) practice of airway and cervical spine control, breathing and circulation. Assessment of injuries takes place initially in the form of a primary survey, during which time life threatening injuries are sought. This is followed by a secondary survey, when a more detailed assessment of injuries is carried out, including spinal injuries. All polytrauma patients should be assumed to have a cervical spinal injury until proven otherwise; precautionary cervical spine immobilisation should be instigated for all patients at the scene of the injury by pre-hospital staff. By immobilising the spine immediately, major injuries can be treated at the scene, or on arrival at hospital, without the risk of disrupting an unstable cervical spine injury and causing secondary neurological injury.²

IMMOBILISATION OF THE SPINE

Until spinal injuries can be excluded or 'cleared' the spine must be immobilised and this can be achieved in a number of ways. However, all methods continue to allow varying degrees of movement. Soft cervical collars are the most inefficient and provide very little stability and therefore should not be used. Whereas the application of Gardner-Wells forceps can be considered the most effective, it is rarely a practical solution in the acute setting. Two methods are in common use,

compromising between simplicity of application and effectiveness: these are semi-rigid collars and manual in-line stabilisation (MILS). In the prehospital setting, MILS should be applied as an initial manoeuvre as the patient's airway is assessed and then, when available, a semi-rigid collar should be applied. Further stability is achieved by using sandbags or blocks on either side of the head, with two non-elastic self adhesive tapes strapped across the head and on to a rigid spinal board. Users should be aware of the disadvantages of semi-rigid collars (Table 1).

Table 1. Disadvantages of semi-rigid collar

Total immobilisation is not achieved
Increase the chances of difficult laryngoscopy
Can exacerbate cervical spinal injuries
Can cause airway obstruction
Can increase the intracranial pressure (ICP)
Increases the risk of aspiration
Increases the risk of deep vein thrombosis (DVT)
May cause significant decubitus ulcers

Laryngoscopy is more difficult with a semi-rigid collar in place. If laryngoscopy and intubation is urgently indicated the collar should be removed and MILS applied instead (Figure 1). During laryngoscopy MILS reduces cervical spine movement by up to 60%. An assistant squatting behind the patient applies MILS by placing his or her fingers on the mastoid processes and the thumbs on the temporoparietal area of the skull. The hands are then pressed against the spinal board and act to oppose movements of the head caused by the anaesthetist. Axial traction should not be applied because of the risk of exacerbating cervical spinal injuries. Until the spine is 'cleared' a log roll should be performed for any movement or transfer of the patient.^{3,4}

CLEARING THE CERVICAL SPINE

Imaging the spine does not take precedence over the treatment of life threatening conditions. Once the patient is stable, the exclusion of spinal injuries and

Summary

This review is for anaesthetists who specialise in intensive care, focusing on the first few days following injury to the cervical spine and the spinal cord. Involvement often starts in the emergency department with resuscitation of patients with polytrauma and continues with supportive care on the intensive care unit.

Pete Ford

Consultant in Anaesthesia
Royal Devon and Exeter
Foundation trust
Barrack Road
Exeter
Devon
EX2 5DW
UK

Abrie Theron

Consultant in Anaesthesia
Carmarthenshire NHS
Trust
West Wales General
Hospital
Dolgwili Road
Carmarthen
SA31 2AF
Wales
UK

ligamentous injuries requires a combination of clinical assessment and radiological investigation. Clinical clearance of cervical spine injury is difficult or impossible in patients who are unconscious (due to sedation, anaesthesia or head injury), or have distracting injuries to other parts of the body. Anaesthetists should understand the principles of clearing the cervical spine, since a proportion of patients cannot be clinically cleared for several days and prolonged cervical spine immobilisation (with its inherent risks) may be necessary.

