SPINAL PSEUDARTHROSIS IN ANKYLOSING SPONDYLITIS

CLINICOPATHOLOGICAL CORRELATION AND THE RESULTS OF ANTERIOR SPINAL FUSION

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We reviewed 40 extensive destructive vertebral lesions in 35 patients with established ankylosing spondylitis. Of these, 31 had presented with localised pain while three had a neurological deficit. The radiographs suggested ununited fractures through either ankylosed discs (37) or vertebral bodies (3). Corresponding fractures were seen in the posterior column in 34 cases.

Sixteen patients with 18 lesions underwent anterior spinal fusion, and pseudarthrosis was consistently proven by histopathology. Two pseudarthroses healed in conservatively treated patients. Thirteen of the operated patients were followed for an average of 7 years 7 months. There were two cases of non-union and one required an additional posterior fusion; in the remainder fusion was sound.

The term “destructive vertebral lesion” has been used by different authors to denote a spectrum of radiographic changes seen in ankylosing spondylitis. These changes have seldom been correlated clinically or pathologically, and there is little evidence to suggest that the various changes are all part of the same pathological process. Ball (1971) showed that the anterior spondylitis described by Romanus and Ydén in 1953 probably precedes ossification of the annulus fibrosus, and is not the precursor of extensive destruction with sclerosis around the whole disc margin.

Cawley et al. (1972) classified destructive vertebral lesions in ankylosing spondylitis according to whether the lesions were localised or extensive. Localised lesions occurred either at the rim of the vertebra or in a small circumscribed area of the vertebral end plate, while extensive lesions involved both areas and spread across the whole disc margin. Yau and Chan (1974) explored two patients with extensive destructive lesions in the dorsolumbar spine and found that mobile fibrous tissue had replaced the disc in both cases. In a third patient they found a posterior column fracture in line with a fibrous disc. In all three patients the spine was ankylosed at other levels, and anterior fusion led to effective relief of pain. Another term used to describe similar extensive lesions is spondylodiscitis (Simmons and Goodwin 1984). This implies an inflammatory aetiology, which adds to the confusion.

Our present study includes only the extensive destructive lesions defined by Cawley et al. (1972). We aimed to establish the pathogenesis by the correlation of clinical and pathological findings and follow the results of treatment by anterior spinal fusion.

MATERIAL AND METHODS

Between 1970 and 1986, 220 patients with ankylosing spondylitis confirmed by established clinical and radiographic criteria were seen in the spine clinics of the University Department of Orthopaedic Surgery at the Queen Mary and Duches of Kent hospitals in Hong Kong. Of these, 35 patients (16%) either presented with or developed destructive vertebral lesions of the extensive type. There were 31 men and four women with ages ranging from 24 to 70 years.

Clinical presentation. The period between the onset of symptoms of ankylosing spondylitis and the radiographic detection of an extensive vertebral lesion varied from three and a half years to more than 30 years. At the time that the lesion was identified 31 patients complained of back pain, but its duration was very variable, from one day to 30 years. The onset of pain was acute in
13 patients and insidious in the others. Seven patients related their acute pain to trauma; this was usually a fall on to level ground with direct impact on the back.

All patients had marked stiffness of the spine, and a rounded or occasionally angular kyphotic deformity was found in 31 patients, centred over the lower dorsal spine or the dorsolumbar junction. Commonly, there was well localised tenderness to palpation of the spinous processes near the summit of the kyphos. Four patients had no significant deformity.

Four patients had neurological symptoms and objective signs were found in three of them, two being paraparetic and one having weakness of one lower limb with hypoaesthesia. Signs were markedly improved by a period of bed rest. The fourth patient complained of weakness in both lower limbs but no objective motor loss could be detected.

Sixteen patients had significant hip disease as a result of ankylosing spondylitis; seven of them required unilateral or bilateral total hip replacement. The average ESR at the time of diagnosis in 31 patients was 35 mm in the first hour, varying from 13 to 75 mm.

**Radiology.** There were 40 extensive vertebral lesions in the 35 patients. Of these, 37 lesions occupied a disc space while three occurred within the body of a vertebra. Figure 1 shows that most disc lesions were near the dorsolumbar junction, the highest being at T9–10 and the lowest at L4–5 level. Two of the lesions within a vertebral body were at T11 and one was at L3.

