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The Surgical Reconstruction of Fractures and Fracture Dislocations of the Thoraco-Lumbar Spine

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Summary. *Sixty patients have undergone surgical reconstruction of the injured thoraco-lumbar spine during the period 1968 to 1978 at the Spinal Unit of the National Murayama Hospital. The aim of treatment of any fracture, dislocation, or fracture-dislocation of the spine is to render it stable and painfree. This is best achieved by reduction and stabilisation of the involved segment of the spinal column. Where the posterior ligaments and intervertebral disc are ruptured healing of these structures with return to normal stability cannot be anticipated. In order to obtain permanent stability at the affected vertebral level we elect to perform anterior intervertebral fusion.*

Résumé. *A l'hôpital National de Murayama, de 1968 à 1978, 63 blessés ont bénéficié d'une reconstruction chirurgicale après fracture du rachis dorso-lombaire. Le but du traitement de toutes fractures, luxations ou luxations-fractures du rachis est de reconstituer une colonne stable et indolore. Il est atteint au mieux par la réduction et la stabilisation du segment fracturé. Lorsque les ligaments postérieurs et les disques sont rompus on ne peut obtenir la restauration complète de ces structures, ni par conséquent retrouver une stabilité normale. Pour y parvenir les auteurs ont maintenant recours à la fusion rachidienne par voie antérieure.*

Key words: *Surgical reconstruction, Thoracolumbar spine, Fracture, Dislocation*

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The aim of reconstruction of the spinal column after injury is to restore stability and give maximum protection to the integrity and function of the cord. This allows early rehabilitation, lessens the likelihood of such complications as decubitus ulcers and urinary tract infections, and prevents additional damage to the cord [1, 2, 4, 5, 7]. The early management of these severe injuries determines the eventual prognosis. We have therefore undertaken a programe of operation in order to secure accurate reduction and stabilisation.

Material

Two hundred and seventy six patients with spinal injuries, of whom 236 had associated neurological damage, were treated at this hospital during the years 1968 to 1978. Of these 276 patients 114 had sustained injuries to the thoraco-lumbar region (T.11 to L.1), 94 to the cervical region, 43 to the thoracic region and 25 to the lumbar region (Table 1). Operation was carried out on 63 of the injuries to the thoraco-lumbar spine. The age range of the patients at the time of surgery was from 15 to 65 years with a mean age of 29.3 years. There were 50 males and 13 females.

Method

Reduction of Fractures or Fracture-dislocations of the Spine. The thoraco-lumbar region is particularly susceptible to indirect trauma since this is the junction between the mobile lumbar spine and the relatively immobile thoracic spine [10]. In cases of complete dislocation with interlocking of the articular facets bilaterally, open reduction is preferred [3, 8]. Closed reduction by means of traction and extension in cases of complete dislocation is not only impossible but carries the danger of production or deterioration of a neurological lesion, due to further narrowing of the spinal canal by the interlocked articular processes during traction and extension of the dislocated spinal column [7].

Open reduction is performed through a small longitudinal incision over the spinous processes of the involved vertebra, under local anaesthetic. The posterior elements of the dislocat-

Table 1. Patients treated at the Spinal Unit of the National Murayama Hospital during the years 1968 to 1978

Level of injury	No. of patients without spinal cord injury	No. of patients with spinal cord injury	Total
Cervical	15	79	94
Thoracic	2	41	43
Thoracolumbar (T11–L1)	13	101	114
Lumbar	10	15	25
Total	40	236	276

ed spine are exposed and the superior facet of the vertebra below is excised with a surgical airdrill. The spine is then easily reduced and the wound closed (Fig. 1). Post-operatively the patient is nursed with the trunk in slight extension. This operation is then followed by an anterior inter-body fusion two to four weeks later to stabilize the spine. In long-standing cases, where reduction has been neglected, reduction is not only difficult surgically but may also be dangerous in that further cord damage may result. In these cases a staged approach is advocated, thus.

1. Application of the halo-pelvic distraction apparatus.
2. Posterior release of the interlocked articular facets by excision.
3. Anterior release with discectomy and spinal osteotomy by the anterior approach.
4. Anterior spinal fusion after reduction has been achieved by spinal distraction.
5. Additional posterior spinal fusion where necessary.