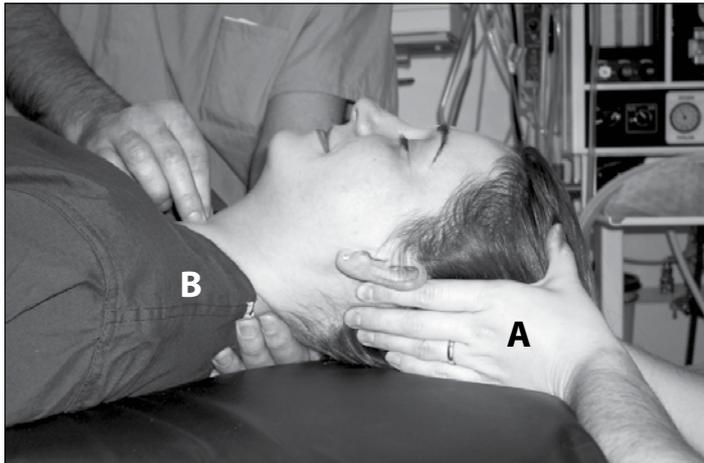


Figure 1. A - Application of manual in-line stabilisation (MILS); B - Bimanual application of cricoid pressure.

Two sets of screening clinical criteria have been proposed prior to imaging the cervical spine, in an attempt to reduce the number of unnecessary X-rays. These are the Canadian c-spine rule and the National Emergency X-radiography Utilisation Study (NEXUS) criteria. Both are sensitive tools.¹

The **NEXUS criteria** include;

- No evidence of posterior cervical tenderness
- No history of intoxication
- An alert patient
- No focal neurological deficit
- No painful distracting injuries

If all the criteria are fulfilled then the cervical spine can be cleared without the need for imaging.

The **Canadian c-spine rule** asks 3 questions;

1. *Are there any high risk factors which makes performing radiological investigation mandatory?*

- Age >65 years
- Mechanism of injury; fall >3 feet (1 metre), axial load to head e.g. diving, motor vehicle collision; >100km.h⁻¹, rollover or ejected, bicycle collision
- Parathesia of extremities.

2. *Are there any low risk factors which allow for safe assessment of range of motion?*

- simple rear end
- sitting position in Emergency Department
- ambulatory at any time
- delayed onset of neck pain
- absence of midline c-spine tenderness.

3. *Able to actively rotate neck 45° left and right?*

The NEXUS criteria have 99% sensitivity, 12.9% specificity, 99.8% negative predictive value and a 2.7% positive predictive value, whereas the Canadian c-spine rule has 100% sensitivity and 42.5% specificity. Both tests have been validated in clinical practice and have been shown to be accurate and reliable. Either test is suitable for use in everyday practice.



Figure 2. Lateral cervical spine X-ray, showing fracture-dislocation of C4 (A) on C5 (B).

If these screening tests indicate that radiological imaging is required, the strategy needed to clear the cervical spine differs depending on whether the patient is awake or unconscious. In the alert patient it is generally agreed that clearing the spine requires a 3-view plain X-ray series (lateral and AP cervical spine views with a 'peg view'), with a computerised tomogram (CT) for areas that cannot be visualised or are suspicious. If these are normal, but the patient is complaining of neck pain, a lateral cervical spine X-ray should then be performed in flexion and extension.

In the unconscious, since ligamentous injuries are difficult to exclude with accuracy using radiography, there is less agreement on the best method. Three options are available:

1. First the cervical spine is left uncleared and the spine kept immobilised until the patient is fully conscious. Inherent with this method are the complications of immobilisation for any long duration, particularly decubitus ulcers.
2. Alternatively the patient has a combination of plain Xrays and/ or CT scans to exclude bony injuries and, where available, this should followed by magnetic resonance imaging (MRI) or fluoroscopy to exclude ligamentous injuries.
3. MRI may not be available and there are considerable practical difficulties associated with its use in unconscious critically ill patients. A thin cut CT scan is an alternative, including coronal and sagittal reconstruction of the entire cervical spine. Although less sensitive than MRI for the detection of ligamentous injury, CT is more practical and the number of unstable ligamentous injuries missed is extremely small.^{1,3,5} It is worth remembering that the incidence of ligamentous injury without bony injury in blunt trauma is extremely rare.

