X-ray Appearances of Tuberculosis of the Spine

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PREFACE

THE purpose of this book is to present the x-ray findings from a series of cases of tuberculosis of the spine which were subjected to anterior spinal surgery between 1955 and 1967. We have had the opportunity of comparing the preoperative x-rays with the findings at the time of operation and also, in some cases, of comparing the postoperative x-rays with the findings at secondary operations.

Modern textbooks on x-ray subjects tend to devote little space to the x-ray appearances of spinal tuberculosis, as this condition is not common and is of little importance in the countries in which these textbooks originate. On the other hand, there are some highly populated areas of the world where spinal tuberculosis is still very common.

This monograph is particularly oriented towards describing, in detail, the various x-ray appearances of tuberculosis of the spine and its differential diagnosis.

INTRODUCTION

THE material on which this article is based has been collected in Hong Kong over the past sixteen years. In the first ten years of this period, an average of 500 new patients suffering from skeletal tuberculosis were treated annually for this condition. Since then, this figure has dropped to just over 100 new cases per annum. From July of 1957 to May of 1959, some 1000 consecutive cases of skeletal tuberculosis were diagnosed, of which 58.7 per cent were found to have spinal tuberculosis.

In over 800 cases an anterior spinal approach was made to the lesion, and we were able to compare the x-ray appearance with the operation findings. We were able to see, on the x-ray appearances, what we had missed while examining the x-rays preoperatively. Reexamination of the preoperative x-rays postoperatively proved very fruitful and taught us a great deal about the x-ray appearances. It was often possible to explain shadows on the preoperative x-rays whose significance had been missed or not fully understood before operation. This helped us very much in improving the standard of interpretation of x-rays. It is well to remember that, in spinal tuberculosis, a series of x-rays taken at intervals of three months or less is of greater value in the diagnosis and progress of the disease than single films; it also should be remembered that tomograms are of great help in this disease and that the lesion as seen at the time of operation is always more extensive than the x-ray would lead one to suppose.

It must be stressed that, in the early stages of tuberculosis of the spine, the x-ray can be completely negative and some months must elapse before any changes are visible on the x-ray at all. The time lag between the onset of the disease and its visibility on the x-ray probably varies between six weeks and, at the most, twelve months—according to the virulence of the organism and the resistance of the patient. It should be emphasized that many lesions heal before they can be seen on an x-ray. One of the difficulties is obtaining a good quality of x-ray in the first place

since density of the trunk and the problem of getting the spine close to the x-ray plate interfere with good results.

In the anteroposterior film the vertebral laminae are superimposed on the vertebral bodies, so obscuring the finer details of the trabeculae of the vertebral body. In routine investigations for spinal tuberculosis, the lateral view is much more useful since it gives information regarding the site and extent of the disease and also the state of the disc spaces. Oblique views may also be of help, particularly to show lateral destruction as seen in the aneurysmal syndrome.

Schinz has pointed out that there can be no talk of an early diagnosis of tuberculosis of the spine, while Ganguli emphasizes that x-ray evidence of fusion and healing can be very misleading. The latter states that "An apparently well-healed spinal lesion, confidently alleged to be the site of bony ankylosis, is often a smouldering focus ready to burst out at the slightest provocation."

FREQUENCY

In 1000 consecutive cases of bone and joint tuberculosis seen in Hong Kong between July of 1957 and May of 1959 at the Special Out-Patient Department, there were 587 cases of spinal tuberculosis. We plotted every involved vertebra to make a barograph (Fig. 1). It will be noted that the peak of the barograph is at L-1 and that the curve before and after this peak is a good curve from a statistical point of view. Following Galton's observations on binomial distribution, it would suggest that the primary source of infection in spinal tuberculosis lies in most cases at the level of the first lumbar vertebra.

