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TREATMENT OF PATIENTS WITH UNSTABLE FRACTURES OF THE THORACIC AND LUMBAR SPINE

A Follow-up Study of Surgical and Conservative Treatment

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A follow-up study was made to compare the effect of surgical reduction and stabilization of unstable vertebral fractures with the results of conservative treatment. Twenty patients treated by conservative methods and 18 patients subjected to surgical stabilization were analyzed with respect to period of immobilization, healing time, degree of residual deformity, neurological restitution and incidence of complications. The wide variety of initial impairment did not permit any definite conclusions with regard to neurological restitution. In all other respects, however, surgical stabilization produced better results as reflected by shorter periods of immobilization, hospitalization and rehabilitation, less residual deformity, and a lower incidence of complications. It may be concluded therefore that surgical treatment of unstable vertebral fractures may be of benefit to both patients and society.

Key words: conservative treatment; paraplegia; surgical stabilization; thoracic and lumbar spine; unstable fractures; vertebral fractures

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The aim of treatment of unstable vertebral fractures is to achieve stability of the injured segment and healing of the fracture in a good position. In cases with neurological impairment the treatment aims at achieving as complete and rapid a neurological restitution as possible.

The treatment of unstable fractures and fracture dislocations of the thoracic and lumbar spine is a controversial subject. The choice between surgical and conservative treatment has been debated for a long time. Much progress has been made both in conservative and in surgical treatment. In surgical treatment this has been achieved by using Williams' plates bolted to the spinous processes (Williams 1963), by osteosynthesis with metal plates (Roy-Camille et al. 1976), by "dynamic spine alloplasty" (Weiss 1975), and especially by the Harrington technique for stabilizing unstable vertebral fractures (Harrington 1967). Essential contributions to conservative treatment have been made by the works of Guttman (1946, 1973), Yamada & Ikata (1969), Odéen (1974), Normell & Odéen (1976), and Hein-Sörensen (1978).

Unlike those who feel that "the use of rods and clamps is rarely indicated" (Bedbrooke 1979), the Department of Orthopaedic Surgery at the Karolinska Hospital agrees with many others (Kaufner & Hayes 1966, Kelly & Whitesides 1968, Katznelson 1969, Böhler 1970, Riska 1976, Stauffer & Neil 1975, Flesch et al. 1977, Yosipovitch et al. 1977, Convery et al. 1978, Jacobs et al. 1980) that unstable vertebral fractures should be stabilized. Soreff's work (1977),

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demonstrating a relation between residual complaints and deformity at the fracture site after vertebral fractures, has widened our indications for stabilization to include a risk of progressive high-grade kyphosis.

In order to permit a more reliable analysis of the results of our stabilizing operations, a comparison was made with a series of cases treated conservatively at the Department of Neurology, Karolinska Hospital. In this comparative study the following parameters were investigated:

1. Period of immobilization
2. Healing time
3. Degree of residual deformity
4. Neurological restitution
5. Complications

PATIENTS AND METHODS

The study included 20 consecutive patients with vertebral fractures and neurological injuries, living in the county of Stockholm and treated conservatively at the Department of Neurology, Karolinska Hospital, during the years 1971–1976. This group will be designated as Group 1. The 20 patients included in Group 1 are shown in Table 1. This group included 16 men and 4 women. The average age at injury was 28 years (range 16–53). The fractures were divided according to the classification presented by Roberts & Curtiss (1970) into wedge fractures (Type 1), compression burst fractures (Type 2), and rotational dislocation fractures (Type 3). The neurological impairment (paraplegia) was considered incomplete when sensory function or sensory and motor function was found in segments two or more levels below the level of injury. Except for 2 patients with Type 2 fractures, all other patients had Type 3 fractures. Nine patients had total paraplegia. Eleven patients were injured in traffic accidents, 8 patients by falls and one as a result of direct violence. Seven patients had serious associated injuries. Conservative treatment in Group 1 always involved bed rest and physiotherapy. Decompressive laminectomy without fusion was performed in 10 cases, generally within 24 hours of injury. Closed reduction was performed in one case. Twelve patients were treated in a plaster cradle.