NEUROLOGICAL ASSESSMENT

During the primary survey of resuscitation, a brief and rudimentary neurological assessment is performed using the AVPU scale (alert, verbal stimuli response, painful stimuli response or unresponsive). Following on, the secondary survey (which involves a more detailed head to toe search for injuries) includes a more thorough neurological assessment documenting both sensory and motor function, rectal tone, and reflexes. At this stage, if abnormalities are detected, a more formal neurological assessment using the ASIA (American Spinal Injury Association, see Figure 4) scoring system should be completed. An ASIA score is obtained from the essential components of the neurological assessment. It is a reliable and reproducible neurological examination which must be repeated daily to monitor for improvements or deterioration. ASIA also provide useful guides to aid standardised motor and sensory neurological examination (available at: http://www.asia-spinalinjury.org/publications/Motor_Exam_Guide.pdf and http://www.asia-spinalinjury.org/publications/Key_Sensory_Points.pdf).

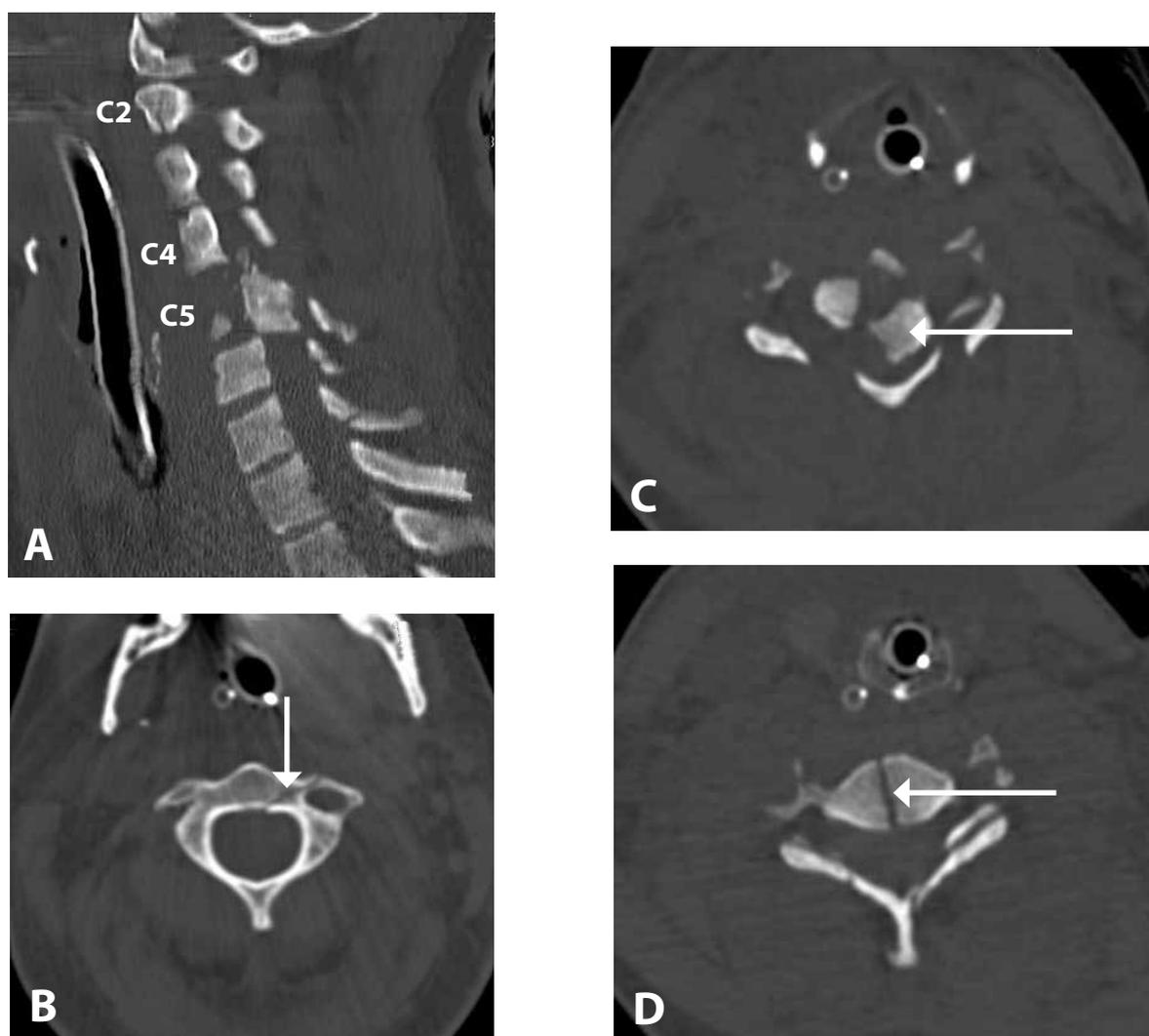


Figure 3. Computed Tomography (CT) of the cervical spine. A - sagittal reconstruction showing fractures at multiple levels; B - transverse section fracture through the vertebral body of C2 to the left of the dens (arrowed); C - transverse section - comminuted fracture with displacement of the left hemi-body into the spinal canal (arrow), presumably compressing the cord; D - transverse section - midline fracture through the vertebral body (arrow), with bilateral fractures of the laminae of the vertebral arch..

Patient Name _____

Examiner Name _____ Date/Time of Exam _____



INTERNATIONAL STANDARDS FOR NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY



MOTOR
KEY MUSCLES
(scoring on reverse side)

	R	L	
C5	<input type="checkbox"/>	<input type="checkbox"/>	Elbow flexors
C6	<input type="checkbox"/>	<input type="checkbox"/>	Wrist extensors
C7	<input type="checkbox"/>	<input type="checkbox"/>	Elbow extensors
C8	<input type="checkbox"/>	<input type="checkbox"/>	Finger flexors (distal phalanx of middle finger)
T1	<input type="checkbox"/>	<input type="checkbox"/>	Finger abductors (little finger)
UPPER LIMB TOTAL (MAXIMUM)			
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> = <input type="checkbox"/> = <input type="checkbox"/>
	(25)	(25)	(50)

Comments:

L2	<input type="checkbox"/>	<input type="checkbox"/>	Hip flexors
L3	<input type="checkbox"/>	<input type="checkbox"/>	Knee extensors
L4	<input type="checkbox"/>	<input type="checkbox"/>	Ankle dorsiflexors
L5	<input type="checkbox"/>	<input type="checkbox"/>	Long toe extensors
S1	<input type="checkbox"/>	<input type="checkbox"/>	Ankle plantar flexors
LOWER LIMB TOTAL (MAXIMUM)			
