ABC of Spinal Cord Injury

DAVID GRUNDY
JOHN RUSSELL

MEDICAL MANAGEMENT IN THE SPINAL INJURIES UNIT

The cervical spine

In injuries of the cervical spine skull traction is normally maintained for six weeks initially. The cervical spine may be held in flexion, extension, or the neutral position, depending on the nature of the injury. Thus flexion injuries with suspected or obvious damage to the posterior ligamentous complex are treated by placing the neck in a degree of extension. The standard site of insertion of skull callipers need not be changed to achieve this; extension is achieved by correctly positioning a pillow or support under the shoulders. A support under the head produces flexion. Most injuries are managed with the neck in the neutral position. An appropriately sized neck roll is also inserted to maintain normal cervical lordosis.

Left: unstable flexion injury in man who sustained a complete tetraplegia below C5. Note forward slip of C4 on C5 and widened interspinous gap, indicating posterior ligamentous damage.

Middle and right: the same patient six months later conservatively treated. Flexion/extension views show no significant movement but a persisting slight flexion deformity at the site of previous instability.

After six weeks a lateral radiograph is taken and if there are signs of instability the traction is continued for a further two or three weeks. After the traction is removed the patient is gradually sat up in bed over the course of a few days, wearing a firm cervical support, such as a Philadelphia collar, before mobilisation into a wheelchair. This process is most conveniently achieved by using a "profiling" bed, but the skin over the natal cleft must be inspected frequently for signs of pressure or shearing. Patients, particularly those with high level tetraplegia, often have postural hypotension at first, so profiling must not be hurried.

A 41 year old tetraplegic patient injured after a dive into the shallow end of a swimming pool. "Profiling" before mobilisation into a wheelchair.

Patient with C6-7 dislocation with an incomplete tetraplegia. The dislocation was reduced operatively and posterior spinal fusion performed. The halo was applied and traction administered. Ten days later halo bracing was assembled and he was mobilised into a wheelchair.

The decision to perform spinal fusion is usually taken early, and sometimes it will have been performed in the district general hospital before transfer to the spinal injuries unit. The decision when to operate will depend on the facilities available and the condition of the patient. However, some patients require late spinal fusion because of failed conservative treatment.

If postural hypotension is a problem antiembolism stockings and an abdominal binder to reduce the peripheral pooling of blood due to sympathetic paralysis are helpful, but often ephedrine 15-30 mg needs to be given as well, 20 minutes before profiling starts. With stable spinal injuries the firm collar may be discarded 12 weeks after injury and a soft collar worn temporarily for the patient's comfort.

The application of a halo brace is an excellent alternative to skull traction in many patients and allows early mobilisation. It is usually worn for six to eight weeks and then replaced by a firm cervical collar.

It is safe to perform flexion-extension radiographs under medical supervision 12 weeks after injury if spinal instability is suspected, but if pain or paraesthesiae occur the procedure must be discontinued. Most unstable injuries in the lower cervical spine are due to flexion-rotation forces and in the upper cervical spine to hyperextension. If internal fixation is indicated a posterior approach is the one of choice.

C7-T1 bilateral facet fracture-dislocation with fractures of the spinous processes of C6 and C7 and a complete tetraplegia below C7. Treated by operative reduction and stabilisation by wiring of the spinous processes of C5 to T1 and bone grafting.

Upper cervical spine and cervicothoracic junction

As injuries of the upper cervical spine are often initially associated with little or no neurological deficit prompt appropriate treatment is important.

Fractures of the atlas are of two types. The commonest, a fracture of the posterior arch, is due to an extension-compression force and is a stable injury which can be safely treated by immobilisation in a firm collar. The second type, the Jefferson fracture, is due to a vertical compression force to the vertex of the skull, resulting in the occipital condyles being driven downwards to produce a bursting injury, in which there is outward displacement of the lateral masses of the atlas and in which the transverse ligament may also have been ruptured. This is an unstable injury with the potential for atlantoaxial dislocation, and skull traction for at least eight weeks is necessary.

Lateral view: diving injury in an 18 year old man with compression fractures of the bodies of C5 and C6 and an associated Jefferson fracture of the atlas, not obvious on this view. Anteroposterior view, clearly showing Jefferson fracture, with outward displacement of right lateral mass of atlas. Treated by skull traction.

Odontoid fracture in 64 year old woman, due to hyperextension injury after a fall on to her face at home. Reduced by applying 4 kg traction force, with atlanto-occipital flexion; position subsequently maintained using a reduced weight of 1.5 kg.

