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VERTEBRAL FRACTURES

CONSERVATIVE TREATMENT OF THORACIC AND LUMBAR VERTEBRAL FRACTURES

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INTRODUCTION

Two hundred and seventy-five thoracic and lumbar vertebral fractures treated conservatively at the Orthopaedic Clinic of the University of Florence and the Centro Traumatologico Ortopedico have been reviewed. Two hundred and twenty-two cases had no neurological complications and 53 had spinal cord involvement (paraplegia). The two groups will be described separately.

Fractures of the thoracolumbar spine constitute a significant proportion of acute injuries in modern societies yet the literature contains no clear guidelines for prognosis in the less severe injuries (Decoulx & Rieneau, 1958; Horal *et al.*, 1972; Young, 1973; Kaufer, 1975; Lapras *et al.*, 1977; Albasir, 1979; Harkonen *et al.*, 1979; Heppenstall, 1980; Gui, 1981; Bedbrook, 1982). Attention has been focused primarily on the more demanding fractures and particularly those with neurological involvement (Roy Camille, 1979; Jacobs *et al.*, 1980; Das De & McCreath, 1981; Gertzbein *et al.*, 1982; Fredrickson *et al.*, 1982; McKibbin, 1982; Ryan & Taylor, 1982; Soreff *et al.*, 1982; Gumley *et al.*, 1982).

The long term prognosis for simple fractures has, however, clear medico-legal implications which are becoming more relevant to orthopaedic practice. Further, the role of reduction and its long term benefits are yet to be clearly defined (Nicoll, 1949; Watson-Jones, 1955; Bohler, 1955; Monticelli, 1963; Louis *et al.*, 1975). The purpose of this study on uncomplicated thoracolumbar fractures was twofold. First, to define the long term prognosis and second, to clarify the role and benefits of reduction.

CLINICAL MATERIAL AND METHODS

Vertebral Body Fractures

Between 1962 and 1978, 630 patients were treated conservatively in the Ortopaedic Clinic of the University of Florence, and in the Centro Traumatologico Ortopedico, for dorsal and lumbar fractures without spinal cord or cauda equina involve-

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Table 6.
WEDGE FRACTURES: AGE GROUPS - INCLUDING MULTIPLE FRACTURES

Age Groups	10-19	20-29	30-39	40-49	50-59	60-69
Males	16	13	17	27	19	8
Females	1	6	6	8	22	2
Total	17	19	23	35	41	10

Table 7.
COMPRESSION FRACTURES: AGE GROUPS - INCLUDING MULTIPLE FRACTURES

Age Groups	10-19	20-29	30-39	40-49	50-59	60-69
Males	2	7	19	19	24	7
Females	2	0	1	14	15	10
Total	4	7	20	33	39	17

Whilst this investigation has focused on vertebral body fractures, in 12 patients these were associated with fractures of the posterior elements — transverse processes (4), spinous processes (4), articular facet (1) and a combination of the first two in another patient. These additional fractures bespeak the complex nature of the fracture mechanisms but it is not considered that they affect the central issues of the study.

Radiographic Measurements:

The initial films at the time of injury were taken with the patients in the recumbent position but at follow-up standing anteroposterior and lateral views were employed.

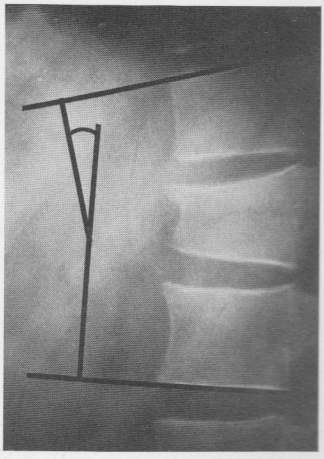

FIG. 3 - Cobb method of measuring the angle of kyphosis.

a) *Kyphosis (Fig. 3)*

This was measured in the initial films, after reduction, and at follow-up, by the Cobb method. A line parallel to the superior endplate of the nearest normal vertebral body above the fracture, with a similar line parallel to the inferior endplate of the nearest normal distal vertebra is drawn and the angle measured is that made by intersecting lines drawn perpendicular to the first two. In the case of multiple fractures the most severely damaged vertebra was chosen. In making our measurements, account was taken of the negative angle normally present in the upper lumbar region between adjacent endplates as a consequence of the normal lordosis. A reduction in the normal lordotic angle was recorded as a negative kyphosis angle.