MODE OF SPREAD

In experiments on monkeys, rabbits, and guinea pigs which have been carried out in Hong Kong for the past ten years, every possible method of producing spinal tuberculosis in animals has been tried. Our only success has been by the injection of tubercular bacilli into the kidney, prostate, and other abdominal and pelvic organs. While this work is not yet complete, there is evidence to suggest that the infection may spread directly towards the spine at the level of the infected organ and then through the spine, up and down the spine anteriorly, and

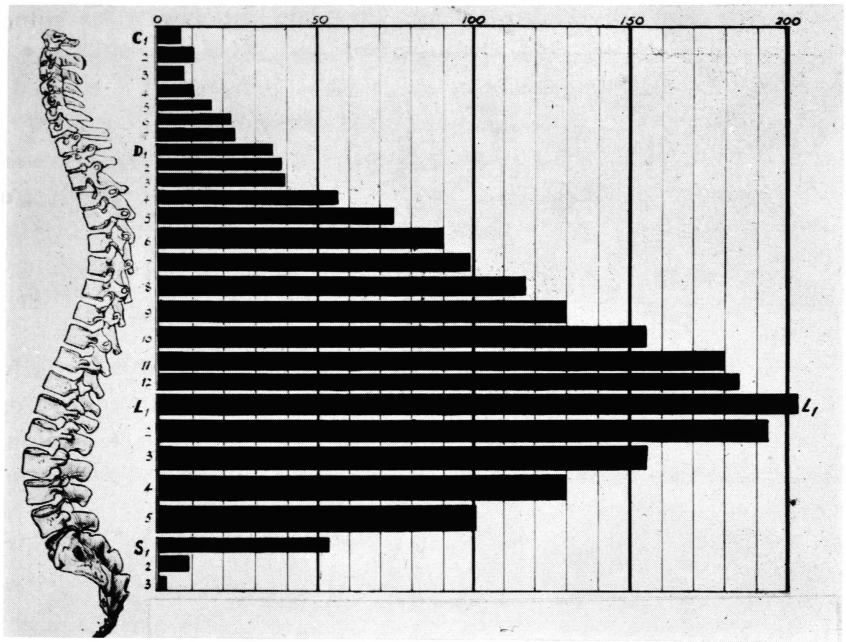

FIGURE 1. Barograph for 578 consecutive cases of tuberculosis of the spine with a binomial distribution suggesting the entry of the infection at a site opposite L-1. Cases were seen in Hong Kong between July of 1957 and May of 1959. (Each involved vertebra is presented as one unit.)

in the spinal canal (Fig. 2). This would explain the multiple involvement of the spine which may occur in tuberculosis and which has been recognized by Peabody and other authors for many years. This would also explain the barograph.

Batson suggested that infection could spread up by way of the paravertebral plexus, and we feel that this is a very definite mode of spread in spinal tuberculosis. We are, as yet, uncertain whether the spread is by vein or by lymphatic in the vein wall. It is of importance to understand this since it helps to explain some of the x-ray findings.

AGE INCIDENCE

The age incidence of this condition varies widely on a geographic basis and is largely dependent upon the standard of living in the country concerned. In countries where bone and

