Instability due to unrecognised fracture-subluxations after apparently isolated injuries of the cervical spine

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Instability may present at a different level after successful stabilisation of an unstable segment in apparently isolated injuries of the cervical spine. It can give rise to progressive deformity or symptoms which require further treatment. We performed one or more operations for unstable cervical spinal injuries on 121 patients over a period of 90 months. Of these, five were identified as having instability due to an initially unrecognised fracture-subluxation at a different level. We present the details of these five patients and discuss the problems associated with their diagnosis and treatment.

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The incidence of unstable injuries of the cervical spine is about 30 per million of the population per year. Early reduction of dislocations and fractures can be carried out indirectly, i.e., by traction, after suitable imaging, but this may not confer stability. Surgical treatment allows decompression of the spinal canal when indicated, stabilisation of the spinal column and early mobilisation. Urgent surgery may be necessary in the presence of an increasing neurological deficit, for example when there is an expanding epidural haematoma. Decompression of the spinal cord will almost always need to be accompanied by stabilisation. Surgery may be carried through an anterior or posterior approach or both. The anterior approach has less morbidity and allows excision of the disc and vertebrectomy when required. The posterior approach gives a wider exposure. The occiput and atlas can also be stabilised. While immob-

ilisation in a halo jacket is sometimes indicated, over the last two decades surgical stabilisation of unstable cervical injuries has become increasingly common.

Non-contiguous fractures and subluxations of the cervical spine and multilevel vertebral fractures are well described, but initially undiagnosed fracture-subluxations (IUFs) of the cervical spine are poorly recognised.¹ They may only become apparent after stabilisation of an obviously unstable segment.

In the cervical spine, instability at one level which is revealed after successful stabilisation of another may give rise to progressive deformity and radicular, myelopathic and local symptoms, which sometimes require further treatment. We present our experience of this condition and recommendations for its management.

Patients and Methods

Between 1991 and 1998, 121 patients underwent one or more operations, including the application of a halo jacket, for unstable cervical injuries. Their mean age was 43 years (11 to 86). Of these 52% had been involved in motor-vehicle accidents, 32% had fallen from a height, 14% had been injured at sport and 2% had been victims of violence. One patient had survived an air crash; 27 had multiple injuries. In 46 (38%) immobilisation in a halo jacket was their definitive management. There was a decrease in the use of this device during the six-year period, reflecting a change in management policy. A variety of methods of fixation was used including anterior plates (24%), posterior hooks or plates (25%), and combined anterior and posterior surgery (13%).

All patients presenting with neck trauma and clinical signs had radiography of the cervical spine. In all unconscious patients plain radiography and CT of the craniocervical junction were carried out. Dynamic flexion-extension imaging of the cervical spine allowed for assessment of ligamentous injury in the unconscious patient.² This was carried out in the critical-care unit and was found to be easier than MRI in patients with multiple injuries. MRI was performed when possible in those with neurological symptoms or signs and in those in whom there was a dislocation requiring indirect reduction by traction or posterior reduction and internal fixation.

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Fig. 1a

Fig. 1b

Fig. 1c

Fig. 1d

Fig. 1e

Fig. 1f

Case 1. Figure 1a – Lateral radiograph showing narrowing of the C5-6 space and possible subluxation of C4 on C5. Figures 1b and 1c – T2-weighted sagittal (b) and STIR (c) MRI showing the prolapsed intervertebral disc at C5-6. There is a large haematoma posterior to the upper spinous processes and no evidence of injury at C4-5. Figure 1d – Lateral radiograph immediately after operation showing the cervical spine plate and bone graft at C5-6. There is persistent loss of alignment of C4 on C5. Figure 1e – Lateral flexion radiograph taken about four weeks after surgery showing that the deformity has increased at C4-5. Figure 1f – Lateral radiograph showing posterior stabilisation of C4-5 and C5-6 segments by screws in the lateral mass.

Of the 121 patients, five were identified with initially unrecognised fracture-sluxations (IUFS). Table I gives their details. We describe two illustrative cases.

