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CLINICAL AND RADIOLOGICAL LONG TERM FOLLOW-UP OF VERTEBRAL FRACTURES IN CHILDREN

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Vertebral fractures sustained in childhood have been suspected to cause early and increased amount of back pain later in life (Damje 1955, Jelinkova & Keplova 1960, Huraj & Steno 1964) and also to be one of the etiological factors in the production of Scheuermann's dorsal kyphosis (Sörensen 1964). No relevant follow-up study of these injuries has to our knowledge been made.

The immediate and semi-late results of these fractures have been described earlier (Gelehrter 1957, Jelinkova & Keplova 1960, Ehalt 1961, Vinz 1964, Povacz 1969). The longest mean observation time in any of these materials is 6 years (Gelehrter 1957), but that report contains only 57 per cent of the original material.

It should therefore be of interest to elucidate with regard to the above-mentioned questions, based on a significant number of patients followed for a sufficient length of time, if these patients later in life suffered from an increased morbidity in "degenerative" spine disease, some of which are supposed to have a traumatic origin (Gelehrter 1957, Horal 1969).

From a radiological point of view the adult radiographic appearance of fractured vertebrae sustained in childhood should help to clarify the etiology of some of the aberrations from normal observed in the radiograms of adult vertebral bodies.

MATERIAL AND METHODS

The patients in this material were all the children that were treated at Göteborg's Children Hospital between 1948-1956 with the diagnosis of fractures in the thoracic

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Figure 1.



Figure 2.

Figure 1. Radiogram of the injured spine in a 6-year-old boy with fresh compression fractures of Th 4, 5, 6, 7 and 8. There is wedging of all these vertebrae and distortion of the anterior contour of the body in Th 4, 5, 6 and 7 in which an upper "beak" is formed.

Figure 2. Radiogram of the injured spine in a 9-year-old boy with fresh fractures of Th 3, 4, 5, 6, 7 and 8. Besides changes seen in the upper end-plates of all these vertebrae the lower one in Th 6, 7 and 8 also shows a flattened out or even slightly concave contour.

and the lumbar spine. This hospital is the only one in the Göteborg region serving injured children up to 15 years of age.

Since the diagnosis is based on radiograms, all spinal radiograms taken during that time period were again examined and those with positive signs of fracture were selected. Naturally, all these children had sustained some trauma. Those

with changes like Scheuermann's disease or congenital deformations were excluded.

The most important criterion of a vertebral fracture in this material has been the occurrence of wedging in one or more vertebral bodies (Figure 1). Even in adults this is the most commonly used singular sign of vertebral fracture, but for reasons that need not be mentioned here, it is not always the whole truth in older patients. In children, however, it must be regarded to be so, since the vertebral bodies in childhood always have convex end-plates. The discs tend to be more of the ballooning type. The wedge-shape typical of a vertebral fracture as a rule is asymmetrical in contrast to the one in Morbus Scheuermann where it is symmetrical. After fracture the upper end-plate is compressed so that it has lost its convex form and either is flattened out or even concave. Also the lower end-plate of a fractured vertebral body might undergo similar changes (Figure 2). It is to be observed that not only is the form of the end-plates changed but naturally the vertebral body itself might show changes such as distortion of the anterior contour of the body, and a radiographically denser zone in the spongiosa. Practically never is a true fracture line to be seen and prior to puberty very rarely a totally avulsed vertebral corner.

All together 59 patients fit into the above-mentioned category during 1948-1956. It was possible to have 48 (81 per cent) of these patients evaluated clinically in 1969 and 47 (80 per cent) had new roentgenograms made of their spines. Of those 11 who did not show up for examination 1 had died in the meantime, 3 moved abroad, 5 denied repeated calls or did not want to participate in the follow-up and 2 were impossible to contact due to unknown address. At the time of injury the age of these patients varied from 1-16 years of age (Figure 3).

