compound wound or the open reduction of an irreducible fracture-dislocation may be necessary but laminectomy, performed routinely as an exploratory or diagnostic procedure, cannot be justified in the patient with traumatic spinal cord injury.

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STABILITY OF SPINAL FRACTURES AND FRACTURE DISLOCATIONS

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IN 1793 discussion on the stability of spinal fracture dislocations was first mentioned by Sommering. The use of laminectomy as a method of management of spinal fractures and fracture dislocations has been argued ever since. Historically, it has been fairly severely dealt with, and yet the argument continues even into 1970. The problem of stability has still not been solved.

For a period of 15 years in Western Australia, a neuropathological study has been undertaken of all cases coming to post-mortem, and the few cases who have been submitted to surgical exploration. What do we mean by stability of spinal fracture dislocations? The definition of the word is simple, but as discussed by a number of authorities, it probably means very different things to different people. 'Stability' means to be stable, to be secure, to be inviolate; whilst 'instability' surely means to be insecure or to have a fear of the unknown. The present author believes that we are no longer in the latter category. We no longer should have any fear of the unknown; we now know the pathological problems of stability and this is a subject that can now be practically discussed.

Neuropathology teaches us a great deal about what happens in the spinal column of patients who have sustained fracture dislocations of either the cervico-dorsal junction or the lumbo-dorsal junction. In considering the concept of stability of such fractures, I believe that we have omitted a most important aspect

of consideration, and that is time. We must remember in our discussion of stability that in certain types of dislocation it will be time that will usually mean stability occurring. So often in our treatment of patients with fracture dislocation of the cervical column, we are dictated to by that unknown—'What will happen to the patient?'—we are afraid of further cord damage, and yet the present author has not really seen this happen except in one case (a patient without fracture dislocation of the vertebral column, who progressed from being paraplegic to being tetraplegic, a phenomenon well described by Frankel (1969). We are afraid of the loss of function of the spinal column; of its being an unstable column as a functional part of the motor skeletal system. And finally, we are afraid of pain. All of these matters we can now consider in the light of our neuropathological and neurophysiological knowledge.

NORMAL ANATOMY

If we consider the normal anatomy of the cervico-dorsal or lumbo-dorsal junction, there are a number of factors involved in either the cervico-dorsal or the lumbo-dorsal junction as far as stability is concerned. The spine is stable providing a number of important elements remain intact:

1. The disc. A dissolution of the disc by either infection or injury will cause a potential instability.
2. The anterior longitudinal ligament, which pathologically plays a much greater part than we originally thought.
3. The posterior interspinous ligament, which in most normal people is small and insignificant, and does not play much part.
4. The ligamentum nuchae, an important ligament joining the interlaminal spaces and extending to the capsular ligament of the articular facets.

There are other important aspects of stability. An hour in a dissecting room or mortuary with a few fresh specimens will prove the following:

(a) The division of the posterior interspinous ligament does not interfere with the stability of the vertebral column.
(b) That division of the ligamentum nuchae still does not interfere with the immediate stability of the vertebral column.
(c) That the interarticular facetal joints and their capsule, if disrupted, do not interfere with stability.
(d) It is not until the disc is cleanly divided by a sharp knife that the spinal column begins to show some potential instability.
(e) It is not until the anterior longitudinal ligament is stripped (but not necessarily divided) that the vertebral column then becomes potentially unstable under the influence of stress.

These are anatomical facts which can be confirmed in any mortuary or any dissecting room by study of the normal vertebral column. What then of the abnormal column? In a column subjected to extreme stress, the majority of the injury falls upon the ligamentous complex posteriorly and the epiphyseal plate where usually there is a fracture through the vertebral body. This has been shown clearly pathologically, and in all of our 70 specimens we have not once demonstrated a pure dislocation. All have been associated with a fracture. Radiologically, of

course, it is not possible to always see the fracture which is present, whereas pathologically it can always be demonstrated.

	Avascular bone	Real stability	Anterior ligament	Posterior ligamentous complex
Flexion rotation injuries	Present	95·6%	Intact	Rupture (associated with fracture)
Extension injuries	Nil	All	Rupture	Intact (associated with fracture)
Burst injuries . .	Present	All	Intact	Intact

FIG. 1a

Results—Bony pathology (70 Cases).   *All* cases at *autopsy* were *fracture* dislocations.