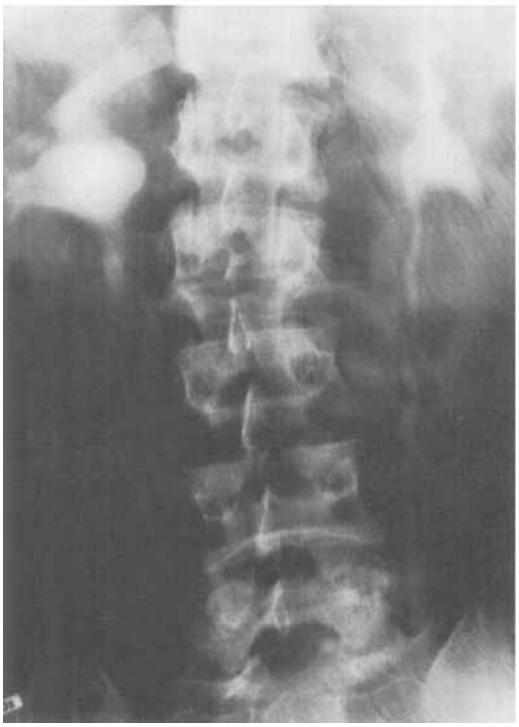
The results of conservative treatment have been compared with those in a series of 18 patients, designated as Group 2, who were operated upon at the Department of Orthopaedic Surgery, Karolinska Hospital, during the years 1976–1979. The group included 9 men and 9 women. The average age was 33 years (range 16–70 years). Nine patients were injured in traffic accidents, 8 patients by falls and one as a result of direct violence. Two patients (Nos. 1 and 16) operated upon according to the principles described below at another Stockholm Hospital, but rehabilitated at the Department of Neurology, Karolinska Hospital, were included in Group 2. This group moreover included one patient who returned to his native country following his discharge from hospital and consequently was lost to follow-up. Except for healing time, however, all other parameters could be analyzed on the basis of the available records. To allow an adequate comparison between the two groups, patients operated upon for progressive kyphosis in inveterate vertebral fractures were excluded. The cases included in Group 2 are shown in Table 2.

The patients in Group 2 had been treated for unstable vertebral fractures with or without neurological impairment. The type of fracture and the degree of neurological impairment were defined as in Group 1. Three patients had Type 2 fractures, the remaining 15 Type 3 fractures. Two patients had complete and 10 patients incomplete paraplegia. Ten patients had severe associated injuries. Surgical treatment aimed at decompression of the spinal canal, reduction of the deformity, and stabilization allowing immediate mobilization. Stabilization was achieved by Harrington distraction rods (Figures 1–4) in 16 cases, by compression rods in one case and by a combination of the two methods in one case. Stabilization was completed by a fusion comprising one segment below and one segment above the level of injury. In one patient (No. 6) anterolateral and in one patient (No. 16) posterolateral decompression was performed in addition to stabilization. In one patient (No. 11) reoperation was performed 24 hours after stabilization to remove a loose fragment from the spinal canal and the rods were replaced. In 4 cases laminectomy was performed. Healing was defined as callus formation between the injured and the adjacent vertebra or the presence of callus between main fragments of comminuted vertebral fractures. Kyphosis of less than 5° was defined as slight kyphosis.

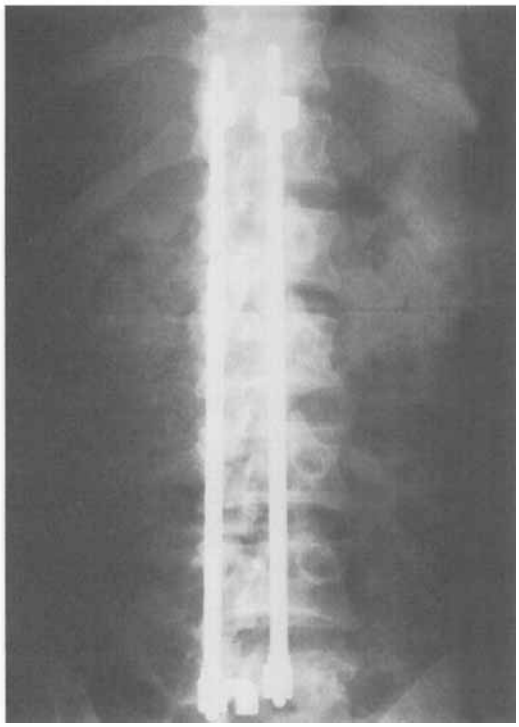
Neurological restitution was classified as follows:

