Recurrence of deformity after removal of Harrington's fixation of spine fracture

Seventy-six cases followed for 2 years

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The radiographic result was assessed in 76 patients with acute unstable fractures of the thoracic or lumbar spine admitted during the years 1977–1984, and who were managed by early reduction and stabilization using Harrington distraction rods and a three-segmental posterolateral fusion. The radiographs were analyzed for anterior and posterior heights plus sagittal and frontal widths of the fractured vertebral body and the angles of kyphosis and scoliosis of the spine. All the measurements were made at admission, immediately postoperatively, and at the latest follow-up at least 3 months after removal of the rods, which was done as a routine procedure 6–12 months after the accident. The mean follow-up was 29 months.

The posterior height and sagittal width of the vertebral bodies were best restored, whereas the initially well-reduced anterior height and the angle of kyphosis often had returned to values close to those seen on admission. The best anatomic restoration was obtained in rotation-dislocation injuries of the thoracic and thoracolumbar spine, and was poorest in burst fractures of the lumbar spine.

Patients with unstable thoracolumbar fractures are treated by Harrington rods and posterior fusion in many trauma units (Flesch et al. 1977, Riska 1981, Lifeso et al. 1985). Severe posttraumatic vertebral deformity has been shown to correlate with residual local symptoms (Day and Kokan 1977, Härkönen et al. 1979). Reduction and internal fixation are probably more efficient than nonoperative management for restoring the vertebral anatomy, and stabilization of the fractures prevents additional neural damage and allows earlier mobilization (Jacobs and Casey 1984). However, there are few detailed reports on the ultimate radiographic results achieved by Harrington instrumentation in different types of unstable vertebral fractures.

We report the long-term radiographic outcome in severe vertebral fractures and fracture-dislocations treated with Harrington rods and posterior three-segmental fusion. The clinical observations in our patients have been published by Böstman et al. (1987).

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Patients and methods

From 1977 on, we have performed prompt internal fixation of unstable fresh fractures of the thoracic or lumbar spine. The lack of stability was diagnosed by radiologic criteria (Holdsworth 1970, Denis 1984) or the presence of neural involvement. We have used dual long Harrington distraction rods and a three-segmental posterior fusion with decortication, joint resection, and transportation of iliac bone. The hooks are placed proximally and distally on the third lamina from the injured vertebra (Figures 1 and 2). Contoured Harrington rods (DeWald 1984) and the rod-sleeve method (Edwards and Levine 1986) were not in use at the time of the operations reviewed here. No laminectomies were performed. Postoperatively, the patients were nursed in bed for 6 weeks. Thereafter, a hyperextension brace was worn for 4 months after the injury. As a routine the rods were removed after union of the fractures 6 to 12 months after injury. Solid union of the fracture site was observed at the removal operation in all the cases.

During the period 1977–1984, 123 patients were admitted to our department for an unstable fracture of the thoracic or lumbar spine, and were managed by Harrington instrumentation. The present study includes 76 patients operated on within 72 hours of the accident and followed up clinically and radiographically until at least 3 months after removal of the rods. The reasons

Figure 1. A flexion-rotation unstable fracture of the L1 vertebra.
A. On admission a marked sagittal displacement.
B. After emergency reduction using Harrington distraction rods.
C. At follow-up 4 years later, a minor kyphosis has recurred owing to gradual recollapse of the vertebral body; but there is no sagittal displacement, and the spinal canal is well restored.

for exclusion of the remaining patients from this study were death from concomitant injury in 4, delayed Harrington procedure 4–18 days after the accident in 25, lost to follow-up in 7, and incomplete radiographs in 11 cases. In 18 patients with emergency Harrington operations, an early dislocation of the hooks occurred; but these patients were immediately reoperated on and were therefore included in the study. There were 50 males and 26 females. The mean age was 30 (14–76) years. The level of injury was in 12 cases thoracic (T5–T11), in 39 cases at the thoracolumbar junction (T12–L1), and in 25 cases in the lumbar spine. The fractures were classified as burst type in 30, wedge compression in 24, and rotation-dislocation in 22 patients.