Potentially unstable cervical fracture dislocations   .   .   428 Cases
    (Stoke Mandeville: Melbourne: Perth)
Late instability   .   .   .   .   20 Cases = 4·6%

All flexion rotation injuries are *potentially unstable.*

FIG. 1b

THE PATHOLOGY OF INSTABILITY

1. An extension injury of the cervical column does not interfere with the ligamentum flavum, with the posterior interspinous ligaments, or the facetal joints. It usually interferes with the anterior longitudinal ligament and the disc. With flexion, these extension injuries are quite stable. We have noted in our pathological studies that in the majority of such extension injuries coming to post-mortem there is a multiplicity of levels of damage and this is what usually happens in the severe hyperextension injuries although they are stable.

2. Compression injuries which are usually seen in the cervical spine—known as the dispersion injuries, but occasionally also seen in the lumbar spine. These are injuries caused by a vertical stress through the vertebral body with no injury at all to the anterior, longitudinal, and posterior ligamentous complex, with injury only to the vertebral body itself and perhaps to the vertebral end plates or epiphyseal plates. These injuries, sometimes known as the 'tear-drop' fracture in the cervical spine, are always stable and in our series of radiological follow-ups and our series of pathological follow-ups these injuries have always been stable, and have never shown any tendency to instability over a period of time.

Here we are again considering the problem of time, but radiologically these injuries can be said to be perfectly stable, and never give rise to any problem from the point of view of nursing or medical management.

3. The third factor in stability is the presence of aseptic or avascular necrosis

in the vertebral body, which over a period of time will cause increased deformity and potential instability. This is a real factor in the severe crush injuries of the lumbo-dorsal column with severe displacement when seen originally at the time of admission, and this factor must always be remembered in the conservative reduction of the fracture. It is the reason these fracture dislocations collapse even
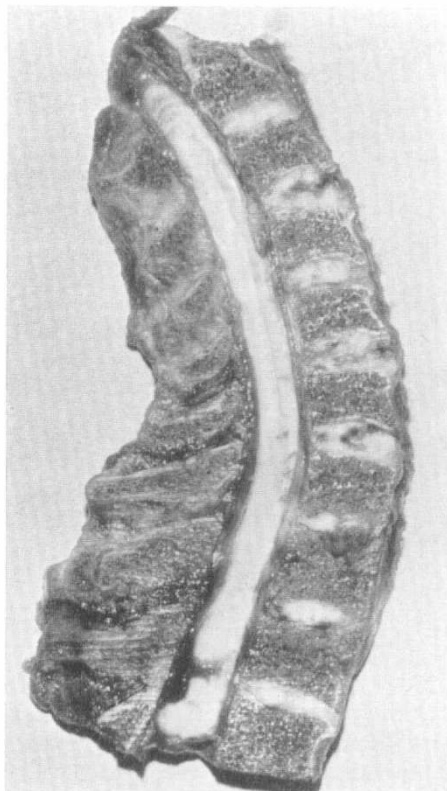

FIG. 2

Extension injury of the column shows cord
swelling, multiple disc damage, extradural
haemorrhage, but a stable spine.

after adequate conservative reduction, as was shown recently by the series from Stoke Mandeville (Frankel *et al.*, 1969). It has also been noted in the series treated by internal fixation. So that aseptic necrosis is always a pathological entity to be remembered in severely comminuted cases.

4. The anterior longitudinal ligament plays a very important part in stability. The figure shows a complete fracture dislocation of C7 on T1 with an intact anterior longitudinal ligament, in which there is already calcification taking place, and histologically union is well on the way. There is already organisation in the posterior ligamentous complex. This patient lived for five weeks and was unable to have his fracture dislocation reduced because of other complications, but in

Fig. 3

A stable compression fracture of the vertebral column.

Fig. 4

A potentially unstable injury showing the importance of
the anterior longitudinal ligament.

the position as indicated in Figure 4, the fracture was stable. It is not suggested that we should accept such positions, but after all it is a stable fracture dislocation, and I believe that this figure shows very well why I have now introduced the term 'potential instability'.