0. No restitution
1. Somewhat increased sensory or motor function
2. Increased sensory or motor function, 1–2 segments
3. Increased sensory or motor function, 3 or more segments

Complications developing within the first 8 weeks following treatment were included in the study.



Figures 1 and 2. Patient no. 14. Unstable vertebral fracture of L2 involving the body and both vertebral arches, with slight luxation. Kyphosis 24° and scoliosis 10°.



Figures 3 and 4. Patient no. 14. The fracture is stabilized by two Harrington distraction rods applied between Th11 and L5, followed by fusion of L1–L3. Slight residual kyphosis.

Table 1. Group 1 (conservatively treated patients)

Pat. No.	Sex/age	Type of fracture Level of fracture	Associated injury	Para-plegia	Causa-tive violence	Surgery	Initial deformity Kyphosis	Residual deformity Kyphosis	Healing in months	Brace	Neuro-logical resti-tution	Complications during the first 60 days
1.	M 16 years	2 Th 3	Open tibial fracture	Incom-plete	Traffic accident	0	18°	20°	6	Ordinary	3	Deep venous thrombosis + orthostatic reaction
2.	M 22 years	3 Th 5	Skull trau-ma, hemo-thorax	Com-plete	Traffic accident	0	26°	30°	12	Ordinary	0	Pulmonary embolism, decubitus of heels and sacral region
3.	M 16 years	3 Th 6	Skull trauma	Com-plete	Traffic accident	0	27° Scoli-osis 10°	33° Scoli-osis 10°	3	Cradle	0	Pyelitis
4.	M 16 years	3 Th 6	Skull trauma	Com-plete	Traffic accident	Laminec-tomy Th 5,6,7	35°	45°	Pseud-arthrosis	Ordinary	0	Deep venous thrombosis + pyelitis
5.	M 25 years	3 Th 7	Rib fracture	Incom-plete	Traffic accident	0	30° Scoli-osis 5°	37° Scoli-osis 10°	12	Ordinary	1	Pyelitis
6.	F 22 years	3 Th 8	Hemo-thorax	Com-plete	Traffic accident	Closed reduction in gener-al anes-thesia	38° Scoli-osis 10°	33° in brace Scoli-osis 15° in brace	Pseud-arthrosis	Cradle	0	3 weeks of septic fever, severe ortho-static reaction
7.	F 24 years	3 Th 8	Abdominal injury (laparot-omy)	Com-plete	Traffic accident	0	22°	50°	12	Cradle	0	0
8.	M 17 years	3 Th 10	Skull trauma, 6–8 per cent burn injury of left arm	Com-plete	Fall	0	17°	15° in brace	5	Cradle	0	0
9.	M 27 years	3 Th 10	Lung contusion	Com-plete	Direct violence	Laminec-tomy Th 10	22°	22°	10	Cradle	1	Deep venous thrombosis