The analysis based on anteroposterior and lateral radiographs included measurements of the anterior and posterior heights and the sagittal and frontal widths of the fractured and adjacent intact vertebral bodies according to Willén et al. (1985). The relative heights and widths were assessed by calculating the ratio between the heights and widths of the injured and the intact vertebrae. In addition, the anteroposterior displacement (mm) of the vertebral body and the kyphosis

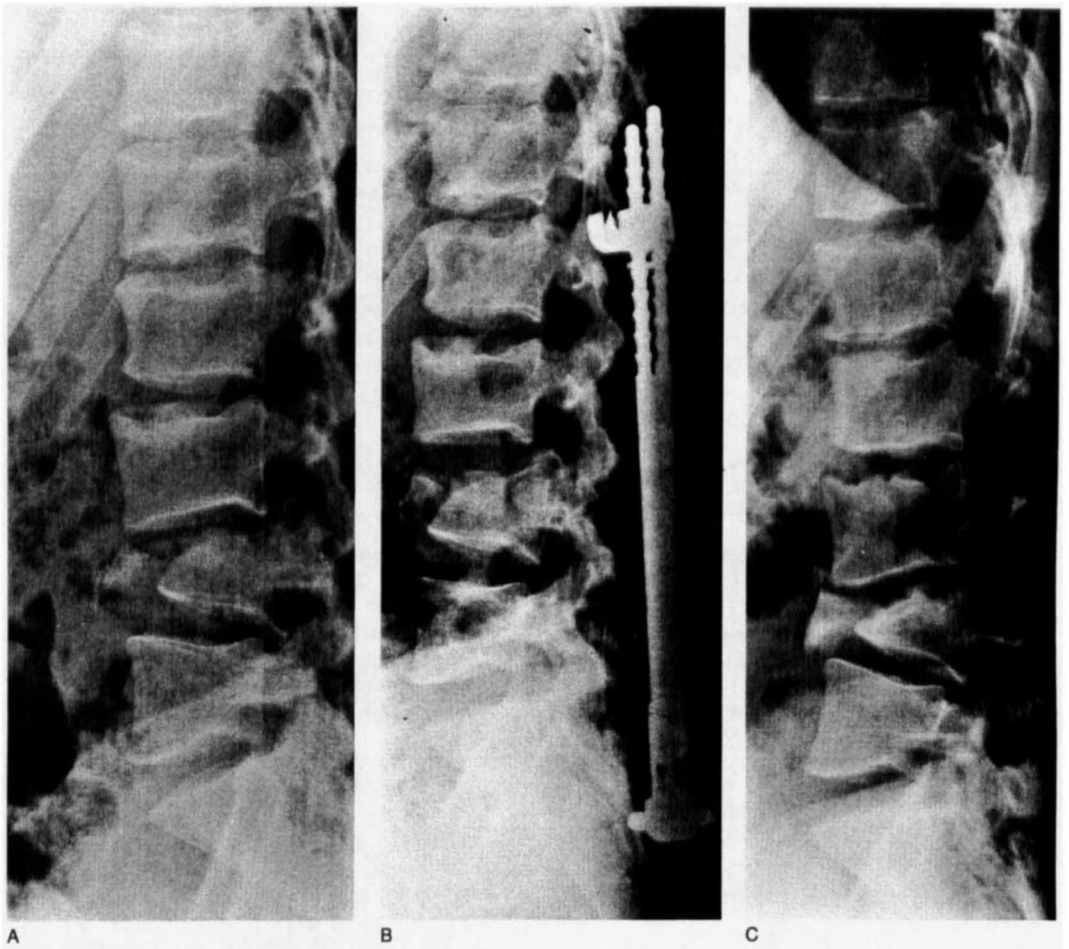

Figure 2. A principally burst-type fracture-dislocation of the L4 vertebra.
A. On admission.
B. After reduction and fixation the radiographs show an apparently successful realignment.
C. At follow-up 2 years later, no restoration of the cancellous bone structure has taken place in the vertebral body, and the ultimate radiographic outlook is close to that seen on admission.