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> = <input type="checkbox"/> = <input type="checkbox"/>
	(25)	(25)	(50)

SENSORY
KEY SENSORY POINTS

	LIGHT TOUCH		PIN PRICK	
	R	L	R	L
C2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
C3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
C4	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
C5	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
C6	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
C7	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
C8	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
T1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
T2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
T3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
T4	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
T5	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
T6	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
T7	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
T8	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
T9	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
T10	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
T11	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
T12	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
L1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
L2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
L3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
L4	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
L5	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
S1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
S2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
S3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
S4-5	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

0 = absent
1 = altered
2 = normal
NT = not testable

TOTALS

	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	=	<input type="checkbox"/>
	(56)	(56)	(56)	(56)		(56)

(DAP) Deep anal pressure (yes/No)

PIN PRICK SCORE (max: 112)

LIGHT TOUCH SCORE (max: 112)

• Key Sensory Points

NEUROLOGICAL LEVEL <small>The most caudal segment with normal function</small>	SENSORY	<input type="checkbox"/> R <input type="checkbox"/> L	MOTOR	<input type="checkbox"/> R <input type="checkbox"/> L	SINGLE NEUROLOGICAL LEVEL	<input type="checkbox"/>	COMPLETE OR INCOMPLETE?	<input type="checkbox"/>	<small>Incomplete = Any sensory or motor function in S4-S5</small>	ZONE OF PARTIAL PRESERVATION	<small>(In complete injuries only) Most caudal level with any innervation</small>	SENSORY	<input type="checkbox"/> R <input type="checkbox"/> L	MOTOR	<input type="checkbox"/> R <input type="checkbox"/> L
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Figure 4. An ASIA spinal cord injury assessment chart (Available to download at: http://www.asia-spinalinjury.org/publications/59544_sc_Exam_Sheet_r4.pdf).