5. Unilateral fracture dislocations completely unreduced, whether at post-mortem or during life are stable because there is an intact anterior longitudinal
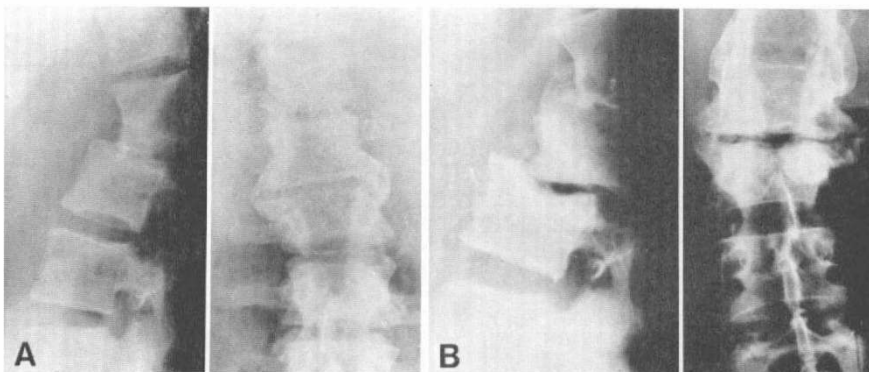

FIG. 5

The iatrogenic cause of instability, progressive infection below the site of the fracture dislocation which had healed by good paravertebral callus.
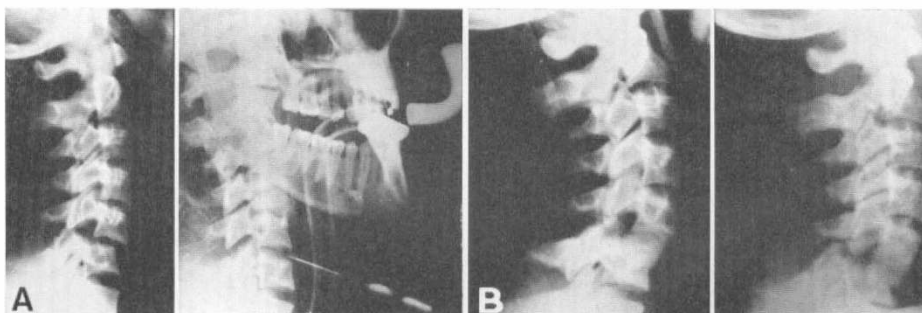

FIG. 6

A, Unilateral fracture dislocation C5 on C6 partially reduced. B, Re-dislocation after operation.

ligament and a ruptured posterior complex, but the disc is either not badly damaged whilst the displacement is not allowed to get worse because of the unilateralness of the fracture dislocation. Many authors indicate that unilateral fracture dislocations are very unstable, but I am sure they are only potentially unstable; if they are reduced and treated adequately by normal conservative methods of management over a period of time they all become stable.

6. Bilateral dislocations are always potentially unstable, but usually stable after reduction.

7. Another important factor in the potential instability of such vertebral column fractures and fracture dislocations is the iatrogenic factor of time, plus

laminectomy. One well-documented case can be quoted where laminectomy was performed in 1953. In 1956, when the X-rays were investigated, the patient's fracture had healed, but the disc space below was beginning to show changes. Over a period of a further 10 years, this showed instability with gross infective changes. Originally this was thought to be Charcot's joint, but we are now convinced that it was an infection. The iatrogenic factor of total laminectomy including facetal joints and the introduction of infection, can over a long period cause further difficulties as far as stability is concerned in the vertebral column. A further iatrogenic factor occurs in a typical case after the so-called need for early stabilisation:

R. L. Male, aged 22—admitted to hospital with C4 on C5 unilateral fracture dislocation (which I regard as being potentially stable), had an anterior stabilisation done within three days of being in hospital. By so doing, the anterior longitudinal ligament, which is important in such flexion rotation injuries, was damaged. Ultimately, his fracture dislocation was re-displaced.

These then, are the pathological factors associated with the problems of instability.

THE RISKS OF SURGERY

What are the risks of surgery to patients with such fracture dislocations as we are considering? I believe that the risks are several:

(*a*) Infection.
(*b*) Increased deformity.
(*c*) Increased neurological disability.
(*d*) Non-union.

Of these risks, I propose only to discuss the risk of increased deformity.

In such fracture dislocations, increased deformity does occur after inopportune posterior surgery and even more so after inopportune anterior surgery, as already discussed in the pathological factors previously mentioned.