Table 1. Mean relative anterior and posterior heights (percent) of the vertebral body and mean kyphosis angle in relation to level of injury. Mean *SEM*

	Level of injury		
	T 5–11 n 12	T 12–L 1 n 39	L 2–5 n 25
Anterior height			
on admission	66 *6*	58 *3*	60 *3*
postoperative	* 89 *3*	*** 81 *2*	* 77 *3*
ultimate	85 *3*	72 *3* *	68 *4* *
Posterior height			
on admission	90 *2*	93 *1*	92 *2*
postoperative	* 96 *1*	*** 98 *1*	* 100
ultimate	97 *1*	97 *1*	98
Kyphosis angle (degrees)			
on admission	16 *2.4*	15 *0,9*	5.1 *1.7*
postoperative	5.7 *0.9*	5.9 *0.6*	*** 3.5 *1.1*
ultimate	13 *1.2*	*** 14.1 *1.2* **	12 *1.8* ***

* $P < 0.05$, ** $P < 0.01$, and *** $P < 0.001$ (Student's *t*-test).

Table 2. Mean relative anterior and posterior heights (percent) of the vertebral body and mean kyphosis angle in relation to type of fracture. Mean *SEM*

		Type of fracture					
		Burst n 30		Wedge compression n 24		Rotation dislocation n 22	
Anterior height							
on admission		65 *3*		53 *3*		60 *4*	
postoperative	**	80 *3*		76 *3*	***	86 *4*	
ultimate		71 *3*	*	68 *4*		81 *3*	
Posterior height							
on admission		92 *2*		94 *2*		90 *2*	
postoperative	*	99 *1*		99 *1*	***	98 *1*	
ultimate		97 *2*	*	97 *1*		98 *1*	
Kyphosis angle (degrees)							
on admission		9.1 *1.7*		13 *1.6*		15 *1.5*	
postoperative	*	4.6 *0.9*		6.0 *0.8*		* 4.8 *0.7*	
ultimate		12 *1.7*	***	16 *1.8*	***	11 *1.0*	***

See symbols in Table 1.

Table 3. Mean relative sagittal width (percent) and displacement (mm) of the vertebral body in relation to level of injury. Mean *SEM*

		Level of injury					
		T 5–11 n 12		T 12–L 1 n 39		L 2–5 n 25	
Sagittal width							
on admission		112 *4*		115 *2*		125 *2*	
postoperative		104 *2*	***	106 *1*	***	115 *2*	
ultimate		104 *2*		106 *1*		117 *2*	
Displacement							
on admission		18 *5*		14 *2*		18 *2*	
postoperative	*	3 *1*	***	5 *1*	***	10 *2*	
ultimate		2 *1*		5 *1*		10 *1*	

See symbols in Table 1.

Table 4. Mean relative sagittal width (percent) and displacement (mm) in the vertebral body in relation to type of fracture. Mean *SEM*

		Type of fracture					
		Burst n 30		Wedge compression n 24		Rotation dislocation n 22	
Sagittal width							
on admission		123 *2*		116 *2*		114 *3*	
postoperative	***	113 *2*		108 *2*	***	105 *2*	
ultimate		113 *2*		109 *2*		106 *1*	
Displacement							
on admission		16 *1*		11 *2*		20 *3*	
postoperative	***	8 *1*	**	5 *1*	***	5 *1*	
ultimate		9 *1*		5 *1*		4 *1*	

See symbols in Table 1.

and scoliosis angles were measured according to Willén et al. (1985). All of these variables were considered on admission, immediately postoperatively, and at the latest follow-up after removal of the Harrington rods. The mean follow-up time was 29 (9–95) months.

Differences were tested with the Student's *t*-test for independent and paired samples, regression analysis, and the Spearman rank correlation test.