GENERAL MANAGEMENT

Airway management

Patients may require airway instrumentation as an emergency (for airway obstruction, respiratory failure or as part of the management of a severe head injury) or later in their management as part of anaesthesia for surgical management of other injuries.

The extent to which the injured cervical spine can be safely moved is unknown. Therefore the main aim during management of the airway, in patients with potential cervical spine injuries, is to cause the least amount of movement possible. All airway manoeuvres will produce some degree of movement of the cervical spine, including jaw thrust, chin lift and insertion of oral pharyngeal airways. Mask ventilation is known to produce more movement than direct laryngoscopy.

Most anaesthetists are comfortable with direct laryngoscopy and oral intubation and it is therefore the obvious first choice in establishing a definitive airway in the polytrauma setting. During direct laryngoscopy,

significant movement occurs at the occipito-atlanto-axial joint. Manual in-line stabilisation (MILS) is used to minimise this movement. Previous anecdotal reports of the spinal cord being damaged following direct laryngoscopy in patients with unstable cervical spine injuries were based on weak coincidental evidence.⁶ Therefore the technique of direct laryngoscopy with MILS is now an accepted safe technique for managing the airway in patients with potential cervical spine injuries. In addition the gum elastic bougie is a useful adjunct during direct laryngoscopy. It allows the anaesthetist to accept inferior views of the vocal cords thereby limiting the forces transmitted to the cervical spine and therefore movement. No particular laryngoscope blade has shown a superior benefit except the McCoy levering laryngoscope which will improve the view at laryngoscopy by up to 50% in simulated cervical spinal injuries. The McCoy is therefore an alternative to the Macintosh for those experienced in its use (Figure 5).

The laryngeal mask airway (LMA) or intubating laryngeal mask airway are both extremely useful in the failed or difficult intubation. The forces applied during insertion can cause posterior displacement of



Figure 5. The McCoy levering laryngoscope.

the cervical spine, but the movement is less than that seen in direct laryngoscopy. In the ‘can’t intubate, can’t ventilate’ scenario there should be early consideration of the surgical airway or cricothyroidotomy. These techniques can produce posterior displacement of the cervical spine, but this should not prevent the use of this life saving procedure.

Nasal intubation has formerly been included in the Advanced Trauma Life Support course airway algorithm. However, the low success rate and high incidence of epistaxis and laryngospasm has resulted in this technique losing favour. Awake fiberoptic intubation has consistently produced the least amount of movement of the cervical spine in comparative studies. However, in the acute trauma setting, blood or vomit in the airway may make the technique impossible. Further disadvantages include a relatively prolonged time to intubation, risk of aspiration and, if gagging or coughing occur, an increase in the intracranial pressure (ICP). Despite these concerns, for those anaesthetists with sufficient expertise and in the appropriately chosen patient, awake fiberoptic is an option.^{1,4}

With the recent development of video technology there has been a growth in the utilization of videolaryngoscopes. Videolaryngoscopes allow indirect laryngoscopy whereby alignment of the oral, pharyngeal and laryngeal axes is not necessary. In the elective setting they have been shown to be easy to use and master, and improve the view of the larynx compared with direct laryngoscopy, in patients with difficult airways. However this improved view does not always translate into an ease of intubation, as the endotracheal tube must be directed in some way ‘around the corner’. Intuitively one would expect videolaryngoscopes to reduce cervical spine movement during intubation as the view is achieved indirectly. However although there are studies showing a superiority of videolaryngoscopes over direct laryngoscopes, when cervical spine movement is analysed the studies are heterogeneous in their design and in their choice of scope. There are also studies which do not show any benefit. Furthermore, as has already been mentioned, blood or vomit in the airway may make the view using videolaryngoscopy inadequate. Therefore at this stage

videolaryngoscopy should not supersede direct laryngoscopy but remains an incredibly useful backup tool.