In a case of severe dislocation halo-pelvic distraction is most helpful to achieve a reduction of the dislocation.

Stabilization of the Injured Spine. Two surgical procedures have been recommended for stabilization of the injured spinal column, anterior and posterior intervertebral fusion [3, 4]. We do not employ the more commonly used methods of posterior stabilization except to temporarily supplement an anterior intervertebral fusion. Anterior intervertebral fusion, which we regard as a relatively easy procedure at any level of the spinal column, has been our procedure of choice since it is more certain to result in a permanent fusion.

Operative Technique of Anterior Intervertebral Fusion. The patient is placed in the lateral position. The operating table is broken at the mid-portion of the spine in order to afford a good exposure and to facilitate the approach to the involved intervertebral disc. A left-sided anterior approach is usually preferred. Within the thorax we adopt an extrapleural approach to minimise the effects on respiratory function and to ease post-operative care. The lumbar spine is exposed by the extra-peritoneal approach. The crura of the diaphragm are then stripped forwards off the 11th and 12th ribs and the transverse process of the 1st lumbar vertebra. This exposure of the vertebrae should give adequate access to the front and to the opposite side. The intervertebral disc is exposed without ligation of the segmental vessels.

The damaged intervertebral disc is removed as completely as possible. The anterior longitudinal ligament is also sectioned to open up the disc space. It may also be necessary to