The mean follow-up time was 16 years, ranging from 13-21 years. At the follow-

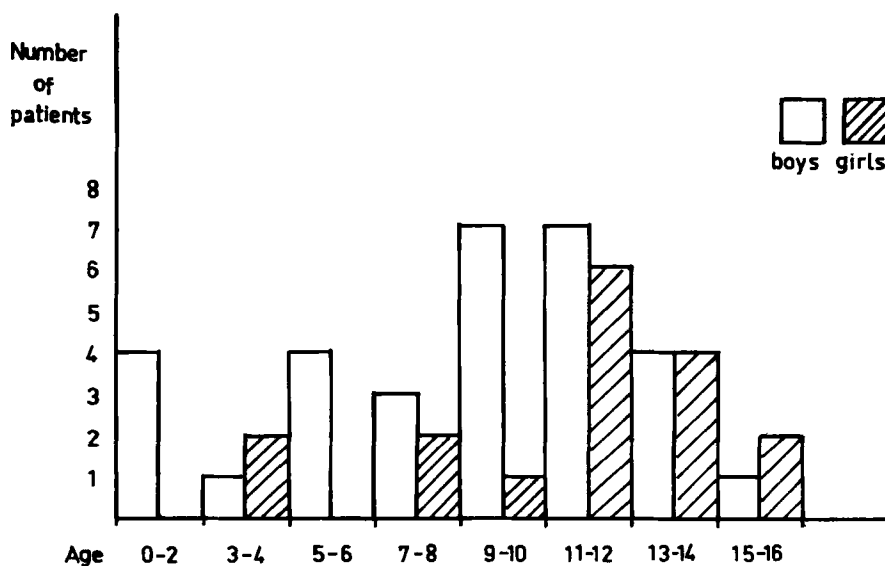


Figure 3. Age of the followed 48 patients at the time of the injury.

up 5 patients were under 20 years of age, 17 patients 20–24 years of age, 16 patients 25–29 years of age and 10 patients 30–34 years of age.

The material consists of 31 men (65 per cent) and 17 women (35 per cent). The preponderance of males to females is statistically significant and has earlier been observed in the literature (Hamilton 1951, Olsson 1951, Gelehrter 1957, Ehalt 1961, Vinz 1964). The mean age in boys was 9.9 years, in girls 11 years. As seen from Figure 3 our material shows a decrease in number of patients after 13 years of age, the reason of which is unknown. Most of the previous authors (Gelehrter 1957, Ehalt 1961) have described an increase with increasing age up to 16 years.

This material also contains 4 children under the age of 2 with fractured spines. None of the previously presented materials contain children that young, the youngest being 2 years (Vinz 1964).

The most common mechanism of injury was fall from a height (Table 1) followed by traffic accidents. The same etiological factors were found as in other materials (Olsson 1951, Westerborn & Olsson 1952, Gelehrter 1957, Jelinkova & Keplova 1960). The main localization of the fractured vertebrae both in boys and in girls was in the thoracic spine alone. This was seen in 65 per cent of the boys (20 patients) and 82 per cent of the girls (14 patients). Fractures localized only to the lumbar spine were seen in 6 per cent in boys (2 patients) and 12 per cent in girls (2 patients), while injuries in both these areas were seen in 29 per cent (9 males) and 6 per cent (1 female), respectively. The number of fractured vertebrae was 136 among the boys (4.4 fractured vertebrae per patient), while in girls the same number was 46 (2.7 injured vertebrae per patient). The localization of all the fractured vertebrae is seen in Figure 4, where the preponderance to the mid-thoracic area is obvious.

The fractures seen in this material were all of the compression type (see Figures 1 and 2 and Table 2). Most commonly occurring was the small compression fracture, which was seen in 96 vertebrae in boys and 35 in girls (71 per cent and 76 per cent respectively). Compression fractures with an anterior beak were seen in 33 vertebrae in boys (24 per cent) and in 8 vertebrae in girls (17 per cent), while fragmented compression fractures (see Figure 6), all occurring in the lumbar spine, were seen in vertebrae in boys (5 per cent) and 3 vertebrae in girls (7 per cent). In this material this latter type of fracture was never seen in the thoracic spine. Also among adults this type of fracture without concomitant fracture of the pedicles is extremely unusual. One of the patients with fragmented compression

Table 1. Mechanism of injury.

