Basic principles of management for cervical spine trauma

J. K. O'Dowd

Received: 23 July 2009 / Published online: 22 August 2009
© Springer-Verlag 2009

Abstract This article reviews the basic principles of management of cervical trauma. The technique and critical importance of careful assessment is described. Instability is defined, and the incidence of a second injury is highlighted. The concept of spinal clearance is discussed. Early reduction and stabilisation techniques are described, and the indications, and approach for surgery reviewed. The importance of the role of post-injury rehabilitation is identified.

Keywords Trauma · Cervical spine · Review · Assessment · Treatment

Introduction

The management of spinal trauma ranges from dealing with patients with trivial injuries requiring no interventional treatment, through to major complex, spinal cord and life threatening spinal column injuries. Extensive experience is required for the optimum assessment, decision making and treatment of this patient group and, in this article, the principles of early management and treatment will be outlined.

Traditionally, management of injuries of the cervical spine have been a bolt-on extra in managing the multiply injured patient, but the widespread adoption of the Advanced Trauma Life Support protocols has highlighted the importance of assuming a cervical spine injury in all patients with a history of trauma until proven otherwise.

In the context of the advanced management of spinal injuries, this chapter will outline the main points of the

focussed assessment, the important way points of a full classification of the skeletal and spinal cord injury, the principles of early prioritisation and decision making, the outline of the surgical strategy including indications, timing, approaches, technique and post-operative care, and the outline principles of rehabilitation.

Initial stabilisation

During the resuscitation and initial assessment phase, the cervical spine should be assumed to be injured and should be splinted using a cervical spine collar, two sandbags and a forehead tape. The thoracolumbar spine should be stabilised on a spine board for transfer and then on a flat emergency room trolley allowing log rolling with in-line stabilisation at the neck only (Fig. 1).

Evaluation

The main principles of evaluation are:

- assessing and classifying the skeletal injury,
- assessing and classifying the neurological injury,
- assessing associated spinal injuries,
- identifying associated non-spinal injuries and
- establishing treatment priorities during the assessment phase.

Instability

Instability has been defined [8] as 'the loss of the ability of the spine under physiological loads to maintain its pattern

J. K. O'Dowd (✉)
The RealHealth Institute, 23-31 Beavor Lane,
London W6 9AR, UK
e-mail: johndowd@btinternet.com

Fig. 1 Stabilisation of cervical spine before clearance

of displacement so that there is no initial or additional neurological deficit, no major deformity and no incapacitating pain’.

It is not only important to identify instability but also to identify injuries, which whilst having no overt features of instability have the potential to displace and cause a neurological injury and/or chronic pain and disability. The assessment of instability assists in the initial management of the patient particularly with potential instability, but an understanding and grading of instability is critical to determining definitive management and its presence is likely to mandate a surgical approach to the spinal injury.

Finally, the identification of instability aids in giving the patient, a prognosis early on in the treatment process, and aids the patient’s decision-making process.

Clinical assessment

Details of clinical assessment and classification are covered elsewhere in this volume. Nonetheless, the principles of assessing, the injuries are fully integrated with the early decision making and the principles are reiterated here.

Skeletal injury

The increased use of the two-column model for describing injuries to the spinal column rather than the previously used three column model, has not only simplified the process of classification but also focuses the clinician on assessing, using all possible modalities, both the anterior and the posterior columns [7]. It is the failure of identification of a significant injury in the posterior column that the most frequently leads to a misunderstanding of prognosis for anterior column fractures and leads to unexpected deterioration in some patients.

The clinician has to integrate clinical assessment including history and examination, plain X-ray, CT scan, both planar and two- or three-dimensional reconstructions and MRI scan. The output of these assessments should be a clear description of the injury to the anterior and posterior columns and this will lead to the classification of the injury as described elsewhere in this volume. Injuries to the anterior column typically occur with compression or flexion compression injuries and are the least amenable to identification by examination. The anterior column, however, is clearly visualised in plain X-rays, and in all modalities of CT scanning. Two-dimensional CT reconstruction helps in identifying type B fractures and in combination with three-dimensional reconstruction gives a better visualisation of some fracture patterns in the anterior column. Whilst the MRI scan rarely adds significant additional information to the assessment of the anterior column it can be helpful in quantifying the degree of injury to the adjacent disc and other soft tissue.

The posterior column from occiput to sacrum is readily accessible to the clinician in a patient who is log rolled with in-line stabilisation of the cervical spine. A careful search for localised tenderness, bruising and a gap or step is essential. High quality plain radiography can sometimes demonstrate interspinous distraction and, of course, with gross two-column injury then scoliosis and/or subluxation/dislocation will be seen on anterior posterior X-ray. Two-dimensional CT reconstructions and the MRI scan are powerful modalities for identifying injuries in the posterior column.

Dynamic X-rays are rarely used acutely, but if there is a residual question about stability, then clinical assessment of neck and trunk control is very helpful, and should be augmented by erect X-rays.