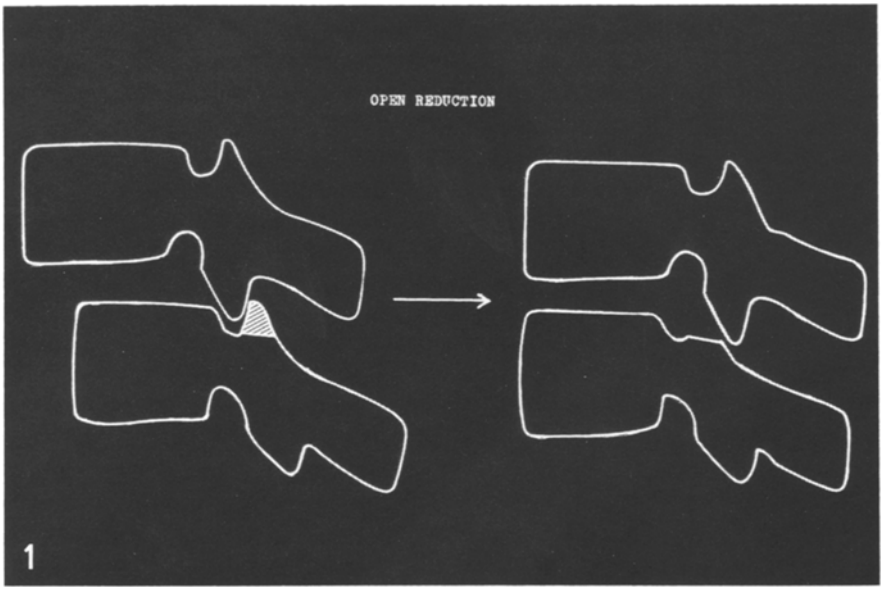


Fig. 1. Schematic drawing of open reduction

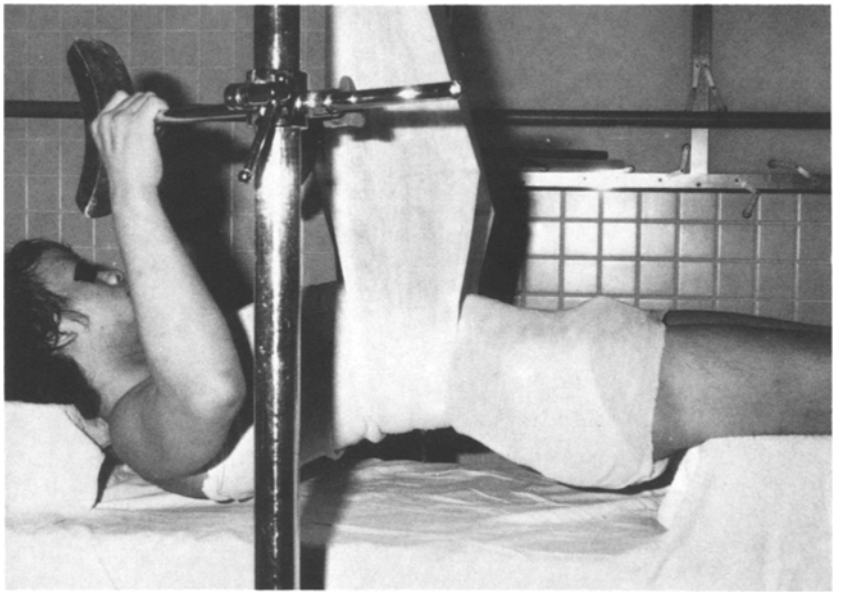


Fig. 2. Applying the plaster jacket using the sling method

resect loose bone fragments of the vertebral body. Following removal of the damaged disc the cartilage of the vertebral end plate is excised as completely as possible. Two iliac bone grafts are inserted into the disc space which is distracted with spreaders. The diaphragm is repaired with silk and the wound closed in layers with a suction drain.

Post-operative Care. The patient is kept in bed initially. After the skin sutures have been removed a plaster jacket is applied with the patient in a supine position supported on a sling (Fig. 2). The patient is then mobilised and discharged for rehabilitation. The plaster jacket is maintained for between 10 to 12 weeks. Patients treated with halo-pelvic distraction are mobilised once the wound is healed. The halo-pelvic apparatus is maintained for up to 24 weeks and then followed by a spinal brace or a plaster jacket.

Results

A total of 63 patients treated by these methods were reviewed (Table 2). Open reduction by the posterior route was the treatment of choice where there was complete dislocation with locked articular facets and 17 of the 63 patients had undergone early open reduction with restoration to normal alignment. All these patients also underwent anterior spinal fusion. There were no post-operative complications.

Closed reduction with bedrest or by means of a sling (Fig. 2) to provide extension was employed in 41 patients who had anterior wedge fractures of the spine or incomplete dislocations without locking of the articular facets. Halo-pelvic distraction was used in 5 patients of whom 3 had severe fracture-dislocations of the spine and 2 had a long-standing dislocation of over 6 months duration. Staged operations were required for reduction and stabilization of these 2 patients with good result. There have been no complications in this group.

Table 2. Surgical Procedures in 63 patients

Open reduction	17
Closed reduction	41
Halo-pelvic distraction	5
Anterior vertebral fusion	63
Combined posterior fusion	6

Anterior intervertebral fusion after reduction of the fracture or fracture-dislocation was performed in all 63 patients. They were followed-up radiologically for one year following operation. All but one patient proceeded to a solid vertebral fusion. The one patient who failed to fuse had an excessively unstable spinal column at the thoracolumbar level caused by longstanding complete dislocation associated with previous laminectomy. The only significant complication was in one patient who developed osteomyelitis of the vertebral body. This resolved uneventfully following curettage of the focus. Posterior intervertebral fusion following anterior fusion was performed in 6 patients who had a long strut-graft employed in the anterior intervertebral fusion.

Neurological assessment was performed in 51 of the 63 patients of whom 53 had complete neu-