b) *Interspinous distance:*

This was taken as the distance in the lateral view between the inferior margins of the spinous process of the fractured vertebra and that of the one immediately above. This measurement was compared (percentage ratio) with the average of the measurements between adjacent levels above and below the fractured vertebra, both in the initial films and at follow-up.

c) *Degree of wedging or compression* (Figs. 4 & 5)

The ratio between the anterior and posterior vertebral heights of the most affected vertebral body was measured and expressed as a percentage. In compression fractures the ratio between the anterior (or posterior if more affected) height and the anterior (or posterior) height of the vertebra above or below were measured in the initial and follow-up films. Changes were again expressed in the form of a ratio.

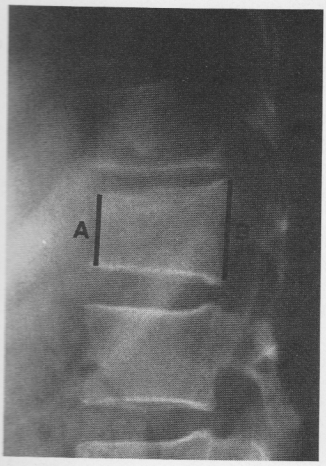

FIG. 4 - Method of measuring the degree of wedging (A/B as %).

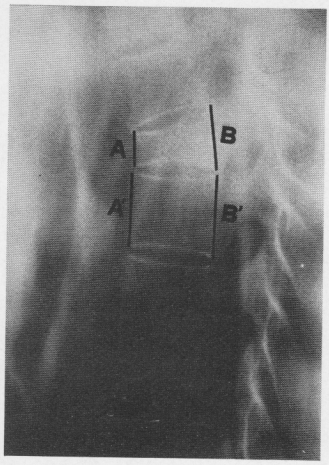

FIG. 5 - Method of measuring the degree of compression (A/A as %).

d) *Change in disc height* (Fig. 6)

The nearest disc to the most affected endplate was measured and this was usually the disc above the fracture. The height in millimetres at the centre of the disc was measured and compared (increase or decrease in mm) with the averge of that for the

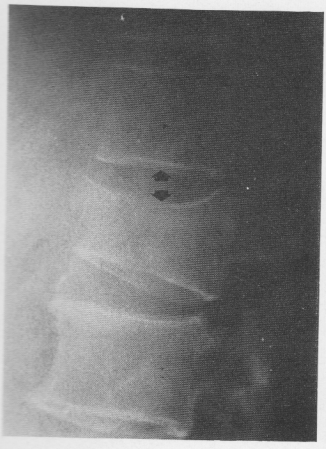

FIG. 6 - Method of measuring the disc space height.

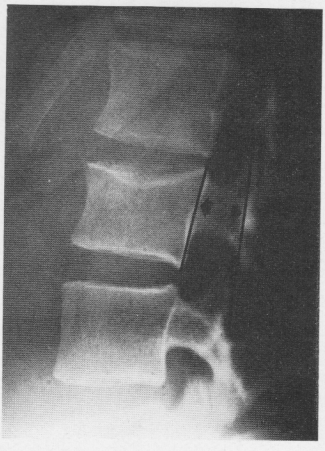

FIG. 7 - Method of measuring the sagittal diameter of the spinal canal.

Table 12.
BURST FRACTURES: DISTRIBUTION (including multiple fractures)

Distrib.	T_8	T_9	T_{10}	T_{11}	T_{12}	L_1	L_2	L_3	L_4
Males	1	1	0	2	9	12	3	2	2
Females	2	0	0	1	5	5	2	0	1
Total	3	1	0	3	14	17	5	2	3

The average period of bed rest was 59 days including that at home after discharge.

Twenty patients had a sufficient degree of ileus to warrant active medical treatment.

Fourteen patients had associated injuries; limbs (10), closed cranial injuries (3), chest (1).

Fifteen patients had transient root symptoms.

An exercise programme was not routinely employed in these patients. No surgical procedures were performed.

a) *Reduction:*

In 93 patients reduction was attempted by the application of a hyperextension cast (Putti, 1942; Bohler, 1955; Watson-Jones, 1955; Antonarelli & Padua, 1978). This was worn for an average of three months and the patients were kept recumbent for approximately two months.

b) *No reduction:*

One hundred and six patients were treated by the application of a plaster jacket and then mobilised according to the severity of their symptoms, whilst for 23 patients a corset was worn, again for no set period.