Suxamethonium is safe to use in the first 72 hours and after 9 months following the injury. In the intervening period there is a risk of suxamethonium-induced hyperkalaemia due to denervation hypersensitivity and it should be avoided.

Spinal cord injury results in important pathophysiological consequences in various systems of the body that require appropriate treatment.

Respiratory management

Respiratory failure is common and pulmonary complications are the leading cause of death. The diaphragm (C3-C5) and intercostals (T1-T11) are the main inspiratory muscles. The accessory inspiratory muscles consist of sternocleidomastoid, trapezius (both 11th cranial nerves), and the scalene muscles (C3-C8). Expiration is a passive process, but *forced* expiration requires the abdominal musculature (T6-T12). The abdominal muscles are therefore important for coughing and clearing respiratory secretions.

The severity of respiratory failure depends on the level and completeness of the injury. Complete transection of the spinal cord above C3 will cause apnoea and death, unless the patient receives immediate ventilatory support. For lesions between C3 to C5 the degree of respiratory failure is variable and the vital capacity can be reduced to 15% of normal. These patients are at risk of increasing diaphragmatic fatigue due to slowly progressive ascending injury resulting from cord oedema. This commonly results in retention of secretions and decompensation around day 4 post-injury, and intubation and ventilation is required. Where facilities are available some would electively intubate and ventilate patients in this group.

In general, the decision to intubate depends on several factors, including:^{7,8}

- loss of innervation of the diaphragm
- fatigue of innervated muscles of respiration
- failure to clear secretions
- history of aspiration
- presence of other injuries e.g. head and chest injuries
- premonitory conditions, especially respiratory disease.

Initially the intercostal muscles are flaccid, allowing in-drawing of the chest during inspiration with a consequential compromise in respiratory function. This gives the characteristic appearance of ‘paradoxical breathing’ – on inspiration the diaphragm moves down, pushing the abdominal wall out and drawing the chest wall inwards. As the muscles become spastic, respiratory function improves, allowing potential weaning of the patient from the ventilator. Paralysis of the abdominal musculature means that in the upright position the diaphragm works in a lower and less effective position and so a supine position is preferred. Abdominal binders can be used to prevent the abdominal contents from falling forward whilst being upright; they are helpful in lesions above T6. Studies have shown immediate improvements in respiratory function with their use.

Patients with high cervical spine lesions have increased bronchial secretions, possibly due to altered neuronal control of mucous glands. Nebulised N-acetylcysteine and other mucolytics reduce the viscosity of secretions and assist in keeping the airway clear.

There is evidence that spinal cord injured patients have an obstructive component, as well as a restrictive pattern of lung function, and patients with tetraplegia can be shown to have bronchial hyper-responsiveness during bronchial provocation tests. The mechanism for this includes loss of sympathetic innervation and unopposed parasympathetic nerve supply. The sympathetic nerve supply to the lung arises from the upper six thoracic segments of the spinal cord. Postganglionic fibres synapse in the middle and inferior cervical ganglia and in the upper four thoracic ganglia; from here they enter the hilum of the lung where they form plexuses around airways and vessels. In addition the restrictive lung function may be due to softening of the cartilage in large airways, a loss of lung elastin and collagen, a reduction in elastic recoil and finally excessive secretions within the airway lumen. Ipratropium and the longer acting salmeterol will improve lung function in up to 50% of tetraplegics.