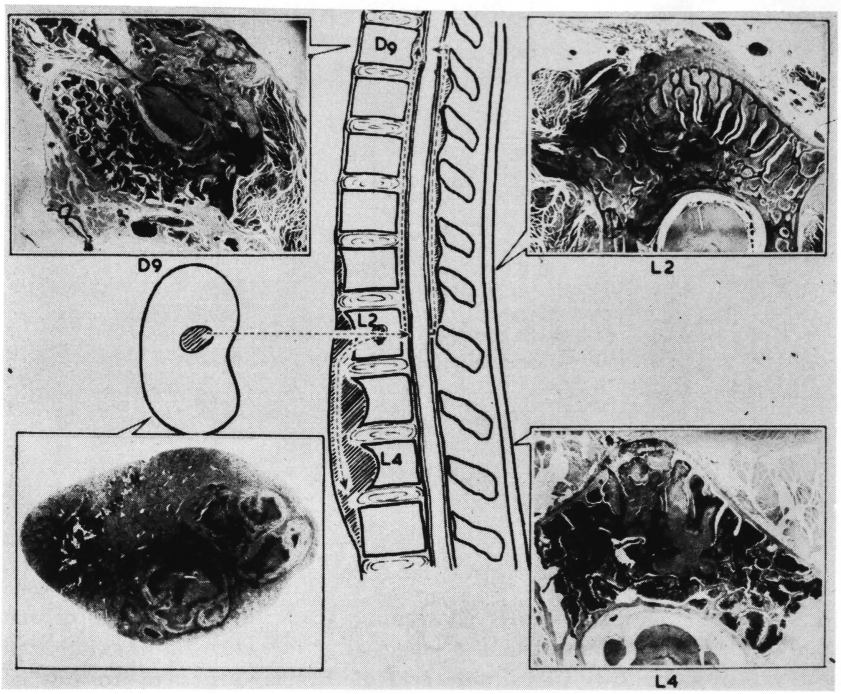

FIGURE 2. Composite picture containing photographs of the kidney and transverse sections of the spine at the levels of D-9, L-2, and L-4. These show infiltration by tuberculous granulation tissue in a monkey. The kidney was injected with 40,000 tuberculous bacilli, and the animal was sacrificed 10 weeks later. The diagrammatic drawing of the spine shows disease spreading from the kidney to L-2; the photograph at this level shows disease spreading through the vertebral body into the spinal canal. The disease was traced by serial sections of the spine in both directions, and the disease spread upwards into the spinal canal in intimate connection with the paravertebral venous plexus. The section at the level of D-9 shows the characteristic picture, with the spinal canal almost filled with granulation tissue which has distorted the shape of the spinal cord and involved the posterolateral aspect of D-9. The caudal spread was mainly anterior and is well illustrated at the L-4 level where site of the disease is mainly in the anterior portion of that vertebra. The monkey has six lumbar vertebral bodies and the kidney lies opposite L-2.

joint tuberculosis is common and the infectivity rate among the population is high, age incidence is low. In the Hong Kong series, 70 per cent of cases were under the age of ten years. In countries where a more advanced standard of living and better hygiene exist and the disease is uncommon, the patient does not become exposed to massive infection in the first few years of life and the age incidence is therefore correspondingly higher.

NUMBER OF VERTEBRAE INVOLVED

In the first 100 cases of spinal tuberculosis treated by radical surgery between 1955 and 1957, an average of 3.4 vertebrae were involved in each instance, as reported by Hodgson and Stock. This compares with the figure of 3.8 given by Mukopadhaya and Mishra. It should be reemphasized that, at the time of operation, more vertebrae are found to be diseased than are shown as such on the preoperative x-rays. Of course, as facilities for diagnosis and early treatment improve, the average number of vertebrae involved decreases.

We have a distinct clinical impression that, with the introduction of Bacille Calmette Guérin (BCG) and the use of antitubercular drugs in patients with chest tuberculosis, we are seeing a less acute and florid type of disease and this has resulted in a decrease in the number of vertebrae involved in each case.

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CONTENTS

X-ray Appearances of Tuberculosis of the Spine

Chapter I

CHANGES OF THE SPINE IN POTT'S DISEASE

"X-rays are pictures of shadows."—Charles Noon

WE shall consider x-ray changes which occur in the spine in cases of Pott's disease under various headings. We shall be describing these lesions as if they were static, but we would emphasize that this is not so; particularly in the growing child, the spine is in a constant state of change—progression or healing of the disease, and changes due to secondary reasons in other portions of the spine. We emphasize the importance of a series of radiographs taken at intervals of two to three months. One can usually determine whether the disease is progressing, is static, or is healing.

The main changes to observe and watch for *in the bone* are described below.

1. Increase of calcification or density, which usually denotes healing.
2. Decrease of density or calcification, which may be due to the disease itself or the enforced rest prescribed as treatment giving rise to osteoporosis. In the latter case the decalcification is uniform throughout the whole spine. Localized decalcification denotes activity and precedes actual bony destruction by the diseased process. In addition to an increase in calcification of the individual trabeculae, there may be a reappearance of trabeculae which had not been seen on previous x-rays. This is a sign of healing. The establishment of a bony block is also a good sign and denotes a healing or healed lesion, in most cases the latter, and is a good sign of permanent arrest of the disease. This was Percivall Pott's criterion for healing in this condition.