Isolated Transverse Process Fractures

During the same period 1962-1978, 60 patients were admitted with a diagnosis of fracture(s) of lumbar transverse processes. Of these, 21 were available for personal review. They were all males and the average age was 46 years. The hospital classification was 12 Workers Compensation, 8 Public and 1 Third Party. The fracture aetiology was as follows: 7 industrial, 6 agricultural, 3 domestic, 3 sports and 2 motor vehicle accidents. The occupational status of the patients was heavy manual (14), sedentary (5) and light manual (2).

There was a total of 51 fractures. Fifteen patients had multiple fractures and in six, a single level only was affected. Of the multiple level fractures, two patients had bilateral injuries. The fractures were equally distributed between the right and the left sides. The distribution according to level is shown in Table 13. Most of the fractures occurred at the L_2 and L_3 levels.

There were no associated significant injuries and no patient developed ileus requiring active medical treatment though there was transient ileus in all patients.

The average hospital stay and that of recumbency was 8 days, after which patients were mobilised, 18 in casts and 3 with either a brace or a corset. The average duration of cast wearing was about one month.

Table 13.
ISOLATED TRANSVERSE PROCESS FRACTURES (including multiple fractures)

L_1	L_2	L_3	L_4	L_5
8	16	15	10	2

EVALUATION AND STATISTICAL ANALYSIS

A Data Flow Chart comprising 77 clinical and radiographic parameters was employed for the study. The follow-up data included: return to previous occupation, change of occupation because of spinal symptoms, the advent of chronic invalidism, back pain and the medical and/or orthotic treatment employed for it.

Pain was categorised as follows: none, interfering only in sport or recreational activities, mild interference with work, significant restriction of working capacity.

The presence of spontaneous fusion was assessed in the radiographs (Fig. 11 A, B). Evidence of spinal cord or cauda equina impairment was clinically evaluated.

FIG. 11 - Spontaneous fusion. (A) Male 53 years old with burst fracture of L_1. (B) The lateral radiograph 9 years later shows spontaneous fusion of D_{12}/L_1. The patient was pain free.

All data were analysed by computer methodology and where appropriate, standard statistical techniques were applied. The minimal level of significance considered was $9 < 0.05$.

RESULTS

In the analysis of data, T_{11} and T_{12} have been considered together with the lumbar fractures, since these vertebral bodies are unsupported by the thoracic cage.

Length of follow-up

The average follow-up for the whole series was 9 years and the range 5-21 years (Table 14). There was no significant difference in the follow-up period for the major sub-groups of wedge and compression fractures.

Spinal pain

In the whole series 74 (33%) patients were free of pain, 58 (26%) had pain which only interfered with sport or recreation, 71 (32%) had some impairment of work capacity because of pain and 19 (8.5%) were restricted at work. Over the years after healing of the fracture, 88 (40%) sought medical advice for spinal pain and 86 (38%) had worn a brace or corset for variable periods of time up to 2 years and 62 of them continued with a spinal support on a permanent basis.

Return to previous occupation

It was established that 180 patients (82%) returned to their previous jobs after an averge of 6 months, 32 (15%) changed their occupations because of spinal symptoms and 7 (3%) became chronic invalids.

Table 16.

LUMBAR SPONDYLOTIC CHANGES AT FOLLOW-UP IN MALE MANUAL WORKERS

Fracture Types		Grade 0	Grade 1	Grade 2	Grade 3	Grade 4
Wedge	61	12	16	17	12	4
Compression	33	3	8	8	3	11

(p = 0,0125)

An attempt at reduction was made in 93 patients and the results are reported in Table 17. The radiographs in plaster at discharge from hospital showed improvement of at least 5° of kyphosis in 68 (73%) patients. In 43 (63%) the reduction had been almost perfect. The follow-up radiographs, however, showed that the correction obtained was held within 5° in only 24 cases (35%) (Fig. 14) and lost in the remaining 44 (65%), though there was still more than 5° improvement over the initial angle in 14 (20%) cases (Fig. 15). In 9 (13%) patients, the follow-up kyphosis angle was greater than the initial measurement, despite the attempted reduction and immobilisation.

In the 129 patients in whom reduction was not attempted 29 (25%) showed an increase in the kyphosis angle at follow-up of at least 5°.