The patient whose X-rays are illustrated in Figure 7(*a*) and (*b*) had his fracture dislocation adequately reduced by conservative means. Stability was achieved with paravertebral callus and the dislocation remained well reduced. We have not seen any case where there has been neurological deterioration because of failure to completely reduce deformity.

L. P. Male, aged 35, cauda equina lesion—fracture dislocation of L1 on L2, whose fracture dislocation after four to five months of conservative treatment showed no signs of union, and who began to have spinal pain because of the movement of the fracture site. Surgery was advised to stabilise at this stage, but was refused. In the long run this was obviously correct, for over a period of a further six months, his lumbar fracture dislocation fused perfectly and his pain disappeared.

What, then, is an actual indication for surgery to reduce the fracture dislocation in the early stage? In our experience we now use this only rarely, and then only on patients with greater than one-half dislocation or fracture dislocation in which conservative means including the use of a gentle re-positioning procedure under general anaesthetic including traction, has been used. In the occasional case, open reduction is necessary. When open reduction has been undertaken, the surgeon must then consider, in view of the pathology present and extent of damage, whether
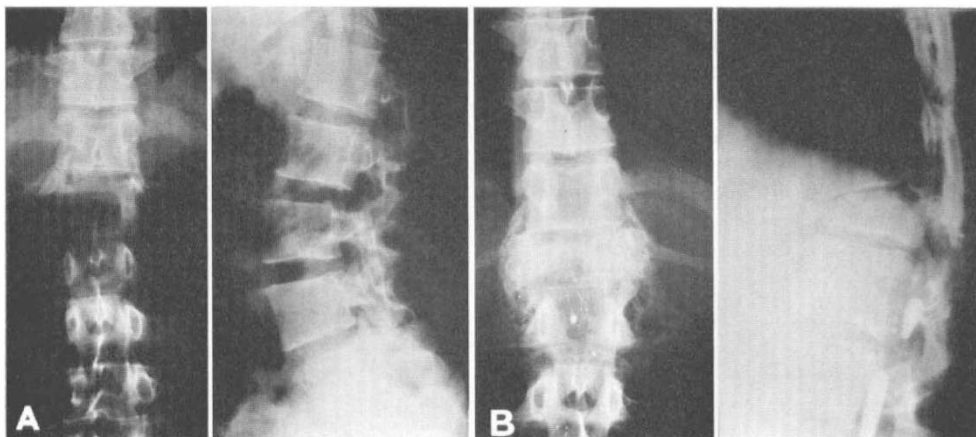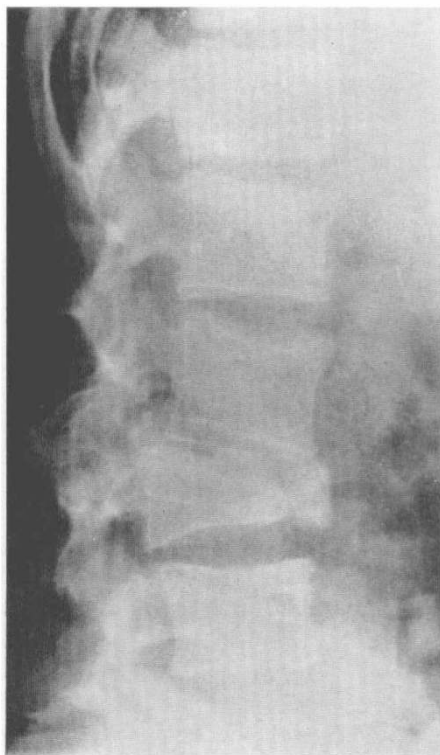
FIG. 7

FIG. 8

Fig. 7.—A, A gross fracture dislocation T12-L1 with potential instability. B, Same fracture dislocation; conservative reduction; good stability.

Fig. 8.—Flexion rotation fracture dislocation L1-L2 with potential instability which stabilised slowly but effectively.

any type of internal splintage is required or not. At the present time the most satisfactory type of internal splintage to be occasionally used is probably the Harrington co-apter or the Knott co-apter. One such case has occurred in our experience in the last two years, where looking back on the indications, the present author still considers there was an indication (Bedbrook, 1969a). Such patients frequently simply need a small incision without laminectomy to adequately reduce the dislocation and the patient is then nursed conservatively.