SITE OF THE DISEASE IN THE VERTEBRAE

There are three main sites where tuberculosis occurs in the vertebrae:

1. The centre of the vertebral body.
2. The paradiscal region.
3. The anterior of the vertebral body.

Central Disease

This arises, according to Doub and Badgley, from an infection which reaches the centre of the vertebral body through a branch of the posterior spinal artery. We feel that central disease in all probability reaches the centre of the vertebral body by means of the venous plexus, as described by Batson. This type of disease can destroy the whole of the vertebral body in much the same way as a tumour, so that a concertina collapse occurs, which is usually accompanied by paraplegia and which we describe fully under the heading, Concertina Collapse of the Vertebral Body. This type of disease is more frequently found in children and is uniformly distributed throughout the spine (Fig. 3). Symptoms appear only after the vertebral body collapses and, in many cases, this collapse is associated with some minor trauma.

Occasionally, in children, central disease may give rise to an expansion or ballooning of the vertebral body when the disease has involved the greater portion of it. This is probably due to the products of inflammation which tend to expand the weakened walls of the vertebral body so that its normal crescentic shape assumes that of a balloon.

Paradiscal Disease

This is really an epiphyseal type of disease, and the infection is said to reach the bone by way of the epiphyseal arteries. We believe that this can be produced by a venous spread as described by Batson. Paradiscal disease is usually present on either side of the intervertebral disc, and narrowing of the intervertebral disc is often the earliest x-ray finding. Symptoms occur when the disease is in its early stages, so diagnosis is usually made

FIGURE 3. Tuberculosis of the lower lumbar spine showing ballooning effect of L-5. This is probably due to expansile products of the inflammatory process in the centre of the vertebral body.

earlier than in central disease. Collapse does not occur as frequently and, when it does occur, it is not as severe as with the central type of disease. When diagnosed early and treated adequately, it carries a very good prognosis—particularly in the lumbar region—and may heal leaving little in the way of deformity (Figs. 4 and 5).

FIGURE 4. Paradiscal disease which shows narrowing of the intervertebral disc. Note the large abscess in L-2 and the smaller one in the bodies of L-1 and L-2, with sclerosis anteriorly on both vertebral bodies.

FIGURE 5. Another case of paradiscal disease. Note the abscess in the bodies of L-3 and L-4, the narrowing of the intervertebral disc, and the reversed spondylolisthesis.

Anterior Disease

This type of disease is due to the extension of a paravertebral abscess, which strips the covering of a vertebral body and is more common in the thoracic spine. It occurs when the infection spreads up and down the spine beneath the anterior longitudinal ligament and the periosteum. The peripheral portion of the vertebral body loses its periosteal blood supply, and this results

in destruction of the anterior surface of the vertebral body. On x-ray, this appears as anterior disease in the lateral view; however, at operation, the disease is seen to extend around the sides of the vertebral body as well and this may be confirmed by taking oblique x-rays. The disease may involve many vertebrae and is particularly common in children. Although most frequently found in the thoracic vertebrae where the aorta is in contact with the