	Boys	Girls
Fall from height	16	4
Traffic accident	5	1
Fall on stairs	1	5
Trauma during physical exercises	5	3
Trauma at play and similar activities	4	4
Total	31	17

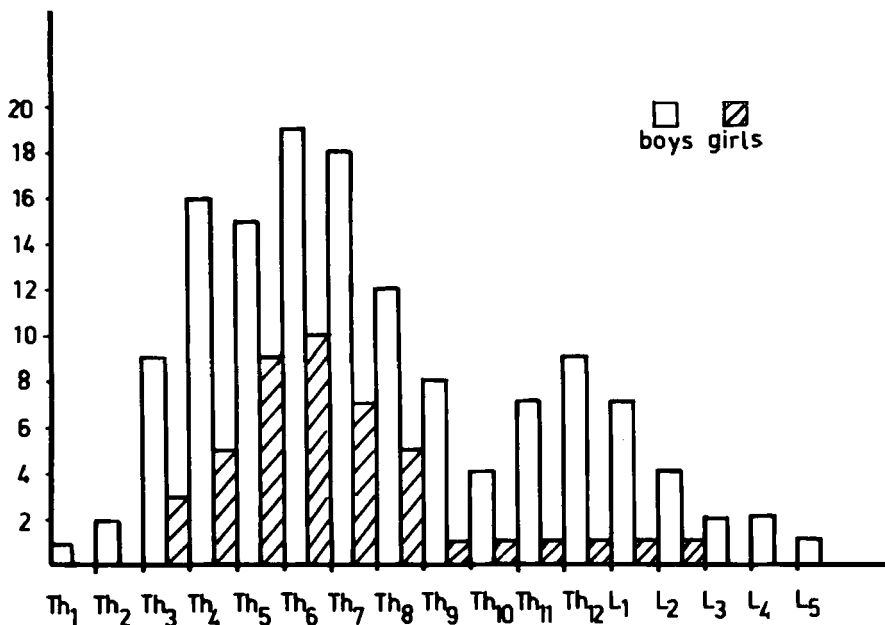


Figure 4. Localization of the fractured vertebral bodies in the followed 48 patients.

Table 2. Radiographically demonstrable changes at the time of injury.

	No. of injured vertebral bodies	
	Boys	Girls
Compression fracture	96	35
Compression with anterior beak	33	8
Compression with fragment	7	3
Total	136	46

Table 3. Primary treatment of the followed 48 patients.

	Boys	Girls
Outpatient care only	10	5
Admitter to hospital	21	12
Plaster of Paris corset	7	6
Plaster of Paris shell	1	1
Corset	1	1
Bed rest	22	9
Total	31	17

fracture also suffered from paraplegia (girl aged 13 years). Concomitant injuries were seen in 17 patients, 12 boys and 5 girls. The most common one was cerebral concussion (6 boys and 4 girls), but there was also 1 patient with ankle fracture, 1 with radial fracture and 1 with rib fracture.

Primary Treatment

The primary treatment is seen from Table 3. About one-third of our patients were recommended bed rest at home. Most of the hospitalized patients stayed for 1–2 weeks. Thirteen patients (7 boys and 6 girls) were treated with plaster of Paris casts, while 2 additional received ordinary corsets. The girl with paraplegia at the time of injury was operated upon with decompressive laminectomy followed by 6 months of plaster of Paris body cast.

Follow-up Examination

At the follow-up examination the patients were asked for back symptoms according to a scheme already described by Horal (1969) and used in a population study for low back pain. The clinical investigation also followed along the same lines, which adheres to the routine used by most orthopaedic surgeons. The mobility of the spine was measured according to the procedure recommended by the American Academy of Orthopaedic Surgeons (1965).

The radiological investigation at follow-up included an antero-posterior and a lateral projection of both the thoracic and the lumbar spines and special views of previously fractured vertebrae.

The primary symptoms, treatment and radiological findings, i.e. all relevant data obtainable from the charts of the patients, as well as all the subjective complaints, the clinical and the radiological findings at follow-up were transferred to a code system and then to an optical card for data processing. The data obtained were tabulated in various groups and each variable statistically analysed.

It was not possible, however, from the original charts to obtain relevant information about the exact extent of the patient's pain at the time of injury nor of the duration of the primary treatment, nor was it possible from the follow-up examination to obtain a clear picture of these things. These factors could therefore not be evaluated.