The "hangman's" fracture, a traumatic spondylolisthesis of the axis, so called because the bony damage is similar to that seen in judicial hanging, is produced by extension of the head on the neck, with distraction. This results in a fracture through the pedicles of the axis in the region of the pes interarticularis, with an anterior slip of the C2 vertebral body on that of C3. Bony union occurs readily, but gentle skull traction should be maintained for six weeks, followed by immobilisation in a firm collar for a further two months. Great care must be taken not to overdistract in this injury. Indeed, in all upper cervical fracture-dislocations once reduction has been achieved subsequent control can usually be obtained by applying a traction force of only 1 to 2 kg. If more weight is used neurological deterioration may result from overdistract at the site of injury. An alternative approach when there is no bony displacement or when a reduction has been achieved is to apply a halo brace.

The cervicothoracic junction—Closed reduction of a C7-T1 facet dislocation has not been found to be possible, and in these circumstances operative reduction by facetectomy and posterior fusion is indicated, particularly in those patients with an incomplete spinal cord lesion.

The thoracolumbar spine

A 25 year old motorcyclist with a complete paraplegia below T10 as a result of a fracture-dislocation of T11-12 with lateral displacement. Normal alignment achieved using Harrington distraction rods. Note normal thoracolumbar curve preserved by shaping the rods.

Most patients with thoracolumbar injuries are treated conservatively, bed rest being required for 8 to 12 weeks before mobilisation. If there is gross deformity, however, or if the injury is unstable and the spinal cord injury incomplete, instrumentation with Harrington distraction rods corrects the deformity and allows early mobilisation.

Fractures of the odontoid, usually produced by hyperextension, result in posterior displacement of the odontoid and posterior subluxation of C1 on C2; flexion injuries produce anterior displacement of the odontoid and anterior subluxation of C1 on C2. If displacement is considerable, reduction is achieved by gentle controlled skull traction under radiographic control. Traction is continued for at least eight weeks, followed by immobilisation in a firm collar for two to three months, depending on radiological signs of healing. Halo bracing is another approach to the management of this fracture. Posterior atlantoaxial fusion is necessary if there is non-union and atlantoaxial instability.

Forced extension injury sustained in car accident by 22 year old woman, resulting in a "hangman's" fracture. There is also associated fracture of posterior arch of atlas.

Wedge compression fractures of T5 and T6 in association with a fracture of the sternum.

There is no place for laminectomy because it may render the spine unstable and does not adequately decompress the spinal cord except in the rare instance of a depressed fracture of a lamina.

Before a patient with an unstable injury is mobilised the spine is braced, the brace remaining in place until bony union occurs. Injuries to the upper thoracic spine are sometimes associated with a fracture of the sternum converting a stable into an unstable injury, because of the loss of the normal anterior splinting effect of the sternum. It is very difficult to brace the upper thoracic spine, and if such a patient is mobilised too quickly a severe flexion deformity of the spine may develop.

Pulmonary embolism, para-articular heterotopic ossification, spasticity, and contractures

Heterotopic ossification in the right hip.

Pulmonary embolism

Anticoagulation, which in the absence of contraindications should have started 24 to 36 hours after the accident, is continued throughout the initial period of bed rest until the patient is fully mobilised into a wheelchair. If a pulmonary embolus does occur, management is as in the non-paralysed patient.

Para-articular heterotopic ossification

After injury to the spinal cord new bone is often laid down in the soft tissues around paralysed joints, particularly the hip and knee. The cause is unknown, although local trauma has been suggested. It usually presents with erythema, induration, or swelling near a joint. There is marked osteoblastic activity, but the new bone laid down does not mature for at least 18 months. This has an important bearing on treatment in that if excision of heterotopic bone is required because of gross restriction of movement or bony ankylosis of a joint, surgery must be delayed for at least 18 months—until the new bone is mature. Earlier surgical intervention may provoke further new bone formation, thus compounding the original condition. As yet there is no convincing evidence that treatment with disodium etidronate prevents the progression of this complication.

Spasticity

Spasticity is seen only in patients with upper motor neurone lesions of the cord whose intact spinal reflex arcs below the level of the lesion are isolated from higher centres. It usually increases in severity during the first few weeks after injury, following the period of spinal shock. In incomplete lesions it is usually more pronounced and can be severe enough to prevent a patient with good power in the legs from walking. Patients with severe spasticity and imbalance of opposing muscle groups have a tendency to develop contractures. It is important to realise that once a contracture occurs spasticity is increased and a vicious circle established with further deformity resulting. Although excessive spasticity may hamper the patient's activities or even throw him out of his wheelchair or make walking impossible, spasticity may have advantages. It maintains muscle bulk, decreases osteoporosis, and improves venous return.