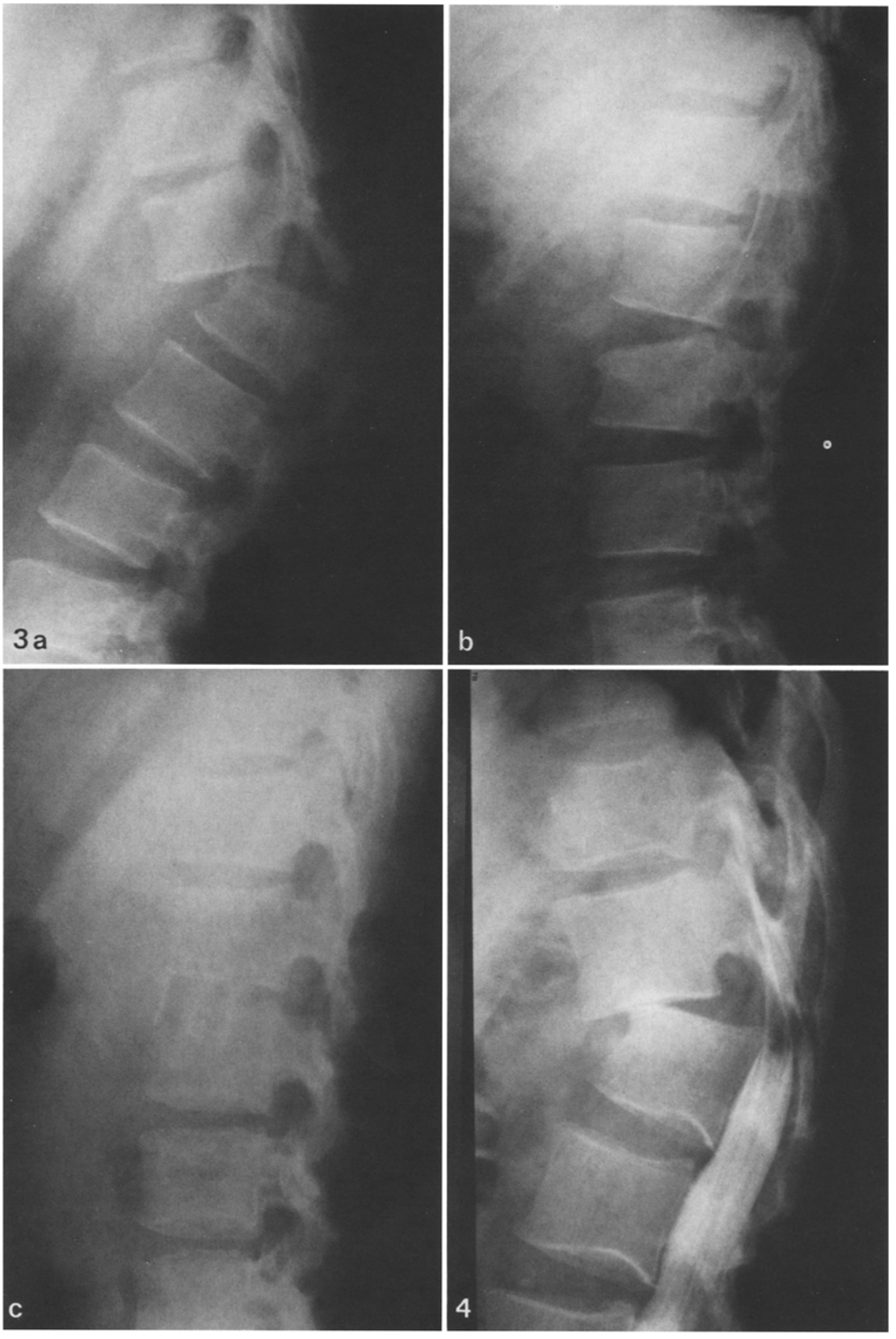


Fig. 3 a–c. a Lateral radiograph of patient with severe dislocation of L.1. (Case 1) **b** Lateral radiograph following open reduction through posterior approach (Case 1) **c** Postfusion lateral radiograph (Case 1). **Fig. 4.** Lateral myelogram of patient with old dislocation of L.1. (Case 2)

rological lesions and 4 incomplete lesions pre-operatively. Two of the 4 patients with incomplete lesions went on to complete recovery and the other 2 had partial recovery following surgical reconstruction. None of the 53 patients with complete lesions showed any neurological improvement following surgery.

Case Reports:

Case 1. A 23-year old male was involved in an industrial accident on 13. 4. 75. He noted immediate paralysis of his lower limbs. He was transferred to our hospital one day following injury. Physical examination revealed total motor loss in the lower extremities and complete anaesthesia below the level of the inguinal ligaments.

A radiograph showed a complete dislocation of L.1 on L.2 (Fig. 3a). Open reduction by the posterior route was done immediately following admission. A post-operative radiograph the next day showed complete reduction (Fig. 3b). Two weeks later an anterior interbody fusion was performed (Fig. 3c). There was no neurological recovery. Three months later the spine was soundly fused.

Case 2. A 22-year old male was involved in an automobile accident on 9. 3. 76. He complained of pain in the thoraco-lumbar region. Initially he was treated by plaster jacket for four weeks for an incomplete dislocation of L.1 on L.2 by another doctor. Six months after the injury he was referred to our hospital with paraparesis. Physical examination revealed hyporeflexia in the lower extremities and hyperaesthesia in the right lower limb but he was able to walk. A radiograph revealed a complete dislocation of L.1 on L.2 and a water soluble myelogram showed narrowing of the spinal canal (Fig. 4).

