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OSTEO-ARTHRITIS OF THE SPINE: SPONDYLITIS DEFORMANS.

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The term osteo-arthritis is used to designate the disease of the articulations, which is characterized pathologically by a marked proliferation of the edges of the articular cartilage, associated with an atrophy or degeneration of the cartilage at the points of pressure, the two conditions producing an amount of impairment of function of the joint varying from the slightest inconvenience to complete ankylosis.

Various terms have been used to designate this condition, some of them suggestive of the general process, while others refer only to the local manifestation. Of the former, chronic rheumatism, arthritis deformans, rheumatoid arthritis, rheumatic gout, dry or proliferating arthritis, malum senile, arthrite sèche are the most commonly met with. Of the latter, the most common are malum coxæ senilis, referring to the disease as seen in the hip and spondylitis deformans, or spondylose rhizomelique, representing the same process involving the spine.

It is with reference to this latter manifestation of the disease that this paper is concerned, and while some mention of the general process is necessary, it will be only such as would be of value in considering the local disease.

The disease has been described by various writers in journal articles, but as yet there has been but slight mention of the subject in the works on orthopedic surgery, and most of the literature is devoted to the report of individual cases, with but little consideration of the disease itself. It is for this reason, and also because it seems to me, from my observation, that the disease is more com-

mon than has been supposed, that the subject is offered for discussion here.

Bradford,[1] in 1883, reported three cases of "rheumatism of the spine," all in men between thirty and thirty-six years of age. In two practically the whole spine was stiff, with ankylosis of the ribs. In the other the rigidity of the spine was confined to the dorsal region. In the first two cases there was a gonorrhœal history. In all of these cases the spine alone was affected.

Marie,[2] under the term spondylose rhizomelique, reports five cases of his own, in one of which there was a distinct gonorrhœal history. One patient was sixty years of age, the others from thirty to forty years, and in all some of the other joints—usually the hips or shoulders—were affected.

Strümpell[3] reports three cases, and in his book describes the type of painless progressive ossification of the spine and hips.

Mutterer[4] reports a case of a man fifty-eight years of age, with complete ankylosis of the spine, together with ankylosis of both hips and some slight trouble with the knees.

S. Popoff[5] reports a case of a man, twenty-eight years of age, in which the process developed very rapidly and was associated temporarily with weakness of the legs. This weakness disappeared as the disease became less active.

Beer[6] reports three cases, thirty-nine, forty-seven, and forty years of age. In one a history of gonorrhœa is given; in one the hips and shoulder-joints were affected; in another the shoulder and hand, and in one there is no mention of the other joints.

Marie and Astic[7] report a case of a man, sixty years of age, with trouble with the back of ten years' duration. The spine is completely ankylosed.

Bechterew[8] reports five cases: two women, about fifty years of age, in both of which about half the spine was rigid, with no other joints affected. Of the three men, one, a patient thirty-nine years

[1] Annals of Anatomy and Surgery, Brooklyn 1883, vol. vii. p. 6.
[2] Rev. de Méd., 1898, xviii, 285.
[3] Deutsche Zeitschrift f. Nervenhk., 1897, p. 338.
[4] Loc. cit., 1898, Bd. xiv., 1 und 2 Heft.
[5] Neurologisches Centralblatt, Jahrg., No. 7.
[6] Wein. med. Blätter, 1887, xx. 127 and 128.
[7] Presse Méd., 1897, October.
[8] Neurologisches Centralblatt, 1893, p. 426; Deutsche Zeitschrift f. Unfallhk, 1897, xi. 326.

of age, had the spine completely ankylosed, with the symptoms of nerve pressure, such as areas of anæsthesia and others of hyperæsthesia. Other joints were not affected. Of the other two, one had paralysis agitans and the other was insane. In both cases the spine was rigid, and there were symptoms suggestive of pressure upon the nerve-roots. The other joints were apparently not affected.