10.	M 42 years	3 Th 11	0	Incom- plete	Fall	Laminec- tomy Th 11–L 2	5° Scolio- sis 5°	55° Scolio- sis 10°	8	Cradle	3	0
11.	F 25 years	3 Th 12	0	Incom- plete	Fall	Laminec- tomy Th 11–L 1	32°	33° in brace	7	Cradle	2	Deep venous thrombosis + decubitus (plastic op.)
12.	M 23 years	3 Th 12	Kidney contusion Zygomatic fracture	Com- plete	Fall	0	11°	25°	7	Ordinary	0	0
13.	M 18 years	3 Th 12	0	Incom- plete	Traffic accident	Laminec- tomy Th 11–L 1	22°	23°	Pseud- arthrosis	Cradle	3	0
14.	M 45 years	2 Th 12	Bilat. calcaneus fractures	Incom- plete	Fall	0	0°	15°	8	Ordinary	3	0
15.	M 33 years	3 Th 12	Hemo- thorax Rib fracture Spleen rupture	Com- plete	Traffic accident	Laminec- tomy Th 11–L 2,	12°	21° (horizontal position)	6	Cradle	3	0
16.	M 29 years	3 L 1	Open tibial fracture	Incom- plete	Traffic accident	0	13°	34°	Pseud- arthrosis	Leather	3	0
17.	M 28 years	3 L 1	0	Incom- plete	Fall	Laminec- tomy Th 12–L 2	20°	30°	Pseud- arthrosis	Leather	3	0
18.	M 53 years	3 L 1	0	Incom- plete	Fall	Laminec- tomy Th 12–L 2	10°	14°	6	Ordinary	3	0
19.	F 30 years	3 L 1	0	Para- paresis cauda equina syndrome	Traffic accident	Laminec- tomy Th 12–L 1	35°	22°	>12	Ordinary	3	0
20.	M 51 years	3 L 2	0	Com- plete	Fall	Laminec- tomy L 2–L 3	0°	Slight	>12	Ordinary	0	0

Table 2. Group 2 (surgically stabilized patients)

Pat. No.	Sex/age	Type, level and date of fracture	Causative violence	Associated injury	Paraplegia	Surgery (time post injury)	Initial deformity Kyphosis	Residual deformity Kyphosis	Brace	Mobilization	Healing in months	Neurological restitution	Complications
1.	M 70 years	3 Th 6 July –79	Traffic accident	Rupture of ileum (laparotomy)	Complete	Harrington distraction rod Th 3–11 Harrington compression rod Th 5–Th 7 Fusion Th 3–Th 9 (3 weeks)	Severe luxation of Th 6–7	Almost normal alignment	Ordinary	Tilted 30 days postop.	5	0	Asystolia
2.	F 55 years	3 Th 7 Dec –79	Fall	Lung contusion (2 weeks in respirator)	Incomplete	Harrington distraction rod Th 5–11 Fusion Th 6–Th 9 (2 weeks)	38°	20°	Boston	Tilted Immed. after respirator treatment	4	3	0
3.	F 50 years	3 Th 12 May –78	Traffic accident	Rib fracture, skull fracture (lobectomy)	0 (paresthesia)	Harrington distraction rod Th 10–11 Fusion Th 11–L 1 (4 weeks)	32°	10°	Jewett	Immed. Walking 30 days postop.	3	–	0
4.	F 35 years	3 Th 12 Nov –79	Traffic accident	Pneumothorax Hemothorax bilat. rib fracture	Incomplete	Harrington distraction rod Th 9–L 3 Fusion Th 11–L 3 (24 hours)	33°	14°	Boston	Tilted 37 days postop.	3	0	0
5.	F 25 years	3 L 1 July –78	Traffic accident	0	0 (paresthesia)	Harrington distraction rod Th 10–L 4 Fusion Th 12–L 2 (24 hours)	35°	0°	Boston	Immed. Walking 30 days postop.	5	–	0

6.	M 29 years	3 L 1 Oct –77	Fall	Diaphragm rupture	Complete	Antero-lateral decompression L 1 Harrington compression rod Th 11–L 3 (43 days) Fusion Th 12–L 1 (73 days)	Luxation of L 1 with compression of the spine	Slight tilting of L 1	0	Circular bed 1 day post op.	Foreign pat. Discharged 2 weeks post last op. Not followed up	3	0
7.	M 21 years	3 L 1 May –79	Fall	0	0	Harrington distraction rod Th 11–L 3 Fusion Th 12–L 2 (12 days)	25°	12°	Jewett	Immed.	3	–	0
8.	M 26 years	3 L 1 Sept –78	Traffic accident	Spleen rupture, fractures of ribs, forearm (laparotomy)	Incomplete	Harrington distraction rod Th 12–L 3 Fusion Th 12–L 2 (4 days)	10° with luxation of L 1	8° normal alignment of the spine	Jewett	Tilted 1 month postop. Sitting pos. 8 weeks later. Walking in parallel bars 2 months postop.	4	2	Lung abscess (respirator 12 days)
9.	F 26 years	3 L 1–L 2 June –79	Traffic accident	0	Incomplete	Laminectomy L 2 cradle (8 hours) Harrington distraction rod Th 11–L 4 Fusion Th 12–L 3 (1 week)	6° Scoliosis 6°	6°	Boston	Immed. Walking 2.5 weeks postop.	5	3	0
10.	F 58 years	2 L 2 March –79	Fall	Bilat. calcaneus fracture, ankle fracture	0 (paresthesia)	Harrington distraction rod Th 11–L 2 Fusion L 1–3 (3 weeks)	15°	0°	Boston	Immed.	5	–	0