At the end of the assessment, phase of the skeletal injury the clinician should have a good idea of the configuration and magnitude of the injury to the anterior and posterior columns and using the Magerl classification [7] reproducible descriptive terms can be used for this injury and the injury allocated to the numerical hierarchy of this classification.

The assessment of spinal cord injury is dealt with elsewhere; essentially, the clinical and radiological assessments, especially, the MRI scan should allow the clinician to identify the anatomical and functional level of the spinal cord injury, the degree of spinal cord injury, i.e. partial or complete and some quantification of the degree of soft tissue damage to the cord, including the presence of spinal shock.

Associated injuries

Up to 20% of spinal injuries occur at multiple levels and there is evidence that in the upper cervical spine one

Fig. 2 Two level cervical injury

identified injury is associated with an 80% chance of a second injury in the cervical spine (Fig. 2). The assessing clinician should therefore assume a second injury, and all patients with a significantly identified skeletal injury in the spinal column should have the whole spinal column examined clinically and assessed radiologically either with plain X-rays from occiput to sacrum or with rapid sequence multidetector CT. This protocol should also be adopted in the unconscious polytraumatised patient where a clinical assessment is unreliable.

Injuries of the spinal column are always associated with significant energy application to the patient and on this basis, as per ATLS protocols [4], careful and repeated search for non-spinal, visceral and other skeletal injuries should be carried out.

The experienced spinal clinician should be establishing treatment priorities during the assessment process so that at the end of this process not only are the skeletal, neurological and associated injury are quantified but also an outline treatment plan has been completed.

Clearance

Clearance is an important concept, which is essential to intensive care physicians managing obtunded or unconscious patients. Management of these patients is simplified if a spinal injury has been excluded and the spinal surgeon is often called upon to review a patient and exclude such an injury. There is good evidence that a spinal injury can only be comprehensively excluded in the following circumstances:

1. An awake patient with no spinal symptoms.
2. An awake patient with localised pain, normal plain imaging, CT scanning and normal flexion, extension X-rays of the painful part.
3. The problems arise obtunded or unconscious patient. Patients with a normal X-ray and fine slice CT scan can be said to have a 98% chance of no significant spinal injury, particularly unstable injuries or subluxation. Even the addition of MRI scanning, however, does not give a 100% clearance and the recommended advice is that if plain X-ray and CT or MRI are normal then the intensive care staff should be instructed that there is only a very low chance of a potential instability in the spinal column, and that they should continue to use a lightweight orthosis and to log roll the patient until criteria one or two above can be met.

Steroid protocol

There is continued controversy around the role of high dosage Methylprednisolone in reducing the impact of spinal cord injury [2] and these issues will be dealt with in a separate article in this volume. Each hospital, region or country will have their own protocol and accepted standard of care but if the local preference is to use the steroid protocol then this should be instituted as soon as the spinal cord injury has been diagnosed and this may well be very early on in the assessment process.

Treatment principles and specific management of the spinal injured patient

The principles of treatment are as follows:

- decompress neurological structures,
- restore vertebral column integrity,
 - anterior column and
 - posterior tension band,
- avoid and manage complications, and
 - approach and
 - implant
- facilitate rehabilitation.

Many patients can be managed non-operatively and in the cervical spine the options for non-operative treatment range from the application of a lightweight orthosis through to a reduction with halo traction and rigid stabilisation with a halo jacket. There is a gradual change in the acceptability of halo jacket treatment for unstable cervical

spinal injuries and much as the management of tibial fractures has migrated from a non-operative treatment approach to operative stabilisation, there is a similar shift in trends for managing unstable cervical spine injuries.

Traction applied with a halo rather than tongs, however, can always be used as the emergency treatment in any displaced injury of the cervical spine except a Hangman's type IIA [6] fracture. In the Hangman's type, IIA fracture traction may displace the fracture and adds dramatically to the risk of spinal cord injury and subsequent death. In all patients with a displaced cervical spine injury, in whom a closed reduction by traction is being attempted, the clinician should perform an MRI scan other than when this is impossible to achieve in the treating centre and there is clinical urgency to the reduction.

The following injuries can be treated on traction:

- displaced Jefferson fracture,
- Hangman's fracture,
- type II/type III odontoid peg fracture,
- displaced subaxial fracture and
- subaxial sub-luxations and dislocations.

In general terms, traction can be used to maintain reduction after reduction is achieved and to 'let the dust settle' in patients who are polytraumatised. The use of a halo jacket can be used for transfer to a specialist unit and for definitive treatment in certain injuries.

The fast reduction protocol has been well-described in the literature [5] and involves halo application under local anaesthetic in an awake patient. The patient should be monitored in a high-dependency unit and in-line traction with X-ray control with 2 kg increments every 15 min to a limit of approximately 60 kg. This protocol has been described as reducing nearly all subaxial displaced injuries.

Surgical indications

In determining, which patients are suitable for surgery, the grade of instability as manifested by the degree of injury to the two spinal columns, or any significant displacement should be considered (Figs. 3, 4). A surgical option should be balanced against the non-surgical option by using an evidence-based approach to predict the likely outcome in relation to neurological sequelae, pain, deformity and degenerative change with one or other treatment method.