Cardiovascular management

Cardiovascular instability is particularly seen with high cervical cord injuries. At the time of injury there is an initial brief period of increased sympathetic activity resulting in hypertension, an increased risk of subendocardial infarction and arrhythmias. This is followed by a more sustained period of neurogenic shock, resulting from loss of sympathetic outflow from the spinal cord, which may last up to eight weeks. This is characterised by vasodilatation and bradycardia and tends to be seen only in lesions above T6. Bradycardia is caused by loss of cardiac sympathetic afferents and unopposed vagal activity and may lead to asystole. This can be treated with atropine. In persistent and problematic bradycardia a pacemaker may need to be inserted. The loss of sympathetic innervation to the heart means that if increases in cardiac output are required, then this is best achieved by an increase in stroke volume.

The initial treatment of hypotension involves intravenous fluid administration. Once the stroke volume cannot be increased further, then vasopressors will need to be commenced using either dopamine or norepinephrine, which are both α - and β_2 -receptor agonists, providing vasoconstriction, with chronotropic and inotropic support to the heart.^{7,8}

Under normal physiological conditions spinal cord blood flow is autoregulated over a wide range of systemic blood pressures. Following trauma, autoregulation of blood flow to the cord fails and hence flow becomes directly proportional to systemic blood pressure; therefore to ensure sufficient perfusion to the cord systemic blood pressure must be maintained.

The end-point of resuscitation is controversial. There is evidence that ongoing ischaemia and secondary spinal cord damage is successfully treated by raising the mean arterial pressure to 85mmHg for up to seven days.⁹ Hence the American Association of Neurological Surgeons (AANS) recommendation of maintaining MAP to 85-90mmHg and avoiding systolic blood pressure less than 90mmHg for over 5-7 days.

Finally, spinal cord perfusion pressure can be calculated using the equation;

SCPP	=	MAP	-	ITP
(Spinal cord perfusion pressure)		(Mean arterial pressure)		(Intrathecal pressure)

i.e. the spinal cord perfusion pressure can be increased by either increasing the MAP or lowering the intrathecal pressure.

Kwon et al performed a feasibility study of intrathecal pressure monitoring and CSF drainage. Insertion of the catheter was found to be safe and without adverse sequelae. Episodes of raised ITP, and therefore potential tissue ischaemia, were found following surgical decompression, which would have otherwise gone undetected.¹⁰ Further studies are required before recommendations can be made regarding this treatment modality.

Autonomic dysreflexia

This complication does not occur during the acute phase of spinal injury, but is mentioned here for completeness. The condition can be triggered by various stimuli, noxious and non-noxious including surgery, bladder distension, bowel distension and cutaneous stimuli. It is more common in complete and higher lesions; it is rarely seen in patients with cord lesions below T10. The condition is due to massive sympathetic discharge. The symptoms may start weeks to years following the spinal injury and include paroxysmal hypertension, headaches and bradycardia. Below the lesion cutaneous vasoconstriction, piloerection and bladder spasm may be seen. Above the lesion there may be flushing, sweating, nasal congestion and conjunctival congestion. The patient may complain of blurred vision and nausea.

If left untreated complications include stroke, encephalopathy, seizures, myocardial infarction, arrhythmias and death. Management options include removal and avoidance of triggers e.g. the insertion of a urinary catheter, bowel routines and avoidance of pressure sores. If surgery is planned, consider the use of spinal anaesthesia as this reliably prevents the symptom complex. Other options include increased depth of anaesthesia and vasodilators for the treatment of hypertension and making use of orthostatic hypotension by placing patients with legs down.⁸

Venous thrombosis

The incidence of deep vein thrombosis (DVT) is 40-100% in untreated patients with a spinal injury and pulmonary embolism is one of the leading causes of death in this group of patients. Prophylaxis must be started as soon as possible although there is no consensus as to exactly when or how this should be initiated. Treatment can be divided into two clear groups, pharmacological and non-pharmacological. Unfractionated heparin 5000iu bd does not prevent DVT, whereas low molecular weight heparin, in particular enoxaparin, is effective in preventing deep vein thrombosis (DVT), but is associated with an increased risk of haemorrhage within the injured spinal cord if given acutely. Therefore mechanical compression devices and graduated elastic stockings are often applied for the first 72 hours, when the risk of DVT is low and anticoagulants considered thereafter. Prophylaxis should be continued for at least eight weeks.⁷

At 72 hours an inferior vena cava filter should be considered if the risk of bleeding is still high and anticoagulants are contraindicated.