The radiological findings observed at the follow-up were the following:

Each vertebral body was scrutinized separately and every change tabulated. As definitely posttraumatic were considered those that were identical to those observed during the primary scrutinizing of the spines, i.e. wedge-shaped vertebral bodies, usually of an asymmetrical type with a concave end-plate and bodies with a slightly deformed anterior contour.

Special care was taken to evaluate changes mimicking Scheuermann's disease, the most typical of which are (Sörensen 1964):

1. Wedge-shaped vertebral body predominantly of the symmetrical type.
2. Irregular end-plates and intracorporeal disc protrusions.
3. Limbus changes with "moth-eaten" epiphyses.

RESULTS

The Clinical Follow-up

Of the 48 patients, i.e. 81 per cent of the original material, that were followed, 18 (38 per cent) patients claimed that following their earlier injury they had had pain with the same localization, while 14 patients (9 males and 5 females) gave a history of back pain in other parts of the spine not localized to the earlier fractured segments. Altogether 32 of 48 patients had had some type of back pain in the spine (67 per cent). The most common type of pain syndrome was lumbar insufficiency, i.e. feeling of tiredness, weakness and stiffness in the spine of varying intensity and duration. Five males had had acute low back pain attacks. Only 10 patients, 7 males and 3 females, had had sufficient back pain to claim sicklisting. The patient with paraplegia, who was the only one operated upon, had a part time job as a secretary. Her neurological losses were unchanged at the follow-up.

The objective evaluation of the spine of the patients in this material revealed no significant aberrations from the "normal", neither in mobility, the configuration of the spine, nor the neurologic signs. The few deviations found were of the same magnitude and frequency as those noted in previous population studies of similar materials (Hult 1954, Horal 1969).

Pain at palpation on one or more of the spinous processus was, however, frequent. This was noted in 11 males and 9 females over the previously fractured vertebral bodies. One female had pain on palpation over an earlier not injured vertebral body. In the lumbar spine this finding occurred in 2 males and 6 females, but half of them had previously not injured the actual vertebra. This is a statistically significant higher occurrence than compared to a similar earlier non-injured population (Horal 1969), where this symptom was seen only in 3 per cent in the thoracic spine and 6 per cent in the lumbar area. The statistical evaluation did not, however, reveal any correlation between pain on palpation and subjective impression of pain at the time of follow-up.

No correlation was found between mobility of the spine and pain, nor was this in any way correlated with the previously injured segment.

The Roentgenological Follow-up

In this material of 47 patients, 17 males (55 per cent) and 9 females (53 per cent) were found without any definite posttraumatic changes



Figure 5. Radiogram of the same patient as seen in Figure 1 at follow-up 13 years later. The patient, now 19 years old, has no demonstrable changes in the previously injured vertebrae Th 4, 5, 6, 7 and 8.

in their spines. In 14 males and 7 females, i.e. less than in half of the followed patients, definite posttraumatic, changes were seen.

Among the first mentioned group of 26 with no definite posttraumatic changes, 1 patient had signs of Scheuermann's disease, localized to the same part of the spine that was previously injured.

The number of posttraumatically altered vertebral bodies was much less than the number primarily injured. Only 2 males and 3 females had the same number of changed vertebrae as primarily injured, while 12 males and 4 females had changes seen in a lesser number. In 4 males no changes were seen at all in spite of the fact that at the time of the accident they had injured 5 or more vertebral bodies (Figure 5). In 6 males and 5 females no changes were seen after 4 to 5 fractured vertebral bodies.