Illustrative case reports

Case 1. A 48-year-old woman was a restrained, rear-seat passenger in a car which rolled over. There was marked tenderness posteriorly in the C5-6 region, altered sensation in the C6 and C7 dermatomes in both upper limbs, and hyper-reflexia in both lower limbs with no other evidence of compression of the cord. Radiographs showed only minimal angulation between C4 and C5 (Fig. 1a). CT

demonstrated no bony injuries but MRI revealed prolapse of a disc at the C5-6 level, with significant reduction of the space available for the spinal cord. A large posterior haematoma was also seen. No abnormality was noted at the C4-5 level (Figs 1b and 1c). She underwent anterior cervical discectomy, fusion with a bone graft and stabilisation with a cervical plate (Fig. 1d). The radiculopathy improved but within two weeks it recurred in the right C5 and C6 dermatomes. There was loss of muscle power (MRC grade 3/5) in the right biceps, an absent biceps reflex and inversion of the right brachioradialis reflex. Further flexion radiographs showed separation of the C4-5 spinous processes and subluxation, reducible in extension, at that level

Table I. Details of the five patients with initially unrecognised fractures and subluxations (IUFS) of the cervical spine

Case	Age (yr)	Gender	Mode of injury	Primary lesion	Neurological deficit	Secondary lesion	Neurological deficit	Time between diagnoses (wk)	Primary treatment	Secondary treatment
1	30	M	Driver, car rolled over	C3-4 unifacetral dislocation	Nil	C4-5 bifacetral subluxation	C6 radicular pain	4	Posterior reduction, 2-hole lateral mass plates	Removal of plates, 3-hole lateral mass plates and interspinous wiring
2	19	M	Rear passenger, unrestrained, car spun at 80 mph	C3-4 bifacetral subluxation	Nil	C4-5 bifacetral subluxation	Nil	6	Posterior Halifax hooks	SOMI hard collar for 3 months. No further treatment required
3	23	M	Driver, van rolled over	C2-3 tear drop fracture	Nil	C4 inferior facet fracture, C4-5 subluxation	C5 radicular pain	1	Halo vest immobilisation for 9 weeks	No further treatment required
4	48	F	Rear passenger, restrained, car rolled over	C5-6 tear drop fracture with disc prolapse	C6, C7 radicular pain	C4-5 bifacetral subluxation	C5 radicular pain	4	C5-6 anterior cervical discectomy and fusion with plate fixation	Posterior C4-6 instrumented fusion and bone grafting
5	12	F	Dive into shallow pool	C2-3 subluxation	Nil	C3-4 subluxation	Nil	6	Posterior C2-3 interspinous wiring and bone graft	Posterior C3-4 interspinous wiring and bone grafting

(Fig. 1e). This was treated in a SOMI collar. Over the next three weeks there was no clinical or radiological improvement and she therefore underwent posterior instrumented cervical stabilisation and bone grafting from C4 to C6 (Fig. 1f). After surgery, there was complete relief of pain in the upper limbs and recovery of the neurological deficit.

Case 2. A 12-year-old girl suffered an injury to her neck when she dived into a shallow pool. She was seen elsewhere two weeks later with no neurological deficit, but with moderately severe pain, tenderness and restriction of neck movements. She was referred to us. Radiographs showed anterior subluxation of C2 on C3 (Fig. 2a). MRI showed an isolated subluxation of C2 on C3 with disruption of the posterior ligamentous complex (Fig. 2b). No lesion was seen at the C3-4 level. At surgery, the posterior interspinous ligaments between C2 and C3 were found to be ruptured. No other significant posterior disruption was seen. The facet joints at the level below were not disturbed. She underwent posterior C2-3 fusion with bone graft and interspinous wiring. Postoperative flexion radiographs showed features of instability at C3-4 with anterior subluxation and angulation $>11^\circ$ (Fig. 2c). At operation the posterior interspinous ligaments were found to be intact at the C3-4 level. The posterior interspinous wiring and bone graft were extended to C4. At follow-up three years later, there were no further clinical or radiological signs of instability at these or other levels (Fig. 2d).