After application of a halo-pelvic distraction apparatus he was treated firstly by anterior and posterior release and then an anterior intervertebral fusion, once reduction had been achieved. Complete neurological recovery resulted. The halo-pelvic apparatus was maintained for three months following the last procedure. Five months following the anterior interbody fusion the bone graft had consolidated (Fig. 5a, b).

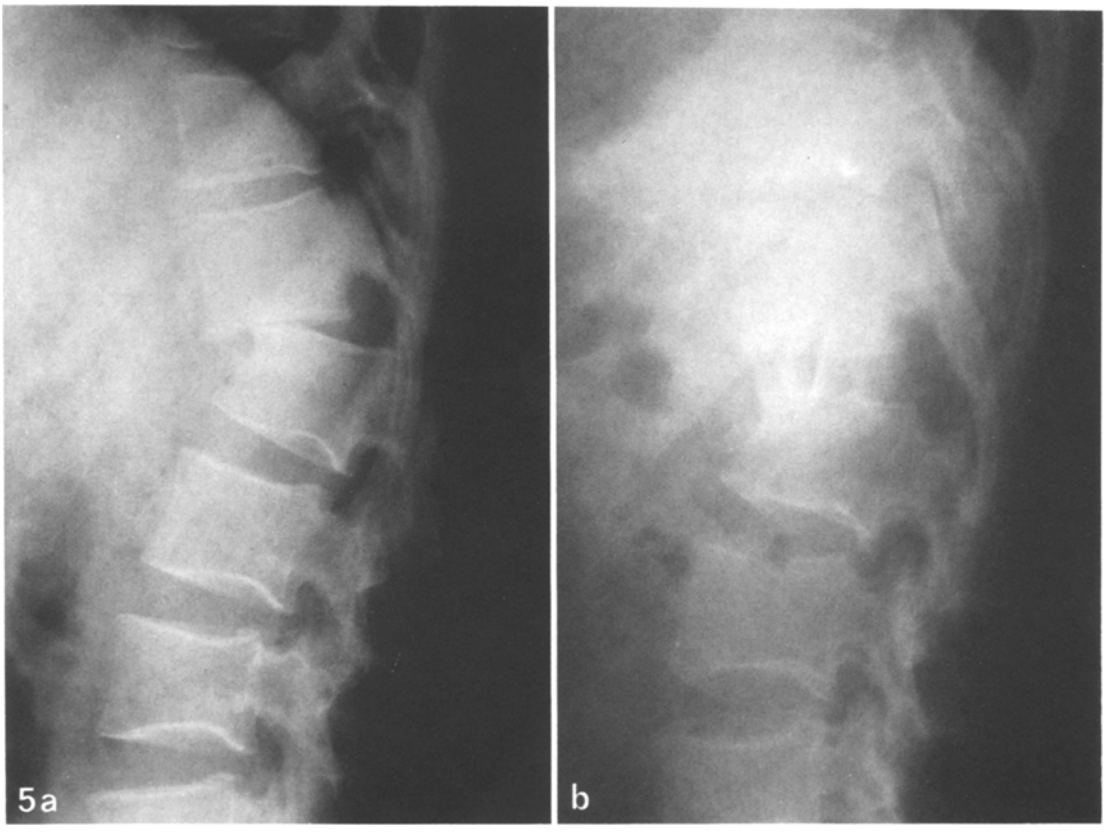
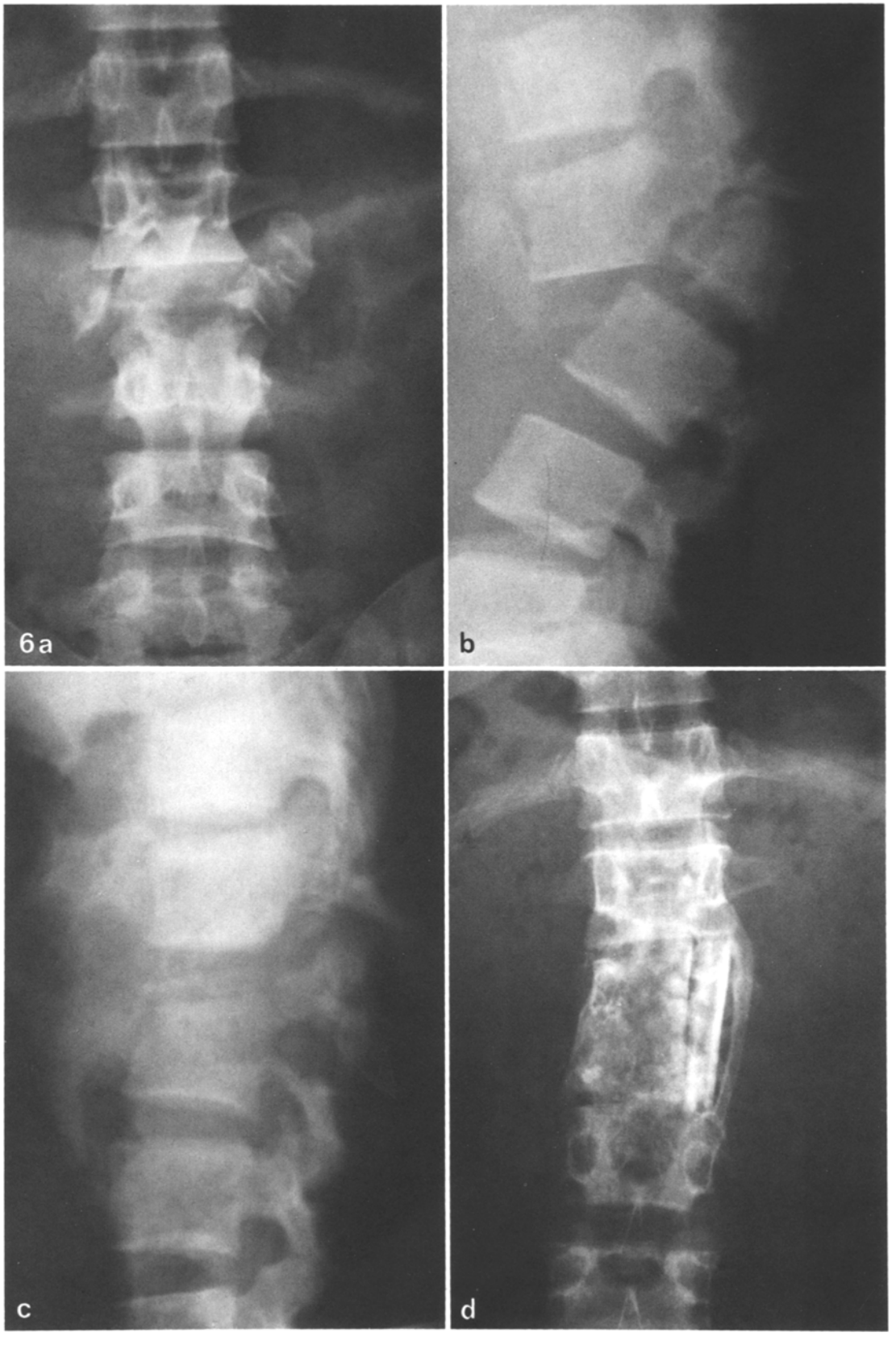