Pat. No.	Sex/age	Type, level and date of fracture	Causative violence	Associated injury	Paraplegia	Surgery (time post injury)	Initial deformity Kyphosis	Residual deformity Kyphosis	Brace	Mobilization	Healing in months	Neurological restitution	Complications
11.	M 28 years	2 L 2 Nov –79	Direct violence	0	Incomplete	Harrington distraction rod with fusion L 1–L 2 (12 hours) Removal of bone fragment in spinal cord (36 hours)	22°	7°	Boston	Tilted 1 week postop. Walking after 11 weeks	3	3	0
12.	F 29 years	3 L 2 Dec –79	Fall	0	Incomplete Bladder paresis	Total laminectomy L 2. Subtotal laminectomy L 3. Harrington distraction rod Th 11–L 4 Fusion Th 12–L 4 (12 hours)	13° Slight scoliosis	0°	Boston	5 weeks postop. Walking with crutches after 2.5 months	3	3	0
13.	M 25 years	3 L 2–3 March –79	Fall	Bilat. calcaneus fractures	Incomplete	Laminectomy L 2–3 Harrington distraction rod Th 12–L 5 Fusion L 2–3 (48 hours)	7°	9°	Boston	Tilted immed. In wheelchair after 35 days	6	3	0
14.	M 22 years	2 L 2 April –79	Traffic accident	Crush injury of left hand. Injury of nervus medianus. Compartment syndrome.	0 (paresthesia)	Harrington distraction rod Th 11–L 5 Fusion L 1–3 (10 days)	24°	5°	Jewett	Immed. Walking 2 weeks postop.	5	–	Sciatic pain during initial mobilization

15.	M 23 years	3 L 3 July –79	Fall	Bilat. calcaneus fractures	Incomplete	Laminectomy L 2 Harrington distraction rod Th 11–L 4 (36 hours)	13°	6°	Boston	Tilted immed. Walking 10 weeks postop.	3	3	0
16.	F 29 years	3 L 3 Nov –78	Fall	0	Incomplete	Posterolateral decompression L 2–4 Harrington distraction rod Th 11–L 5 Fusion Th 12–L 2 (24 hours)	24°	34°	Boston	1 month postop.	Pseudarthrosis with gibbus 34°	3	Gliding of the Harrington rods
17.	M 16 years	3 L 3 Sept –76	Traffic accident	0	0	Harrington compression rod L 1–4 (10 days)	17°	18°	Jewett	Immed.	6	–	0
18.	F 22 years	3 L 4–5 Nov –78	Traffic accident	Subtrochanteric femoral fracture	Incomplete	Harrington distraction rod L 3–sacral bar Fusion L 2–S 1 (3 weeks)	0°	0°	Boston	Immed. Walking with crutches 3 weeks postop.	3	3	0

RESULTS

Group 1

The time of immobilization for this group is shown in Table 3. *The healing time* was less than 6 months for 3 patients, 6–9 months for 6 patients, 9–12 months for 3 patients, and more than 12 months for 3 patients. The remaining 5 patients in this group developed pseudarthrosis.