In five patients there were two disc lesions. Double lesions were present at the same time in two patients, while in the other three the initial lesion had healed for several years, either spontaneously (one patient) or after operation (two patients), before the second lesion appeared.

The most striking radiographic feature was the irregular disappearance of the vertebral end plate on both the upper and the lower border of the disc. The border between disc and bone was ragged and hazy instead of smooth and sharp, while reactive sclerosis extended for a varying depth into the vertebral bodies (Fig. 2). The disc space was conspicuously more radiolucent than its neighbours which were usually fused. The height of the disc space was increased in 18 cases, narrowed in nine and of normal height in 10. Vacuum phenomena were seen in five radiographs of disc lesions, and Grade 1 or Grade 2 spondylolisthesis was seen in four cases (Fig. 3). In the older lesions, vertebral osteophytes were prominent, being seen especially on the anteroposterior radiograph, and sometimes resembling those of a Charcot spine.

The three lesions that occurred through a vertebral body instead of a disc were very similar to each other, with an irregular lytic band crossing the whole width of the body, with sclerotic borders and marginal osteophytes. Tomograms showed that the fracture line...
extended across the pedicles and laminae as seen in a Chance fracture (Fig. 4).

In 31 disc lesions in 26 patients a fracture through the ankylosed posterior elements could be seen in line with the anterior lesion. This fracture varied from a thin radiolucent line to one with the established features of non-union. Lateral tomography was often necessary to delineate the posterior fracture, but the sclerosis on either side of it could best be appreciated on a CT scan (Fig. 5). In the remaining six disc lesions in four patients unfused facet joints were observed in an otherwise ankylosed spine, either at a single level, or for a few contiguous levels below the anterior lesion. Thus in all cases there was a posterior weakness consisting of either a fracture or mobile facet joints. In four patients the posterior column fracture was diagnosed first, and it was then possible to follow the gradual development of a disc lesion anteriorly.

Treatment. Four patients required no treatment because pain was absent or insignificant. Of the others, 27 patients were treated with oral non-steroidal anti-inflammatory drugs, bed rest, and either plaster jackets or custom-made spinal braces. Anterior spinal fusion at one or more levels was performed for 16 patients, the indication being severe pain despite adequate conservative treatment in 13 patients, paraparesis in two and suspected tuberculous spondylitis in one.

RESULTS

Operative findings. In 17 disc lesions in 15 patients findings were very similar. Fibrous tissue had replaced the disc and movement could easily be demonstrated. Osteophytes were usually encountered around the lesion, and adjacent vertebral bone was often softened and brittle but occasionally hardened. In one pseudarthrosis through the body of T11, fibrous tissue had filled a transverse gap which was bordered by much necrotic bone.

In each case, all fibrous tissue was excised and the adjacent bone removed to produce a bleeding surface. In eight disc lesions an en bloc excision of the fibrous disc together with the upper and lower vertebral end plates was achieved. All excised material was sent for histopathology and bacteriology.

Anterior fusion was performed in all cases by impacting one or two full-thickness autogenous iliac grafts, or by strutting the defect with several autogenous rib grafts, or by a combination of both methods. Postoperatively the patients rested in bed for up to two weeks and were then able to walk in a plaster jacket which was maintained for 6 to 12 weeks.

Pathology. Infection was excluded by negative bacteriological results from all 18 operative specimens. The disc changes appeared to be consistent; detailed orientation being based chiefly on findings in the eight specimens.
taken en bloc. Macrosopically the disc had been replaced by a whitish homogeneous fibrous tissue with very irregular upper and lower borders (Fig. 6). Microscopically the fibrous tissue included a poorly vascularised central zone with areas of fibrinoid necrosis, and a peripheral zone which contained irregular bundles of collagen fibres and aggregates of blood vessels. The normally smooth and sharply demarcated cartilage end plates showed severe irregular destruction extending into the subchondral bone (Fig. 7). Fragments of necrotic bone and cartilage were strewn across the border, some embedded in vascular fibrous tissue. Hyaline cartilage was replaced by irregular fibrocartilage, while in the subchondral areas osteoblasts were active in the vicinity of islands of woven bone. Within the fibrous disc and at the border between disc and bone, inflammatory cells were absent or negligible. In the subjacent vertebral body, bone retained its lamellar trabeculae but appeared to be thicker than normal.