Fig. 5a + b. a Pre-operative and **b** post-operative lateral radiographs of same patient (Case 2)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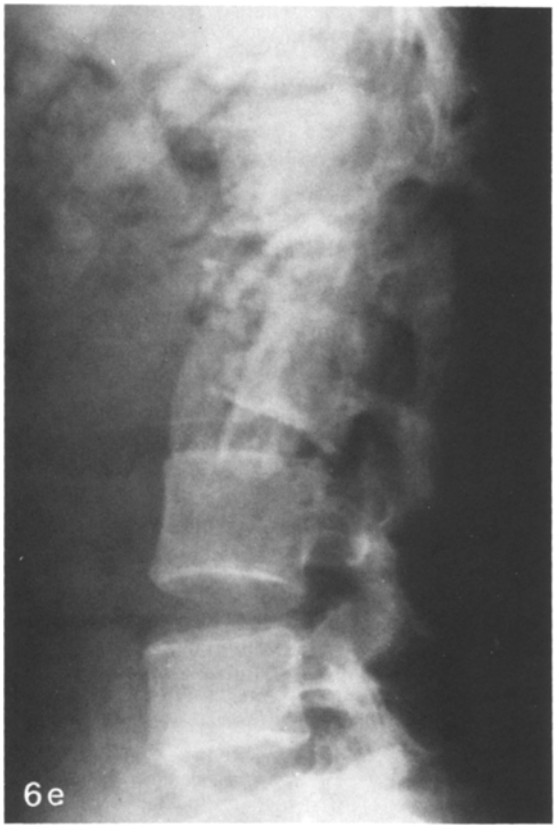