Deformity. The primary deformity varied between slight kyphosis and a kyphosis of 38°, average 20°. The residual deformity varied between slight kyphosis and a kyphosis of 55°, average 28°. In the 10 patients operated upon with laminectomy the average preoperative deformity was 19° and the postoperative deformity 27°. In 7 patients scoliosis of 5–15° was observed.

Neurological restitution. Nine patients had neurological restitution corresponding to Grade 3, one patient to Grade 2, 2 patients to Grade 1 and 8 patients had no restitution at all.

Complications developed in 11 cases as listed below:

Pulmonary embolism	1 patient
Deep venous thrombosis	4 patients
Severe urinary tract infection	2 "
Severe orthostatic reactions	2 "
Severe decubitus	2 "

Group 2

The time of immobilization for Group 2 is shown in Table 4. All patients whose general condition allowed it could be mobilized immediately. Ten patients were able to walk within 4 weeks.
The healing time in this group was less than 3 months for 7 patients and 3–6 months for 9 patients, while one patient developed pseudarthrosis. The remaining patient in this group had returned abroad and could not be included in this part of our follow-up.

Deformity. Preoperative kyphosis varied between slight kyphosis and a kyphosis of 38°, average 18°. Postoperative kyphosis varied between 0° and 20°, average 7°.

Neurological restitution. Nine patients had neurological restitution of Grade 3, one patient of Grade 1 and 2 patients had no restitution at all. Of the 6 patients who were considered to have no neurological impairment 4 had paresthesia that disappeared after the operation.

Complications. One 70-year-old patient (No.1) developed asystolia during operation which required 30 days respirator treatment. In one patient with multiple rib fractures (No. 8) a lung abscess developed postoperatively. In one patient (No. 16) gliding of the rods resulted in pseudarthrosis. One patient (No. 14) had sciatic pain during the initial period of mobilization.

No other complications were noted in this group.

Table 3. Time of immobilization for Group 1 (conservatively treated) patients

Pat. no.	Horizontal position (weeks)	Upright position (weeks)	In wheelchair (weeks)	ADL activities (weeks)
1	6	20	10	12
2	6	14	14	16
3	5	15	6	16
4	7	15	16	20
5	6	14	12	18
6	6	20	20	20
7	5	13	14	16
8	4	13	14	16
9	10	15	17	17
10	6	13	15	17
11	4	15	19	20
12	4	12	14	14
13	4	12	14	14
14	4	10	14	14
15	5	12	13	17
16	7	18	20	20
17	8	17	18	18
18	6	12	14	16
19	5	12	13	17
20	14	16	16	18

Horizontal position
4–14 weeks/average 5.7 weeks
Upright position
10–12 weeks/average 13.6 weeks
In wheelchair
6–20 weeks/average 13.8 weeks
ADL activities
12–20 weeks/average 16.8 weeks

Table 4. Time of immobilization for Group 2 after surgical stabilization

Pat. no.	Horizontal position (weeks)	Upright position (weeks)	ADL activities (weeks)
1	4	10	12
2	2	3	3–4
3	0	1	4
4	5	10	12
5	0	1	2–4
6	0	1	–
7	0	1	2
8	4	8	8
9	0	1	2–3
10	0	1	2–3
11	1	8	11
12	0	8	9
13	0	7	8
14	0	1	2
15	0	8–9	10
16	4	6	8
17	0	1–2	2
18	0	1–2	2–3

Horizontal position
1–5 weeks/average 1.1 weeks

Upright position
1–10 weeks/average 4.2 weeks

ADL activities
2–12 weeks/average 5.7 weeks

DISCUSSION

Comparative studies of recumbent and operatively treated patients with vertebral fractures in the thoracolumbar spine are scarce. Patient series with unstable vertebral fractures are never identical, as both the level and the extent of the lesion varies. Variations with respect to associated injuries and neurological impairment make a comparison between the groups even more difficult. In spite of this, certain conclusions can be drawn from such studies. The series of Lewis & McKibbin (1974) comprised one group of patients treated by open reduction and fixation with a Williams plate and the patients in this group had significantly less spinal deformity and pain as compared to the group treated exclusively by recumbency with postural reduction of the deformity. In a review of 100 patients with thoracolumbar spine injuries, Jacobs et al. (1980) found Harrington rod stabilization to decrease the time required for paraplegic patients to be independent of the wheelchair (from 10.5 to 5.3 weeks) and for ambulatory candidates to walk (from 7.1 to 2.5 weeks). Anatomic reduction was accomplished and maintained in two-thirds of the patients treated with Harrington rods.