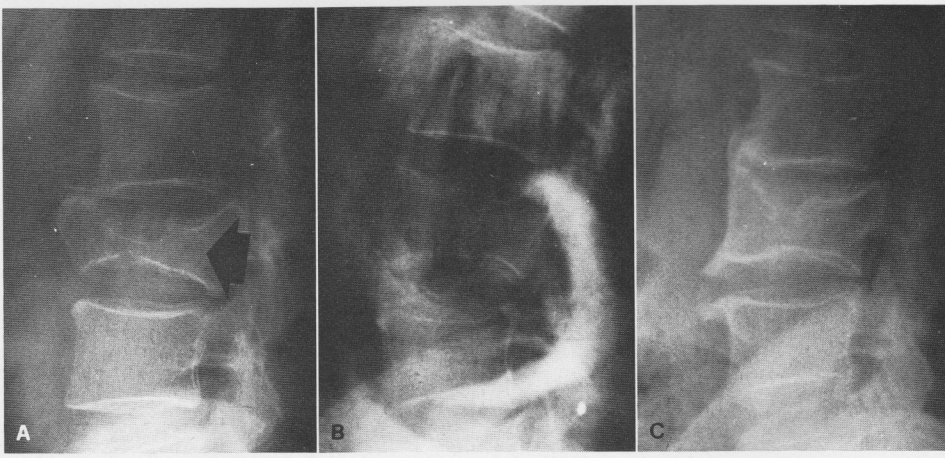

FIG. 12 - (A) Male aged 47 years with a burst fracture of L_3. The initial radiograph shows a 3° kyphosis and more than 30% compression. (B) The post reduction radiograph in a hyperextension plaster shows good correction of the kyphosis (23° negative kyphosis = lordosis). The patient was recumbent for 40 days and wore the cast for 2 months. (C) The 8 years follow-up radiograph shows some loss of reduction, negative kyphosis of 12°, a residual compression of 15% and grade 4 spondylotic changes, with bridging osteophytes and anterior fusion. The patient had no symptoms.

Interspinous distance

This measurement was made, albeit with some difficulty, in all radiographs and was increased by 10% in 52 patients and by more than this in 41. This parameter which reflects in part the degree of kyphosis, also showed no significant statistical correlation with the clinical parameters used in evaluating the follow-up results.

Table 17.
KYPHOSIS ANGLE IN DEGREES IN THE 93 CASES TREATED BY REDUCTION. AVERAGE VALUES +/− standard deviations

Kyphosis angle	Initial	Post-reduction	At follow-up
Negative	5.1 +/− 8	10.2 +/− 6	8.5 +/− 10
Positive	15.2 +/− 9	8.6 +/− 6	14.0 +/− 10

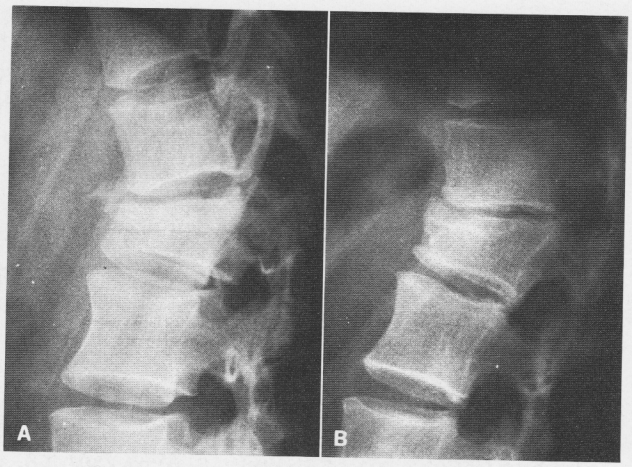

FIG. 13 - (A) Female aged 29 years with a severe burst fracture of L_1 with a kyphosis angle of 30° and more than 30% compression. (B) The follow-up radiographs show, despite an attempt at reduction, a kyphosis angle of 23°, a reduction in vertebral height of more than 30% and grade 3 spondylotic changes. The patient had back pain which mildly interfered with her work and she had to wear a corset at all times.