Fig. 6 a–e. **a** Antero-posterior and **b** lateral radiographs of patient (Case 3) with severe dislocation of L.1 on L.2 **c** Lateral radiograph of same patient following reduction using halo-pelvic distraction apparatus. **d** Antero-posterior and **e** lateral radiographs of the same patient following anterior vertebral fusion

Case 3. A 23-year-old male was involved in an industrial accident on 21. 9. 77. He had a severe fracture-dislocation of L.1 with total cord transection (Fig. 6a, b). The day following injury he was transferred to our hospital and a halo-pelvic distraction apparatus applied. A radiograph taken following the application of the halo-pelvic apparatus showed complete reduction of the fracture-dislocation of the L.1 vertebra (Fig. 6c).

Three weeks later anterior intervertebral fusion was performed followed by a posterior vertebral fusion. He made an uneventful post-operative recovery and was discharged for rehabilitation using a wheelchair. Six months later the halo-pelvic apparatus was removed as the fusion area was soundly united. (Fig. 6d, e).

Discussion

The spine by virtue of its anatomy combining stability with flexibility protects the spinal cord [5, 10]. This function is lost following damage to the spinal column and neurological deficit or deterioration may follow. Correction of the spinal deformity is most important [4, 9], since reduction of the dislocation restores the structure of the spinal column and also most effectively relieves pressure on the compressed spinal cord [1, 2].

Even in the case of a simple wedge fracture of the vertebra, surgery and fusion will eliminate an important source of persistent aching in the affected region and restore the normal alignment of the vertebrae.

Nicoll's [5] original classification divides injuries of the spinal column into two types, stable and unstable. However this is not easy to determine clinically. After bone damage restoration to the normal position is possible if the reduction of the bone fragments is accurate. However healing of soft tissue damage involving both the intervertebral disc and the posterior ligaments cannot be achieved without persistent laxity and instability, in spite of accurate reduction and prolonged immobilisation. The final result is a persistently unstable spinal column with the possibility of late neurological deterioration from cord or root damage. Patients with a persistently unstable spine frequently complain of aching pain in the involved part. In patients with complete cord lesions below the level of injury, spinal instability and a prominent gibbus may result in decubitus ulcer and infection over the gibbus, and problems in sitting and standing balance accompanied by back pain [9]. The para-vertebral muscles surrounding the unstable vertebrae work at a mechanical disadvantage with a resulting weakness and fatigue which may cause pain.

Spinal fusion should be performed in cases with dislocation or fracture-dislocation of the spine since there is division of the inter-vertebral disc and posterior ligaments [1, 2, 4]. In cases where there is a comminuted fracture stability may develop in spite of severe intervertebral disc damage since the damage to the posterior ligaments may be slight and interbody fusion may develop spontaneously [2, 6]. In these fractures early anterior decompression is indicated since the spinal cord lesion results from encroachment of the spinal canal by the fracture. Anterior interbody fusion may result in better bony consolidation than spontaneous interbody fusion, but there is no documented evidence for this.

To establish the diagnosis of instability of the spinal column lateral radiographs in maximal flexion and extension of the involved portion of

the spinal column are taken under weight bearing conditions. Discography of the involved intervertebral discs may also be helpful to establish stability, and it is routinely used in the pre-operative assessment of patients with spinal injury whether in the cervical, lumbar or thoraco-lumbar region. Review of the discograms performed above and below the simple wedge fractures shows disc lesions in a high percentage of cases. Roaf [6] has showed this in his dynamic studies of the spinal column.

In cases with severe disc lesions as shown by discography vertebral interbody fusion follows closed reduction of the affected fracture by keeping the patient supine in a position of hyperextension. This prevents the onset of discogenic pain with occasional instability and increasing gibbus deformity.

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