Individual cases are also reported by Fagge,[1] Spillman and Etienne,[2] Gasne,[3] Raymond,[4] Sänger,[5] Stocker,[6] Henle,[7] Baumler,[8] Davies and Colley,[9] Sturge,[10] and Pasteur.[11]

Of my own cases, ten in all, most of them have been seen in the Orthopedic Clinic (for adults) at the Carney Hospital, and the cases which have been selected are those which are particularly characteristic and in which the other joints have been but little if any involved.[12]

The first case was previously reported by me in the *Boston Medical and Surgical Journal* of December 26, 1895, and is here reported because of its relation to the other cases.

Case I. Mrs. McC., fifty-eight years of age, by occupation a nurse, had always been well and actively engaged in her work until the present sickness. Her family history is good, and she never had the least trouble from rheumatism. In July, 1893, she was caught in a thunder shower and her clothing was wet through. The next morning she complained of pain in the neck, with some tenderness in the upper part of the chest. There was no cough or expectoration. The pain in the neck increased in severity very rapidly, until the slightest motion caused the most intense suffering, and because of this she was admitted to the Good Samaritan Hospital. The patient entered the hospital in the service of Dr.

[1] Transactions Pathological Society, 1877, xxviii. p. 201.
[2] Rev. de Méd., 1898, xviii. p. 746.
[3] Sem. Med., 1899, p. 78.
[4] Loc. cit., 69.
[5] Neurologisches Centralblatt, 1898, xvii. p. 1144.
[6] Clinical Journal, May 9, 1894, p. 35.
[7] Vereinsbeilage S. deutschen med. Wochenschrift, 1894, S. 20.
[8] Deutsche Zeitschrift f. Nervenhk., 1898, xii.
[9] Transactions Pathological Society, 1855, p. 359.
[10] Transactions Clinical Society, 1879, xii. p. 204.
[11] Loc. cit., 1889, xxii. 298.
[12] The pathological specimens are from the Warren Museum at the Harvard Medical School.

Coolidge, and it was through his kindness that I was enabled to see her.

At the time of the first examination she was evidently suffering a good deal. The head was held a little to one side, the chin to the left, the shoulders drawn up, and all motions were most carefully guarded by muscular contraction. Any attempt at motion caused great pain. None of the other joints were in the least involved, and aside from this local condition the patient seemed well.

For the first week or two the patient was kept quiet in bed, and the various rheumatic remedies freely given with very little if any effect. After this a Thomas collar was applied for more complete fixation, and following this light-weight extension was used. These gave some relief, but neither could be used continuously, because of the nervousness of the patient; so that the two appliances were used alternately, each being worn for a few hours. In three or four weeks after the beginning of the attack a swelling appeared in the right side of the neck. This was about the size of a small lemon, and was apparently connected with the spine. At the same time the numbness of the left arm was noticed, with some impairment of motion, and this condition continued and increased until the arm was almost entirely helpless. The right arm and both legs also became involved, never in as marked a degree as the left arm, but enough to make motion in bed, unassisted, impossible. At one time there was difficulty in swallowing, and for a short period breathing was almost entirely diaphragmatic.

The patient's condition remained about the same for two months, after which there was a slow but steady improvement, so that at the end of the third month she was able to sit up for a short time each day, and in December, five months from the onset of the trouble, she was able to move about with but little assistance, and was taken home. The paralytic symptoms referred to in the right arm and legs had by this time practically disappeared, but the left arm was still very helpless. The swelling in the neck was practically the same as when first noticed.

The patient was not again seen until thirteen months later, during which time, aside from the Thomas collar, no special treatment had been carried out. At the time of this examination the improvement in the patient's general condition was most marked. She

moved about with perfect ease, and, aside from the stiffness of the neck and some impairment in the use of the left arm, she seemed well. Extension of the neck was entirely restricted, so that in order to raise the chin the whole body was bent backward. Rotation was also entirely restricted, while flexion was more free, it being possible to lower the chin to the chest. On each side of the neck, over the transverse processes, was very distinct thickening,

FIG. 1.

apparently bony in character. In the left arm all motions were limited, especially those in which the shoulder muscles were used. The fingers were flexed, apparently due to the contraction of the palmar fascia and the flexor tendons. The sensation of the hand and arm was normal.

At the present time the patient's condition is practically the same

as at the time of this last note. She is able to be about at her work, but there has been no change in the condition of the neck or arm.