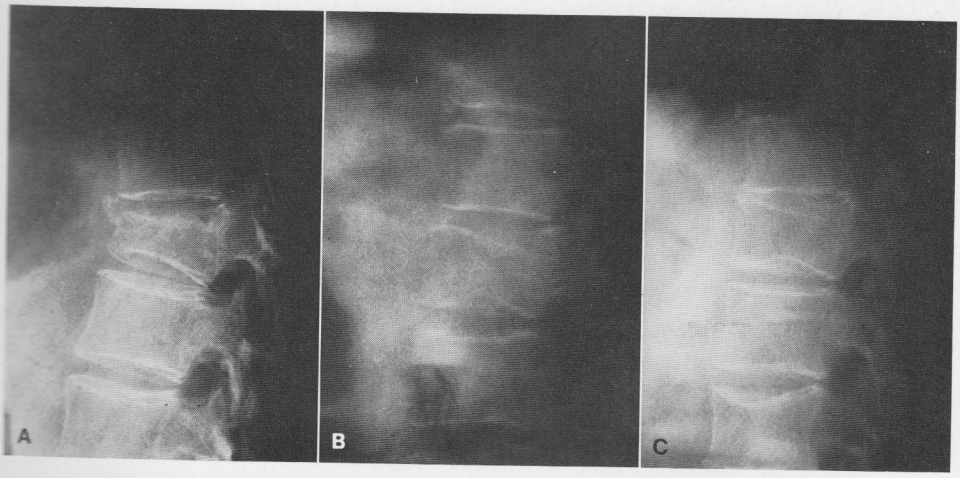

FIG. 14 - (A) Female aged 61 with a burst fracture of T_{11}. There is 20° kyphosis and more than 30% compression. (B) The post reduction radiograph in the hyperextension cast shows good reduction of the deformity. (C) The 10 year follow-up radiograph also shows good correction, with 5° kyphosis, a vertebral height reduction of 30% but with grade 3 spondylotic changes. The patient had mild pain interfering with work and wore a corset at all times.

Reduction in vertebral body height in compression fractures

In 90 of the 92 patients, in whom the follow-up radiographs could be accurately measured, 23 had less than 15%, 36 had 15-30% reduction in vertebral body height, and 31 patients had more than 30%. Again, no significant correlations were found for pain and other functional criteria at follow-up.

Table 18.
SPONDYLOTIC CHANGES

Spondylosis	Grade 0	Grade 1	Grade 2	Grade 3	Grade 4
Pre-existing	137	56	26	1	2
Follow-up	41	53	61	38	29

reported mild interference with working capacity and two were severely restricted for work. Ten patients had sought subsequent medical advice for pain and four of them wore a corset full time. All but two patients (90%) had returned to their previous occupations. Non-union had occurred in 5 of the total 51 fractures.

DISCUSSION

The long term results show that approximately 60% of patients with stable vertebral body fractures achieved excellent or good results as judged by the persistence of spinal pain. Eighty per cent of these patients returned to their previous occupations and only 3% had chronic invalidity as a result of the injury. Conservative treatment is soundly based and no indications for surgical intervention were found in any of the sub-groups. The results for males involved in light and heavy manual work are of interest in that they were the same both for thoracic and lumbar fractures, whereas one might reasonably expect that, because of their occupations, those with lumbar injuries would fare less well. Spontaneous fusion also had no influence on the long term results, which also supports the validity of the conservative approach. The long term results in patients with compensatable injuries warrants comment. In Italy, an injuried worker may have his pension reviewed from time to time, whereas in some other western countries a lump sum payment is awarded when maximum recovery has taken place and a percentage disability can be estimated.

Critical appraisal of the data related to attempted reduction, and what was achieved by it, does not establish any evidence to support the routine application of this method. Indeed, the reverse would seem to be the logical approach to these injuries, since no correlation between residual deformity and pain or other functional criteria was established at long term follow-up. Furthermore, only one third of the cases in whom improvement is achieved by immobilisation in a hyperextension cast will hold this at follow-up, and prolonged immobilisation, an average of three months in this series, can only hamper rehabiliation.

There were no late subluxations and delayed kyphosis with loss of cord or cauda equina function was not observed. These complications are said to be most likely in multiple thoracic fractures in young subjects (Sutherland *et al.*, 1983) and warrant early intervention to arrest progression of the deformity. Despite the fact that some of our patients showed relative narrowing of the canal, none of them developed symptoms or signs of spinal stenosis. On the basis of these findings there appears to be no rationale for the routine use of CAT scans in these injuries (Nykamp *et al.*, 1978; Keene, 1982).