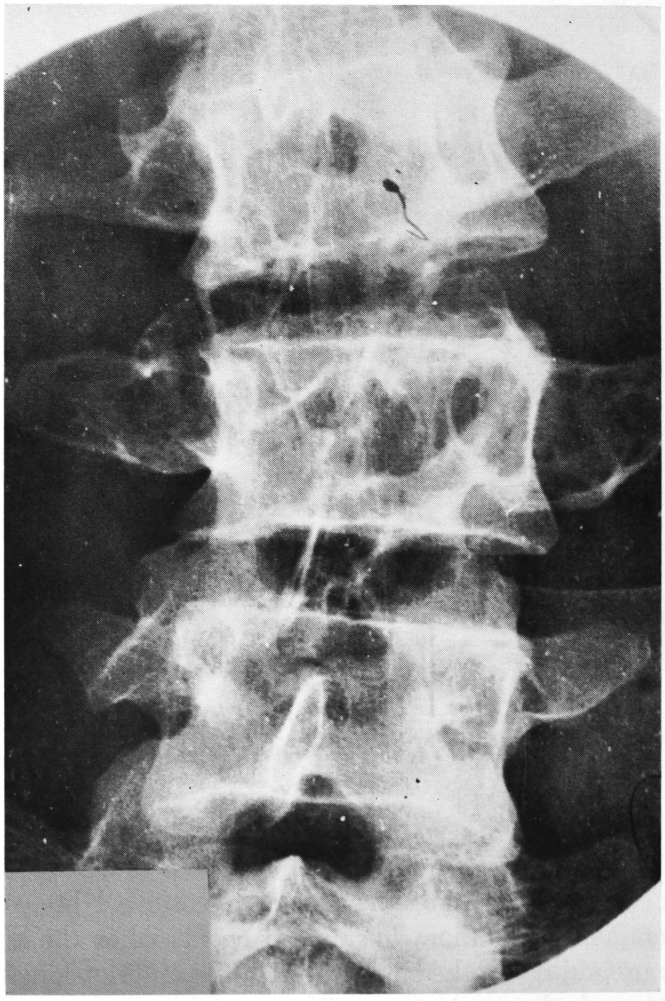

FIGURE 6. An unusual site for a tuberculous spinal lesion affecting the pedicle and transverse processes.

anterolateral surface of the vertebrae, it may also occur in the cervical vertebrae. It is probably inaccurate to call this the aneurysmal syndrome, as described by Ghormley and Bradley.

Collapse of the vertebral body occurs late in this type of disease.

Tuberculous infection rarely involves the transverse processes, the pedicles, the lamina, or the spinous processes but it may do so in isolated cases (Figs. 6 and 7).

FIGURE 7. Lateral view of the same cases in Figure 6.

CONCERTINA COLLAPSE OF THE VERTEBRAL BODY

We have given this name to the x-ray appearance described in Figure 8. The condition has been previously described by Girdlestone as a bellows-like collapse. The lateral x-ray in his case shows definite wedging of the vertebral body of T-8. Our cases have been mid-thoracic, and the collapse at this level has been more concertina-like.

At operation, we find that the vertebral body has been weakend by a tuberculous granulomatous lesion, with little if any pus formation. Consequently, a paravertebral shadow is not well marked. The weakened vertebra fractures and becomes compressed like a concertina, which increases in diameter as it collapses. This would not matter were it not for the posterior portion which encroaches on the spinal canal and usually produces a Pott's paraplegia of sudden onset. This is very difficult to diagnose on x-ray from a vertebral collapse due to neoplastic involvement of the vertebral body, and we would recommend a very careful appraisal of these cases. Clinically the patient complains of acute pain in the back, of sudden onset, which is usually followed a few hours later by paraplegia. The paraplegia is usually of a complete flaccid type, involving both lower limbs with incontinence of urine and faeces. It is emphasized that these cases require urgent anterior decompression.

ANEURYSMAL SYNDROME

This name has been given to the lateral x-ray appearance of the vertebral bodies where there has been scalloping of the anterior border. The condition is more common in the thoracic spine and in children. It may involve only one vertebra, but we have seen it involve seven. It was first described in 1904 by Schulthess, who called it *superficial anterior spondylitis;* since then, this term has been adopted by Giuliani and Volkert and other German authors. There is some confusion about this term, and Jentschura differentiates a "true primary superficial anterior spondylitis" from other similar forms of erosion following in the wake of an abscess or caused by a progressive infiltrating periostitis.

Due to the similarity of the x-ray appearance of the aneurysmal syndrome to erosion of the vertebral bodies produced by an aneu-

FIGURE 8. The paravertebral shadow was found to be caused by granulation tissue. The bony lesion was confined to D-11 which was osteoporotic and full of granulation tissue. Granulation tissue had produced pressure on the dura and the spinal cord, causing paraplegia. Histopathology—granulation tissue with bone spicules in it and occasional areas of caseation.

rysm, Ghormley and Bradley suggest that it is due to the pulsations of the aorta, through the abscess on to the vertebral body.

Menard described this condition, and Wullstein called it a peripheral form of spinal tuberculosis; he also noted the resemblance to aneurysmal erosion. Nichols describes the formation of these abscesses as follows: "The process generally extends forwards to the deeper layer of the pre-vertebral ligaments and strips the ligaments from the vertebral body. As the abscess grows bigger it extends upwards and downwards, stripping the paravertebral ligaments from the vertebral bodies as it goes and attacking the anterior surface of the vertebral bodies."

Ghormley and Bradley were unable to explain why the intervertebral discs remained intact where the lesion was a progressive tuberculous process as described by Nichols. For this reason the authors contend that, in some of these cases, mechanical pressure lifting up the periosteum—combined perhaps with the pulse transmitted through the abscess sac from the aorta—gives an aneurysm-like action and produces an almost pure mechanical erosion.