Results

Height of the vertebral body and kyphosis angle

The mean initial loss of anterior height of the thoracic, thoracolumbar, and lumbar vertebral bodies were 34, 42, and 40 percent, respectively. It was reduced to 11, 19, and 23 percent after the Harrington operation. However, after removal of the rods, recollapse often occurred (Table 1). Grouped according to the fracture type, the mean loss of anterior height at follow-up was 32, 29, and 19 percent in wedge compression, burst, and rotation-dislocation fractures, respectively. The loss of restoration of the anterior height of the vertebral body obtained initially was greatest in burst fractures and smallest in rotation-dislocation fractures (Table 2). The ultimate loss of anterior vertebral height was correlated with the degree of primary compression ($r = 0.48$; $P < 0.001$, regression analysis), and also correlated with the immediate postoperative reduction ($r = 0.61$; $P < 0.001$, regression analysis).

The posterior height of the vertebral bodies was unchanged at follow-up (Tables 1 and 2).

Considering the angle of kyphosis, the findings corresponded to the anterior vertebral height. In patients with lumbar fractures, the mean final 11° kyphosis was greater than the initial 5.1° angle. In cases of thoracic and thoracolumbar fractures, the ultimate kyphosis angle remained almost the same as the initial angle (Table 1). The best permanent correction of kyphosis was achieved in rotation-dislocation fractures (Figure 1, Table 2), although modest, i.e., from 15° to 11°.

Sagittal width and displacement of the vertebral body

In the lumbar spine the ultimate sagittal width of the vertebral body remained increased in all three fracture types; the mean increase was 13, 9, and 6 percent in burst, wedge compression, and rotation-dislocation types, respectively ($r = 0.31$; $P < 0.05$, Spearman rank correlation test; Tables 3 and 4). The mean ultimate sagittal width of the vertebral body correlated with the posttraumatic ($r = 0.56$; $P < 0.001$, regression analysis) and in particular with the immediate postoperative width ($r = 0.80$; $P < 0.001$).

As to the sagittal displacement of the vertebral body, the residual displacement was greatest in the lumbar spine and in the burst fractures (Figure 2; Tables 3 and 4).

The mean lateral angulation of the spine on admission and at follow-up was similar in fractures of the thoracic, thoracolumbar junctional, and lumbar spine (4.4°, 3.7°, 2.5° and 1.5°, 2.2°, 2.5°, respectively).

Discussion

Conservative treatment of severe thoracic and lumbar vertebral fractures often results in progressive kyphosis (Frankel et al. 1969, Burke and Murray 1976, Osebold et al. 1981, Soreff et al. 1982, Willén et al. 1985). Marked residual deformity is associated with persistent local pain (Day and Kokan 1977, Härkönen et al. 1979) and sometimes increasing neurologic symptoms (Denis 1984). The Harrington procedure is probably the most commonly used to reduce and stabilize unstable thoracic and lumbar fractures. The immediate postoperative anatomic result is usually excellent (Flesch et al. 1977, Dickson et al. 1978, Svensson et al. 1984). Willén et al. (1985) reported that patients with thoracolumbar fractures treated by Harrington instrumentation exhibited better anatomic results than those treated conservatively, even though the kyphosis angle often recurred after removal of the rods. However, detailed radiographic follow-up of patients with different types of vertebral fractures managed by early Harrington operations has not been performed.

We found that the maintenance of the reduction achieved by the Harrington operation is best in rotation-dislocation fractures and poorest in burst fractures. This is in agreement with the fact that maintaining reduction of comminuted fractures in cancellous bone is difficult. Recollapse can be prevented in such cases by cancellous bone grafts (Müller et al. 1977), a method applied to vertebral fractures by Dick et al. (1985).

The most important advantage of the Harrington procedure seems to be the successful reconstruction of the spinal canal. This has decreased the need for anterolateral decompression in severe thoracolumbar fractures with neural involvement as compared with the situation before the introduction of the Harrington instrumentation (Riska 1976, Riska et al. 1987).

However, in burst fractures, especially of the lumbar spine, the use of contoured rods, rod sleeves, and cancellous bone grafting of the vertebral body may improve the results.

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