Gastrointestinal management

Bleeding due to stress ulceration should be prevented with an H₂-receptor antagonist, such as ranitidine. Ileus and gastric distention can be treated with nasogastric suctioning and prokinetic drugs, e.g. metoclopramide or erythromycin.⁸

Following injury, the rectum and anus will be areflexic and peristalsis of the bowel is absent, causing a paralytic ileus. Bowel management should start immediately, with digital examination of the rectum and any faeces removed carefully digitally. During the period of spinal shock faeces will need to be removed digitally with the aid of suppositories. The return of bowel sounds heralds the resolution of the ileus and arrival of an *upper motor neuron bowel syndrome* or *hyperreflexic bowel*, which is characterised by increased colonic and anal tone and is associated with constipation and stool retention. Evacuating the bowel is facilitated by reflex activity initiated by a finger and or a suppository placed into the rectum. Stool consistency can be helped by using laxatives.

Pain management

Pain is a frequent complication of spinal cord injury. It can be classified into either musculoskeletal or neuropathic. Neuropathic pain tends to have a burning quality and occurs in the front of the chest, in the buttock and in the legs, whereas musculoskeletal pain has an aching quality tending to occur in the neck, shoulders and back above the level of the lesion.

Treatment of musculoskeletal pain includes paracetamol, non-steroidal anti-inflammatory drugs, opiates and muscle relaxants, such as benzodiazepines. Neuropathic pain is sensitive to anticonvulsants (gabapentin, pregabalin) and tricyclic antidepressants.

SPECIFIC TREATMENT

Different therapies have been tried, attempting to reduce the secondary neuronal injury due to cord ischaemia and inflammation. Although some have shown potential in animal studies, most have not shown significant benefit in clinical studies. Only methylprednisolone has shown any promise. Methylprednisolone 30mg.kg⁻¹ is given over 15 minutes and then 5.4mg.kg⁻¹ is infused over 23 hours. Following the second national acute spinal cord injury study (NASCIS) in 1990, giving methylprednisolone became a standard of care. However subsequent studies questioned its use, with evidence of its deleterious effects including immunosuppression, more gastro-intestinal bleeds and hyperglycaemia. The latest Cochrane review looking at this treatment modality includes 5 randomised controlled trials (3 from North America – the NASCIS trials 1-3, one Japanese trial and one French trial) where methylprednisolone had been given following spinal cord injury. The review found a significant by better recovery in motor function after methylprednisolone, if it was commenced within 8 hours.¹¹ Today methylprednisolone is a treatment option but cannot be considered a standard of care.

Oxandrolone is an oral anabolic steroid and has been shown to improve pulmonary function in patients with tetraplegia in a single

clinical study over a 4 week period.¹² However its long term effects are not known and the drug is known to cause hyperlipidaemia and abnormal liver function tests.

Indications for surgery include correction of deformity, stabilisation of the spine and decompression of the spinal cord to allow neurological recovery. Early surgical decompression has been shown to be beneficial in animal models of spinal cord injury. To date the evidence in humans is lacking, and the timing of surgical decompression remains a topic of debate and ongoing research.¹³

SUMMARY

The initial management of patients involved in blunt trauma follows the ATLS principle of airway and cervical spine control, breathing and circulation. The spine is immobilised as soon as possible to prevent secondary neurological injury. However, extrication collars should be removed and MILS applied prior to establishing a definitive airway, where this is indicated. Despite movement at the occipito-atlanto-axial joint, direct laryngoscopy with MILS is an accepted safe method to manage the airway in patients with potential cervical spine injuries. The gum elastic bougie and the McCoy laryngoscope are useful tools in this context. A high cervical spine injury is likely to result in respiratory failure and cardiovascular instability, which may require ventilatory and/or inotropic support.

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