I remind you again in this paper not to be too concerned about the amount of room the cord and cauda equina have to move in. The neural canal is perfectly adequate for the cord and cauda equina to recover in, particularly after reduction. The Berry Specimens in the University of Melbourne, Australia, effectively demonstrate the capacity of the spinal canal. In most cases, and on an average, the cord only occupies 50 per cent. of the canal (Elliott, 1963).

RETROSPECTIVE STUDY OF OUR OWN CASES AND THOSE OF OTHERS

In an attempt to determine this question of stability from a different perspective, we considered a number of unilateral and bilateral fracture dislocations which we recognised as being potentially unstable. In a small series of some 62 patients with potential instability at the time of admission, we found that only six showed instability. Unilateral fracture dislocations were always stable, and no final instability was ever proven. The natural history of cervical fractures and fracture dislocations of the flexion rotation group is that 85-88 per cent. will get natural bony healing, whilst compression injuries radiologically always get good bony fusion. The extension injuries are always stable, although some of these get satisfactory pseudarthroses.

DISCUSSION

A study of the literature shows that most authors (Galle, 1939; Ellis, 1946; Durbin, 1957; Forsyth, 1959) state that instability occurs in between 10 and 12 per cent. of cases.

In deciding the question of stability or instability, perhaps not enough attention has been given to the whole patient and whether the patient has other complications; whether there is urinary infection; whether the patient is able to be mobilised early. One reason for early stabilisation of the vertebral column has been, it is said, to enable the patient to be rehabilitated early, but in critical analysis of this, early surgery means within the first three to three and a half weeks. In that period of time, the majority of patients in hospital without the aid of intermittent catheterisation or without the use of antibiotics, will always be infected as far as the urinary tract is concerned, and thus the orthopaedic surgeon must also accept the risk of operating if indicated on a patient who already has some bacteriaemia, and then the question of stability really must be considered. Even if a graft is inserted which is stable, the patient is then not going to be up and about for three or four days after the surgery, so that in the long run the time saved is no more than two to three weeks at the very most, with the increased risks of surgery which have now been well demonstrated.

Finally, the present author studied a large series of patients from Stoke Mandeville, Victoria, and Western Australia. This series showed that only 20

cases out of 420 were truly unstable after three months (Bedbrook, 1969*b*) (fig. 1*b*). This author admits that the criterion of stability as used at Stoke Mandeville varies slightly from that used in Victoria, and again slightly from that used in Western Australia, so that where an author at Stoke Mandeville would consider a patient stable, perhaps we in Western Australia would regard the same patient as being potentially, if not truly, unstable. But the overall figure speaks for itself. The present author believes that we should never say that a fracture dislocation is unstable under at least eight weeks, and probably between eight and twelve weeks. Late instability is the only true reason for anterior spinal fusion. Some cases in Western Australia have been fused for failure of conservative management. Because of insufficient numbers we are not prepared to make any accurate estimation on figures, but our summary of pathology confirms that less than 6-10 per cent. of our potentially unstable injuries are really unstable.

Pathologically, these injuries can now therefore be proven to be stable; in the vast majority of patients it is only a question of time, and patient, conservative management. As I indicated in the early part of this paper, Sommering (1793) showed a fracture dislocation with adequate callus completely unreduced, but nevertheless it became a stable injury. In our experience with 28 new cases per year in Western Australia, we have now been able to took at some 350 spinal injuries, both cervical and lumbo-dorsal, and it is our contention that whilst flexion rotation injuries should always be thought of as potentially unstable, in the majority of cases these will be stable.

We believe that the majority of patients are basically stable injuries when they have been adequately reduced or re-positioned; that the majority of cases, nay probably almost all the cases, can be so treated with excellent results both pathologically and clinically. We are certain that in all cases there is very little, if any, risk of deterioration of the neurological state. When a patient is admitted to hospital with an incomplete quadriplegia or an incomplete paraplegia with a potentially unstable fracture dislocation, there is no indication at all for any surgery unless gross displacement is irreducible, and even then such surgery may be dangerous. It can, and will, cause some further deterioration. Morgan (1970) indicated that of some 70 incomplete cases of tetraplegia, 22 were made worse by laminectomy and inadvisable surgery, so that indications for surgery must be extremely rare, and then only undertaken after a period of time . . . time in which the surgeon can consider the injury, consider the pathology, and observe the patient.

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