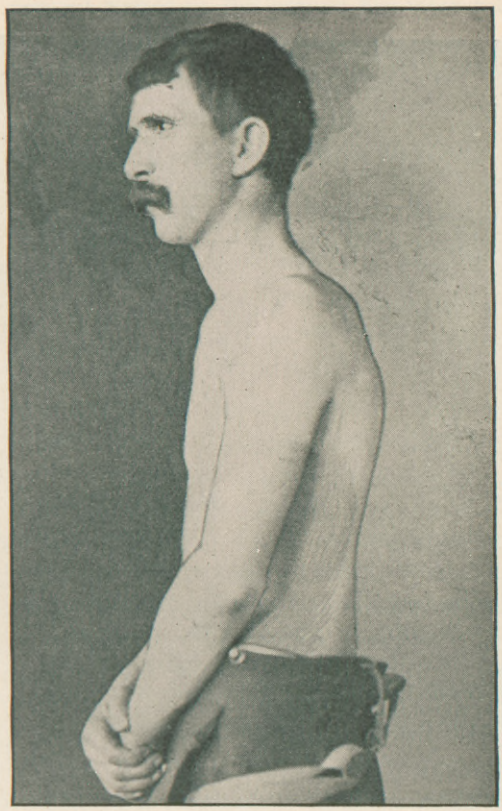
CASE II. Mrs. M., seventy years of age, came to the Carney Hospital over two years ago. She had considered herself, and had been considered by her family, to be well until ten years ago. At that time she fell on the floor, striking the lower part of the spine. Since then she has had more or less pain in the back, and while previously she had carried herself quite erect, she gradually bent over both to the front and to the side. Except the spine, the joints were not affected. At the time of the examination there was a large, rounded kyphosis involving the whole dorsal and lumbar spine, together with quite marked lateral deformity. There was but little motion in the spine, and no symptoms of paralysis. Fig. 1 represents her condition at that time.

CASE III. G. K., a man, twenty-one years of age, a steel polisher by occupation, came to the Carney Hospital in June, 1897. For one year he had been having trouble with the back, with a gradual loss of the use of the arms and legs. At the time of the first examination the whole spine was bent forward and was rigid. None of the other joints were involved. The left arm could not be raised to the head, and both legs were very weak. The knee reflexes were present, the left being exaggerated. There was marked muscular atrophy of both arms and legs. The patient was seen by Dr. Bullard, and the diagnosis of osteo-arthritis with pressure upon the nerve-roots confirmed.

CASE IV. D. F., a man, twenty-nine years of age, an ordinary laborer, came to the Carney Hospital in September, 1897. Some years previous he had an attack of rheumatism when in Ireland, which lasted for three weeks. After that he came to this country, and for a time "fired" in an engine-room. He used "to sit in draughts to get cool." This brought on another attack of rheumatism, and he was unable to walk for seven weeks. The patient was well after the second attack of rheumatism until a few months ago, at which time he had typhoid fever. Soon after he was able to be about he noticed pain in the back, and as this increased and prevented him from working, he came to the hospital. At that

time the spine was straight except for a slight prominence of the eighth, ninth, and tenth dorsal spines. The motions of the whole spine were guarded, but those in which the low dorsal vertebræ were used were least free. A plaster-of-Paris jacket was applied, to prevent an increase of the deformity, and a little later this was

FIG. 2.