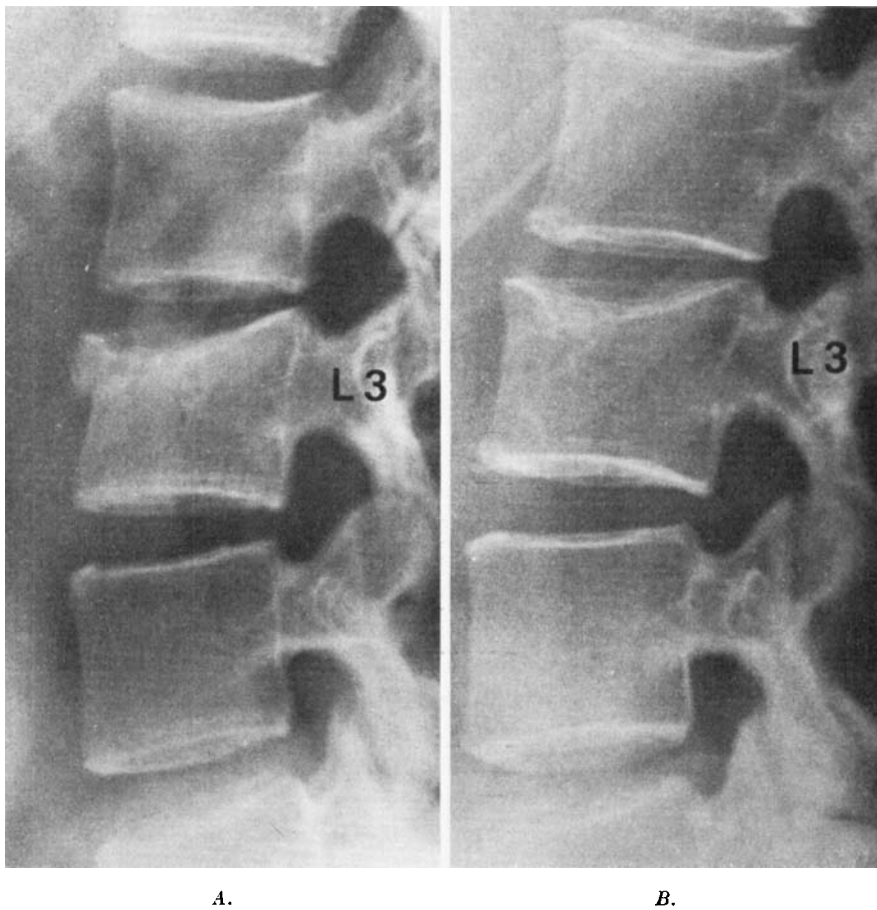


Figure 6. Radiogram of a fractured third lumbar vertebra in a 14-year-old girl.
A. At the time of injury.
B. At follow-up 18 years later.

Spondylosis in the fractured area was seen in 4 males and 5 females (13 per cent and 29 per cent respectively). Compared to the previously mentioned population study (Horal 1969) this number among the males was less than the normal prevalence in the similar uninjured age groups. Among the females, on the other hand, there was a slight increase in occurrence of spondylosis. At the follow-up radiological changes were seen to a greater extent and noted on more vertebral bodies in those patients who at the time of the injury were more than

10 years old, compared to those injured at a lower age (Figure 6). This correlation is statistically significant.

The statistical analysis revealed no correlation between the extent of roentgenological changes found at follow-up and treatment, localization of injury or age at injury. No correlation was found between any of the radiological changes listed above and occurrence of pain. When the patients who stated back pain at their previously injured site were specifically analysed, the mechanism of injury, the past history of physical exercises, the type of job held, the localization of the injury or the roentgenogram at follow-up showed no significance for the occurrence of their pain.

DISCUSSION

It is obvious from the results presented that vertebral compression fractures occurring in childhood do not predispose for back troubles up to the age of 25 years. It is impossible from this follow-up, however, to state that this holds true also in later life, since our patients were around 25 years of age at the follow-up. In Horal's (1969) investigation pain in the back was seen in 39 per cent among the males and 58 per cent among females at the age of 20–29 years, while in this material the same figures are 36 per cent and 59 per cent respectively. If anything, the past history of a vertebral fracture in childhood should most likely cause a premature degeneration of the discs and hence predispose to back pain earlier in life.

Compared with the same material (Horal 1969), the occupation of the patients and their general physical activity in this material were equal.

As in previous presented materials (Hamilton 1951, Damje 1955, Gelehrter 1957, Jelinkova & Keplova 1960, Huraj & Steno 1964, Vinz 1964, Povacz 1969, Rüdý 1969) of vertebral fractures in childhood, the dominance of boys versus girls was noted, and it is most likely that this is due to the more vigorous games played by boys. This might also explain the increased number of fractured vertebrae among male patients.