**Conservative treatment.** Fifteen patients have been reviewed after an average of 4 years 8 months of conservative treatment (range one year to 13 years). Two of them never had back pain and remained comfortable. Three patients became asymptomatic and were able to discontinue treatment. These included one patient with a unilateral neurological deficit whose pseudarthrosis healed after 12 weeks immobilisation in a plaster jacket. One other patient had spontaneous healing of his disc lesion, but then developed a new lesion at another level. Two patients refused operation despite severe persistent back pain. The rest were satisfactorily maintained on long-term treatment with non-steroidal anti-inflammatory drugs.

**Anterior spinal fusion.** Soon after operation, 15 of the 16 patients had good to complete relief of pain, but one had no relief. Thirteen patients have been reviewed after an average of 7 years 7 months (range 15 months to 15 years). Nine continued to have complete relief of back pain, but two had moderate pain requiring drug treatment. Solid fusion was achieved in all but two cases (Fig. 8). Of these, one had persistent pain following anterior fusion, developed non-union and had a posterior fusion 33 months later. Bone fusion was achieved both posteriorly and anteriorly but drugs continued to be required for mild pain. The other patient has had a painless non-union for 13 years and six months. The two patients who presented with paraparesis both gained full neurological recovery after the operation.

Apart from the two cases of non-union there were no significant postoperative complications. However, one patient required a second anterior fusion for a painful new pseudarthrosis five years after his first fusion and another patient developed a new lesion six years after fusion. Both of these new lesions were at different levels from the original one, separated from it by one or two ankylosed segments.

**DISCUSSION**

Our study of extensive “destructive vertebral lesions” in ankylosing spondylitis has provided firm histopathological correlation of clinical, radiographic and operative findings.

Cawley et al. (1972) gave a detailed discussion of the pathology based on biopsy specimens from three patients and agreed with earlier postulates of a traumatic origin.
(Hansen et al. 1967; Kanefield et al. 1969; Rivelis and Freiberger 1969). Our findings reinforce those of Yau and Chan (1974), and provide the necessary proof of traumatic aetiology. The evidence points overwhelmingly to a pseudarthrotic lesion of either the discovertebral junction or the vertebral body, perpetuated by stress and constant movement. We therefore recommend that all such extensive lesions be termed simply “spinal pseudarthrosis”. The anterior lesion may be either discovertebral or vertebral, depending on its site. The term spondylodiscitis is a misnomer; we have found no significant evidence of an inflammatory reaction within the lesion other than that which could be explained purely on the basis of trauma.

There are three possible causes for the formation of a pseudarthrosis. Firstly, the segment in question may have escaped fusion while other levels became ossified. The process of spinal ossification in ankylosing spondylitis is multifocal and not contiguous (Ball 1980) so this process may leave short mobile segments between long ankylosed segments. This sets the scene for high stress and mechanical failure. Our finding of unfused facet joints opposite six of the disc lesions supports this theory.

Secondly, there is a distinct possibility of an acute fracture through an already fused segment. Seven of our patients related the onset of their symptoms to a single episode of minor trauma. In the presence of vertebral osteoporosis, a well known feature of ankylosing spondylitis (Hanson et al. 1971), a relatively small force may be all that is necessary.

Thirdly, the mechanics of a stiff kyphotic spine must result in high stresses, especially near the dorsolumbar junction, and repeated stress may lead to fatigue fracture as in stress fractures of the long bones. Such stress fractures would be more likely to occur through an ankylosing disc since this must offer less resistance than the vertebral body. We believe this to be the most common mode of failure. Both acute and stress fractures are predisposed to non-union by the long lever arms of the ankylosed spine. Stress fractures may occur initially in the posterior column and in four patients we saw such a posterior column fracture prior to the appearance of an anterior discovertebral pseudarthrosis.

Healing may rarely occur with plaster immobilisation or no treatment at all, as we saw in two discovertebral pseudarthroses, but another pseudarthrosis may develop in the next segment or a few segments away.

A few patients had an asymptomatic pseudarthrosis but most had severe pain. We could not correlate the degree of pain with the radiographic severity of the pseudarthrosis. More than half of the painful lesions failed to respond to conservative measures; in these patients anterior fusion gave gratifying results. We recommend this procedure when the pseudarthrosis involves the anterior column and significant kyphotic deformity is present. It allows direct access to the anterior lesion and is biomechanically superior to posterior fusion in a kyphotic spine. However, diligent search should be made for the early posterior column fracture, since it may be better to perform an early posterior fusion than to wait until an anterior lesion develops.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

REFERENCES