There was statistically significant evidence for an increased incidence of radiographic spondylotic changes in compression and wedge fractures at follow-up ($p = 0.0125$) but this could not be correlated with the presence or absence of pain. This lack of correlation between symptoms and post-traumatic degenerative

phenomena, sometimes severe, is paralleled by what is observed so frequently in patients who seek advice because of symptomatic lumbar spondylosis. The tacit implications of these findings are that late loss of function which so often figures in medico-legal reports would appear to have no statistical support as far as the present series is concerned.

Conservative treatment for wedge and compression fractures is the treatment of choice in many modern countries, though there is a growing tendency for operative correction and local fusion when the kyphotic deformity exceeds 25° to 30° (Ryan & Taylor, 1982). The case for intervention is considered to be strongest when there are incomplete cord or cauda equina lesions (Jacobs *et al.*, 1980; Gertzbein *et al.*, 1982; Ryan & Taylor, 1982). With modern techniques, anatomical correction is readily attained and this decompresses the endangered neural elements by restoring the normal contours of the spinal canal. In such circumstances, CAT scanning may facilitate surgery by accurate localisation of by bony fragments in the canal. The same approach holds for burst fractures with neural damage, and in general these fractures reduce well with distraction systems.

In this paper it seems appropriate to detail the routine conservative approach used by the Australian author for stable fractures in his unit. Patients are kept recumbent over pillows until subsidence of pain permits mobilisation and the commencement of an exercise programme. This usually occurs after two to three weeks. Emphasis is placed on isometric flexion and extension exercises together with postural bracing. These manoeuvres convert the abdomen and upper thorax into a more rigid walled cylinder, thereby lessening the load on the injured segment, so that pain gradually subsides. As soon as possible, therapeutic swimming is encouraged in hydrotherapy pool (temperature 31° - 31° C).

Braces or corsets are rarely used in conservative programmes. The patient's own muscles are the most effective brace but in older subjects it may not be feasible to undertake a vigorous exercise programme. In such cases, a modified Knight's brace has proved useful. It consists of four contoured metal uprights covered with leather and a frontal corset. The uprights restrict motion and the direct pressure of the frontal corset raises the intra-abdominal pressure and reduces the load on the spine (Nachemson & Morris, 1964). Such a brace is effective for fracutures up to the level of T_{10}. Bracing for more proximal injuries is contraindicated because to be effective it would have to restrict the respiratory mechanism.

The mechanism of vertebral fractures is complex but somè generalisations are permissible. Central or axial loading results in vertebral compression whilst flexion and compression produce an eccentric deformation, namely the wedge fracture. This explains the distribution of wedge fractures since the lumbar lordosis must first be unwound and then the flexion force will be maximal at the thoracolumbar junction where the more rigid thoracic spine joins the more mobile lumbar region. Unusual fracture patterns generally indicate unusual mechanisms. On the basis of this review, a distinction between wedge fractures and compression fractures appears to be of no practical importance though spontaneous fusion is more likely to occur with the latter. However, when this occurs there is no correlation with the functional end result.

The long term results in the patients with isolated transverse process fractures are of interest since it is widely held that in themselves they are of little importance. Persistent symptoms are presumably an index of the associated soft tissue damage and it is significant that 72% of the patients had multiple fractures. Only 50% of the patients had excellent or good results, using the same criteria as were applied to vertebral body fractures. Nevertheless, 90% of these patients returned to their previous occupations.

CONCLUSIONS

A long term follow-up study of 222 conservatively treated stable thoracic and lumbar vertebral fractures is reported. Particular attention was paid to the common variants of wedge and compression fractures in males engaged in light and heavy manual work. Eighty per cent of all patients returned to their previous occupations. Sixty per cent of patients had no pain, or had mild discomfort that interfered only with sports or other recreational activities.

We were unable to identify any factors in the early stages that could validly be used as indicators of the long term prognosis. Late spondylosis, although more common in lumbar compression fractures, did not correlate with symptoms at follow-up.

No patient required late surgery, nor were there any patients with symptoms of spinal stenosis, although radiographic evidence of encroachment was common in lumbar burst fractures.

We are led to concur with Nicoll who, 34 years ago, stated that the then commonly held assumption that a perfect anatomical result is indispensable for a perfect functional resul, was completely false. Furthermore, in this series, approximate anatomical reduction by closed methods was achieved in only two thirds of the patients and maintained at follow-up in only one third. This irony is compounded by the lack of correlation between persistent symptoms and the degree of residual kyphosis.

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