Such an explanation would account for the persistence of the intervertebral discs in these lesions. As we shall see, in most cases in spinal tuberculosis, the discs are extremely resistant to invasion—and Ghormley and Bradley's explanation seems to arise from an attempt to describe what is normal in tuberculosis of the spine.

The aneurysmal syndrome is said not to occur in the cervical portion of the spine, where the aorta is not in intimate relation with the vertebrae. We believe it unlikely that the aorta has anything to do with the production of this condition for the following reasons:

1. We have seen it in the cervical spine, and we have seen the same appearance on the posterior portion of the vertebral body (Figs. 9 and 10).
2. At operation, we find that the scalloping extends to the sides of the vertebral bodies and again may be present posteriorly (Figs. 10 and 11). If the x-ray is examined carefully, evidence of lateral erosion may be seen.

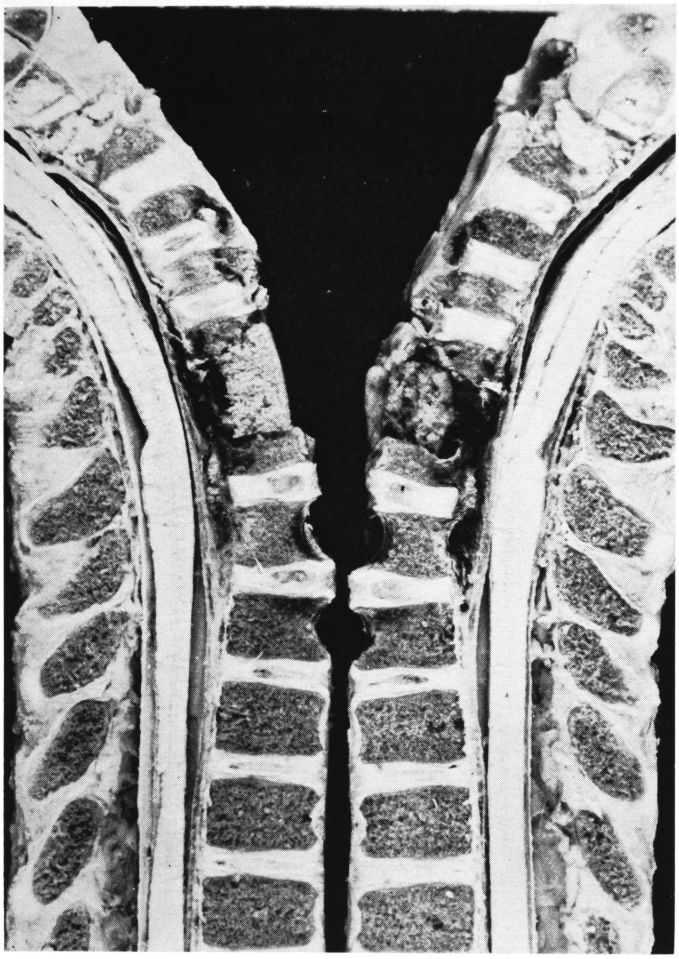

FIGURE 9. Specimen from a case of cervical Pott's disease. The patient died a few days after an operation for anterior spinal fusion. Note the anterior graft. Also note the aneurysmal syndrome on the anterior parts of C-7, D-1, and on the posterior part of C-7. The posterior longitudinal ligament may be seen stripped from the vertebral body. There is also a tuberculous lesion in C-1 and C-2.

FIGURE 10. X-ray of the same specimen as in Figure 9. Note the aneurysmal erosion on the posterior portion of C-7 which is masked by the lateral elements overlying it.

We feel that this condition may be due to the dissecting qualities of the paravertebral abscess in the thoracic region and the consequent elevation of the periosteum and ligaments from the spine with the peripheral periosteal blood supply. As a result, tuberculosis of the spine attacks this devitalized bone and destroys it to produce this condition. When it heals, the scalloping

FIGURE 11. Posterior aneurysmal syndrome in D-10 and a psoas abscess with calcified debris.

becomes less marked and the anterior cortex may be distinguished on the x-ray.

SCOLIOSIS

A lateral curvature of the spine has been recognized for many years as one of the deformities of Pott's disease. Taylor in 1887, Bartow in 1889, and Kirmisson in 1892 stated that the lateral