Treatment of severe spasticity is initially directed at removing any obvious cause. An irritative lesion in the paralysed part, such as a pressure sore, urinary tract infection or calculus, anal fissure, infected ingrowing toenail, or fracture, tends to increase spasticity. Passive stretching of spastic muscles and regular standing are helpful in relieving spasticity and preventing contractures. The drugs most commonly used to decrease spasticity are baclofen, which acts at spinal level, and dantrolene sodium, which acts directly on skeletal muscle. Although diazepam relieves

Contractures at the right hip and knee, associated with unrelieved spasticity.

Factors that aggravate spasticity

- Pressure sores
- Contractures
- Urinary tract infection or calculus
- Anal fissure
- Infected ingrowing toenail
- Fracture

spasticity, its sedative action and habit forming tendency limit its usefulness. If spasticity is localised it can be relieved by interrupting the nerve supply to the muscles affected by neurectomy after a diagnostic nerve block using a long acting local anaesthetic (bupivacaine). For example, in patients with severe hip adductor spasticity obturator neurectomy is effective. Alternatively, motor point injections, initially using bupivacaine, followed by either 6% aqueous phenol or 45% ethyl alcohol for a more lasting effect, are useful in selected patients. Rarely, and if severe spasticity cannot be otherwise relieved, an intrathecal block with 6% aqueous phenol or absolute alcohol is indicated. The effect of phenol usually lasts a few months, that of alcohol is permanent. The main drawback to the use of either is that they convert an upper motor to a lower motor neurone lesion, and thus affect bladder, bowel, and sexual function.

Contractures

A contracture may be a result of immobilisation, spasticity, or muscle imbalance between opposing muscle groups. It may respond to conservative measures such as gradual stretching of affected muscles, often with the use of splints. If these measures fail to correct the deformity or are inappropriate surgical correction such as tenotomy, tendon lengthening, or muscle division may be required. For example, a flexion contracture of the hip responds to an iliopsoas myotomy with division of the anterior capsule and soft tissues over the front of the joint.

Pressure sores

Pressure marks over sacrum and left posterior iliac crest. Relief of pressure over these areas must be continued until marks have faded. In this patient, this was achieved only after three days of bed rest with appropriate positioning.

Effect of unrelieved pressure—a deep sacral pressure sore.

A pressure sore forms as a result of ischaemia, caused by unrelieved pressure, particularly over a bony prominence. The sore may affect not only the skin but also subcutaneous fat and muscle. If near a joint, septic arthritis may supervene. The commonest sites are over the ischial tuberosity, greater trochanter, and sacrum. Pressure sores are a major cause of readmission to hospital, yet they are wholly preventable by vigilance and recognition of simple principles.

Regular changes of position in bed every two to three hours and lifting in the wheelchair every 15 minutes are essential. A suitable mattress and wheelchair cushion are particularly important, cushions needing frequent checking and renewing if necessary. Shearing forces to the skin from underlying structures are avoided by correct lifting; the skin should never be dragged along supporting surfaces. Patients must not lie for long periods with the skin unprotected on operating tables or on x ray diagnostic units. A pressure clinic is extremely useful in checking the sitting posture, assessing the wheelchair and cushion, and generally instilling pressure consciousness into patients. If a red mark on the skin is noticed which does not fade within 30 minutes the patient should avoid all pressure on that area until the redness and any underlying induration disappears.

If an established sore is present the slough is excised and the wound dressed often using a desloughing agent such as half strength Eusol. Once the wound is clean, with healthy granulation tissue, normal saline dressings are used. Indications for surgery are:

(a) a large sore which would take too long to heal using conservative methods;

(b) a sore with infected bone in its base;

(c) a discharging sinus with an underlying bursa. If possible, surgical treatment is by excision of the sore and any underlying bony prominence, with direct closure in layers, leaving a small linear scar. Most pressure sores can be managed in this way. Recurrence is uncommon and if it occurs can be more easily treated following this type of surgery than if large areas of tissue have been disturbed by previous use of a flap.

Mr David Grundy, FRCS, is consultant surgeon, and Mr John Russell, FRCS, director, Duke of Cornwall Spinal Treatment Centre, Odstock Hospital, Salisbury.