The localization of children's vertebral fractures to the mid-thoracic area has been noted previously (Westerborn & Olsson 1952, Gelehrter 1957, Vinz 1964, Rüdý 1969). The increased mobility of the thoracic spine of the children compared to the adult might explain this finding.

The clinical follow-up did not reveal any particular types of fractures that later in life led to an increased amount of back pain or

other sequel; nor were the relatively infrequent symptoms observed influenced by the type of treatment used, the number of fractured vertebrae, the extent of the compression fracture, the localization of the fractures, the age of the patients, the type of accident or the sex.

The only positive finding was the occurrence of distinct pain on palpation of the specific spinous processus, which was significantly more often found over a previously fractured vertebra than over other areas, and this also compared to the general population. No explanation for this finding can be offered at the present time, but on the other hand it was also noted that this single finding had no bearing on the subjective impression of pain at follow-up.

The roentgenologic follow-up revealed that in most patients the sequel was small and in more than half of our patients it was not even possible to trace the old fracture. Only 1 of our 47 patients had developed a wedge-shaped vertebral body with irregular end-plates that is seen in *Morbus Scheuermann* at the same localization as that previously injured. The radiographic findings at the follow-up were astonishingly few, as mentioned before. Changes in the shape of the vertebral bodies from injuries sustained after age 10, however, tend to be of a more permanent type than those fractures occurring earlier in childhood.

This study, thus, has demonstrated the benignity of vertebral compression fractures sustained in childhood. No proof has been given at the follow-up that the primary treatment in any way influences the later results. There should accordingly be no need for more dramatic measures such as repositions according to Böhler or for treatment with long plaster of Paris body jackets. Simple bed rest for 1–2 weeks should be enough for these patients.

In our opinion the very infrequent occurrence of changes similar to *Morbus Scheuermann* in this material (1 out of 47) rules out the theory of a traumatic etiology to that disease.

SUMMARY

This follow-up study contains those children who from 1948–1956 sustained a fracture in the thoracic or lumbar spine and were treated at Göteborg's Children Hospital. All together 59 patients were seen during that period, of which 48 patients or 81 per cent were re-examined clinically in 1969. At the time of accident the mean age was 9 years and the follow-up period averaged 16 years.

Of the 59 patients 65 per cent were boys and 35 per cent were girls. A fall from height was the most common cause of injury and the fractures were mostly localized to the mid-thoracic area. The number of injured vertebrae averaged among boys 4.4 and among girls 2.7.

At follow-up 18 (38 per cent) of the 48 patients stated that they had had pain at the previously fractured site of the spine, while 14 patients (29 per cent) had had pain in some other area. Two-thirds of the patients stated their symptoms as mild, more or less of the back insufficiency type with tiredness. Only 5 out of the followed 48 patients had had acute low back pain attacks and 10 had some time in the intervening period been on the sick list for back trouble. One subject suffered from paraplegia but was successfully habilitated. Compared to the general population of the same age and sex but without previous back injury, our material does not show any overmorbidity in back pain. There was no difference between our patients and the normal population in the same age groups with regard to objective or subjective findings, except a significantly more commonly noticed pain on percussion over the spinous process over an earlier injured vertebral body. A statistical evaluation, however, did not show any correlation between this pain on percussion and the patient's subjective back trouble.

In the roentgenographic examination at follow-up 47 patients (80 per cent) took part. In about 50 per cent of these patients no definite posttraumatic changes could be visualized. The number of posttraumatically altered vertebral bodies was significantly lower than the number of those primarily injured. Only 1 patient had Scheuermann's disease localized to the same area of the spine that was previously injured. Small osteophytes were seen in 20 per cent.

In those patients who at the time of accident were 10 years of age or older, the number of roentgenographic changes observed was significantly greater than in those patients who were younger. This was also true for the number of posttraumatically altered vertebral bodies.

A thorough statistical cross analysis did not demonstrate any correlation between the extent and type of the roentgenographic changes in the vertebral bodies seen at injury and follow-up, treatment and localization of the injured vertebrae or the subjective complaint of pain.

Based on this long term follow-up it is concluded that vertebral fracture sustained in childhood is a benign injury, and that Morbus Scheuermann certainly has no purely traumatic origin.

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