The patients in our stabilized group were spared prolonged bed rest and could be mobilized in a considerably shorter time. Complications due to prolonged bed rest were noted in about 40 per cent of Group 1, but were absent in Group 2. The major complication in this latter group was gliding of the rods resulting in pseudarthrosis (patient No. 16). This was a technical failure, most probably due to the fact that the operation was performed by a surgeon not sufficiently familiar with either the instrumentation or the technique.

One 70-year-old patient (No. 1) in Group 2 developed asystolia during operation. The alternative to surgical stabilization would have been prolonged bed rest with all the risks involved at this advanced age. One patient (No. 8) developed a lung abscess. This complication was related to the patient's multiple rib fractures and might have been avoided through prolonged respirator treatment postoperatively.

We chose to treat the majority of the surgical cases with a modified Boston brace as postoperative external fixation. In our opinion this provides good stabilization and facilitates mobilization. We did encounter some problems, however. Fitting of the braces required the services of a highly qualified and experienced orthotist. Moreover not all physiotherapists and nursing staff were familiar with the rehabilitation of patients equipped with braces. It may be possible that ADL training and especially training of bladder control were complicated and delayed by the brace treatment. To facilitate the latter we modified the Boston brace in collaboration with the orthotics department by providing an opening in the abdominal region which allowed training of bladder control without impairing the brace's stabilizing properties (Figure 5).

The healing time was considerably shorter in Group 2 and the healing incidence higher as compared to the patients in Group 1.

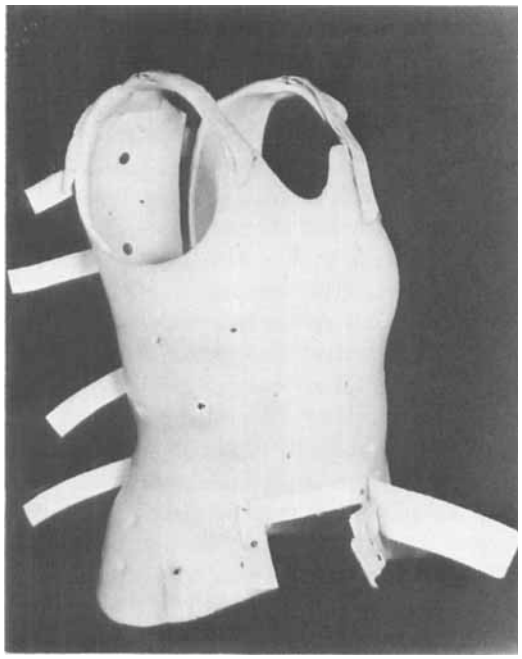


Figure 5. The modified Boston brace.

Because of the wide variation in initial impairment, it was very difficult to make direct comparisons between the two groups with respect to neurological restitution. However, we received a definite impression that the process of neurological restitution in the surgically treated group was quicker and probably much better. Holdsworth & Hardy (1953) claimed that neurological recovery could best be facilitated by open reduction and internal fixation in patients with unstable fractures of the spine. We agree with Lewis & McKibbin that "this is extremely difficult to prove", but it seems to us that as a result of the flexion angulation the neurologic structures are stretched over the deformity and it is more appropriate to obtain neurological decompression and restitution by reduction of the deformity.

Posttraumatic kyphosis is generally considered to cause back pain and poor function after healing. Although the average degree of primary kyphosis in the two groups was almost identical (20° and 18°, respectively), the average residual deformity was considerably less in Group 2 than in Group 1 (7° and 28°, respectively).

We may conclude that surgical reduction and stabilization of dislocated and unstable vertebral fractures shortens the period of immobilization, hospitalization and rehabilitation. It also decreases the risk of complications and to a greater extent reduces the residual spinal deformity.

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