Early surgical intervention can be considered for partial neurological injury. There is evidence that a surgical decompression and stabilisation within 6 h of a partial spinal cord injury will lead to 70% of patients improving by one or more American Spinal Injuries Association, International Medical Society of Paraplegia (ASIA IM-SOP) grades [3]. If, such surgery is delayed beyond 6 h,

Fig. 3 Isolated anterior column injury

Fig. 4 Complex two-column injury

there is only a 12% chance of such improvement. In patients with a complete spinal cord injury, the situation is much bleaker but early decompression may allow recovery of one nerve root level and this will have dramatic functional implications in the cervical spine. In the thoracolumbar spine, a systematic review [1] of the literature looking at 275 publications and showed a mean improvement in Frankel grade of 0.64 in the operative group and 0.82 in the non-operative group. One study had a neurological deterioration as a result in the surgical group. The strong conclusion of this paper is that there is no justification in the thoracolumbar spine for early surgical intervention to improve the neurological outcome.

Indication for surgical stabilisation in subaxial fractures

- Failure of closed reduction.
- Unstable injuries.

- Initially, e.g. bilateral facet dislocation of more than 25% or 11°.
- Dynamic studies.
- Progressive neurological deterioration.
- For early mobilisation in neurologically compromised patient.
- In patients with a high incidence of late complications, e.g. kyphosis of 30° or loss of height of more than 50%.
- Established late instability and post-traumatic kyphosis.

The degree of kyphosis and loss of height is an important prognostic factor in type A compression fractures in the cervical spine.

Surgical approach

The cervical spine can be decompressed and/or stabilised from anterior and/or posterior approaches. In order to some extent, the approach depends upon the following factors:

1. Surgeon's preference.
2. Direction of maximum cord compression.
3. Biomechanical factors favour the posterior approach to reconstruct the tension band in single approach surgery.
4. The clinical results, however, favour anterior approaches. Whilst biomechanically inferior, there appears to be a very high clinical success rate with anterior approaches.
5. Most surgeons confronting patients with a severe two-column disruption will consider anterior and posterior combined approach and this should certainly be contemplated in patients in whom there is evidence of residual instability after completion of a first stage either posterior or anterior. This may be assisted by intraoperative stress X-rays. The detail of the surgical approaches and techniques will be covered elsewhere in this volume.

Post-operative care and rehabilitation

In the modern world of spinal injury care, there is no expectation of patients lying in bed for weeks or indeed months following trauma. If a spinal injury is not stable enough to allow the patient to mobilise within 24–48 h with appropriate bracing, then surgical stabilisation should be considered. After surgery patients should be free to

mobilise as soon as they have recovered from the anaesthetic effects and in the absence of spinal cord injury they will be up and walking within a day of the surgery.

In patients with a spinal cord injury, there will be a period of acclimatisation to gravitational challenge but most spinal cord injury rehabilitation centres will now commence tilting into an upright position within 48 h of surgical stabilisation. There is still certain inertia around the spinal cord rehabilitation community to commence this ultra early mobilisation programme but one of the main benefits of modern surgical stabilisation is to allow such early mobilisation.

Conclusion

The aim of the treating surgeon should be to reverse and certainly prevent deterioration of the neurological injury, to either identify adequate spinal stability to allow early mobilisation or to achieve such stability by the use of modern surgical techniques such that patients can be rapidly rehabilitated to their previous study, social and sporting activities.

Conflict of interest statement None of the authors has any potential conflict of interest.

References

1. Boerger TO, Limb D, Dickson RA (2000) Does canal clearance affect neurological outcome after thoracolumbar burst fractures. *J Bone Joint Surg* 85:629–635
2. Fehlings MG (2001) Recommendations regarding the use of methylprednisolone in acute spine cord injury. *Spine* 26:S56–S57
3. Fehlings M, Aarabi B, Dvorak M, et al. (2008) A prospective multicenter trial to evaluate the role and timing of decompression in patients with cervical spinal cord injury: initial one-year results of the STASCIS study. Paper presented at the AANS meeting in Chicago
4. Kortbeek JB, Al Turki SA, Ali J et al (2008) Advanced trauma life support, 8th edition, the evidence for change. *J Trauma* 64:1638–1650
5. Lee AS, MacLean JC, Newton DA (1994) Rapid traction for reduction of cervical spine dislocations. *J Bone Joint Surg* 76:352–356
6. Levine AM, Edwards CC (1985) The management of traumatic spondylolisthesis of the axis. *J Bone Joint Surg* 67A:217–226
7. Magerl F, Aebi M, Gertzbein SD, Harms J, Nazarian S (1994) A comprehensive classification of thoracic and lumbar injuries. *Eur Spine J* 3:184–201
8. White AA, Panjabi MM (1990) *Clinical biomechanics of the spine*. J.B. Lippincott Co, Philadelphia