Discussion

Missed primary injuries of the cervical spine have a reported incidence of between 5% and 33%.^{3,4} We use a standard protocol for the evaluation of neck trauma and the rate of missed primary cervical injury at our centre is 3%.⁵ Despite this low figure, five of 121 patients (4.1%) were noted to have IUFS when they were further investigated after initial surgical treatment, either because of persisting symptoms

or as part of the follow-up. Three (2.5%) required further surgery. It is surprising that IUFS after treatment of apparently isolated cervical spinal injuries have not been previously reported since they seem to occur as often as missed primary injuries.

In the only previously reported series of non-contiguous fractures and subluxations (NFS) six of 66 consecutive patients (9%) with cervical spinal fractures presented with NFS during a period of 26 months.¹ The pattern of injuries, however, differed considerably from our series. All were recognised at presentation and all six patients had one lesion at C1 or C2 and a second lesion in the levels below. Five of the six had a significant neurological deficit.

Our cases raise some interesting points with respect to management. It is now recommended that patients with suspected cervical injuries have helical CT as part of the triage.⁶ This demonstrates fractures, vascular injuries and damage to the respiratory and digestive tracts, but not soft-tissue injuries. MRI may be more effective for soft-tissue and disc-related injuries but is less specific and sensitive to fractures of the cervical spine compared with CT.⁷ Some patients with dislocations of the cervical spine will have extensive avulsions of the ligamentum nuchae visible on MRI. One of our patients (case 1) had these changes from the occiput to C7, but only had instability at two levels (Fig. 1b). Ruptures of the interspinous ligament and posterior intervertebral joint capsules are not always seen.

It is not our current practice to perform MRI on all patients with cervical injuries who require surgery. Once the primary cervical injury is stabilised, real-time flexion-extension imaging can be carried out with an image intensifier under the same anaesthetic. We do not know if this would help to define those who will require further surgery. It has been used safely at our centre under consultant supervision, to exclude significant instability in unconscious patients.⁵ We plan to use and evaluate this technique further in our patients after treatment of their primary cervical injuries.

Fig. 2a

Fig. 2b

Fig. 2c

Fig. 2d

Case 2. Figure 2a – Lateral radiograph showing anterior subluxation of C2 on C3. Figure 2b – T2-weighted sagittal MRI showing an isolated lesion at C2-3 posteriorly and subluxation of C2 on C3. Figure 2c – Lateral radiograph at six weeks showing anterior subluxation of C3 on C4 after C2-3 posterior interspinous wiring. Figure 2d – Lateral radiograph six months after C3-4 posterior wiring; alignment has been restored.

The initial surgical procedure may be done through an anterior or posterior approach. As the second lesion in patients with IUFS is often an unstable ligamentous injury, further surgery may best be carried out through the posterior approach. If there is any doubt about the stability of an adjacent segment before operation, it may be wise to avoid a posterior approach since there may be risk of damage to the posterior structures with subsequent instability. In our cases, however, there is little evidence that the subsequent instability was due to a posterior operation. Two of our five patients did not have primary posterior surgery.

Based on our findings, patients who undergo surgery for injuries of the cervical spine should be aware before opera-

tion that there is a small risk (4%) of the presence of an initially unrecognised fracture-subluxation at a different level in the cervical spine. Of this group, 50% will require further surgical treatment either under the same anaesthetic or at a later date.

Preoperative MRI is of value in patients with injuries to the cervical spine but may not necessarily demonstrate IUFS, as seen in two of our patients. If the patient has an open surgical procedure intraoperative flexion-extension radiographs should probably be obtained at the end. We plan to start doing this. Awareness of this condition and careful follow-up must be ensured. We recommend that flexion-extension radiographs be obtained at the first post-

operative visit to the clinic. Further surgery should be considered at the second level if there are signs of instability according to the criteria of White and Panjabi,⁸ or if there are significant persistent neurological signs or symptoms.

Despite the delay, it is unlikely that patients will come to long-term harm after definitive treatment of the initially unrecognised injury.

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