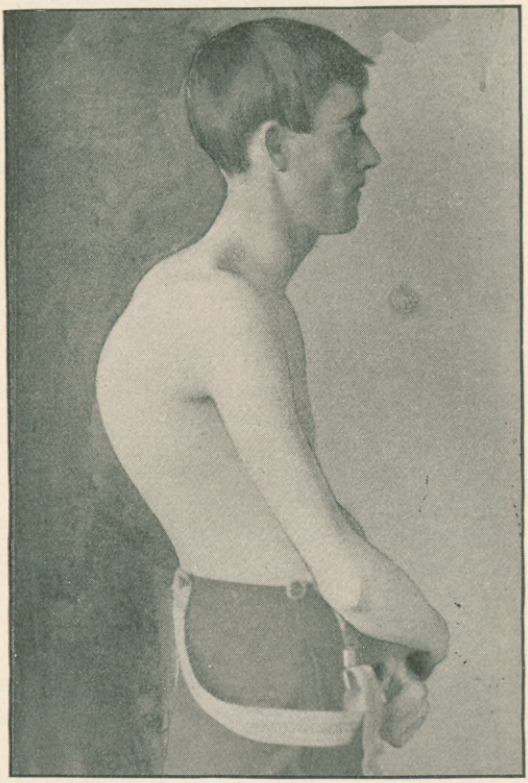


changed to a leather jacket, which has been worn until the present time. There has been some bending forward, as is shown in the photograph (Fig. 2), and his spine has gradually ankylosed, so that at present it moves as one piece from the pelvis to the lower part of the cervical region. The ribs have also become ankylosed, so that the respiration is entirely diaphragmatic. His general health

is good, and, except for an occasional few days of pain in the feet, the other parts of the body have not been involved.

CASE V. P. B., a man, twenty-four years of age, came to the Carney Hospital in the early part of this year. His previous history was good, and there was no history of rheumatism in the

FIG. 3.



family. His work was that of a stationary engineer, having charge of a hoisting engine, and, being obliged to work in all kinds of weather, he was much exposed. Five years ago he noticed pain in the back and feet for a time, but has been regularly at work until the past year. Since then he has been so weak and tired so easily that he could not work. When seen at the hospital the

whole back was arched forward, as shown in Fig. 3, and there was complete ankylosis from the pelvis to the mid-cervical region. The ribs were also ankylosed, so that the breathing was wholly abdominal. The other joints were not involved and there were no signs of nerve pressure. The chief complaint was pain in the small of the back, due, undoubtedly, in part to the active disease and partly to the muscular fatigue resulting from the posture. For treatment, aside from general remedies, the patient has worn a light spring-steel brace with much benefit.

CASE VI. J. S., a man, twenty-five years of age, came to the Carney Hospital in March of this year. For occupation he had done "firing" in a gas-house, and has considered himself well until the past three or four months, since which time he had had pain in the feet, followed by pain in the hands and spine. At the present time the whole spine from the pelvis to the mid-cervical region is rigid, and the ribs are also ankylosed, so that the breathing is wholly abdominal. A few small joints of the hands and feet are involved. The spine is fairly erect, there being but little of the anterior bending.

CASE VII. G. H., a man, thirty-two years of age, consulted me in September, 1898, at the request of Dr. H. W. Cushing, of Johns Hopkins Hospital. The patient was a professor in one of our large universities. His family history was excellent; he had been well previous to January, 1897, when he broke down nervously. He went abroad, and soon after this stiffness of the neck and shoulders developed, not enough, however, to prevent his going about. Soon after this numbness developed in the left arm, with marked loss of power, and later the right arm was similarly involved, only not so severely. The condition improved slightly, and then remained about as it was at the time of the examination. At that time there was a moderate rounded curve involving the upper dorsal and cervical regions of the spine. This portion of the spine was rigid. The shoulders were drooped forward and there was marked atrophy of the muscles of the chest, shoulders, and upper back. Both shoulder-joints were somewhat involved, so that the motions were limited, and there was some thickening about the head of the humerus. On attempted motion there was

marked spasm of the muscles about the shoulders and upper spine. The legs were normal and there was no change in the reflexes. There was a distinct loss of power in the left arm, with some numbness, and there was a tendency to the same condition on the right side. The treatment, which has been almost wholly general, has been followed by improvement.

CASE VIII. C. H., a man, sixty-two years of age, was referred to me by Dr. George Bancroft, of Natick, in April last. When in the Civil War the patient contracted "rheumatism," and the back has been stiff ever since, so that he has not been able to work regularly. The neck has not been involved until the past eight months, previous to which time he overworked and broke down. Since this time the neck has been painful and has been growing worse. When examind the whole lumbar and dorsal spine was ankylosed and free from pain. The cervical region could be moved but slightly, and this only with great pain. Even the atlas and axis were apparently involved, there being but a very few degrees of motion of the head in any direction. The ribs moved slightly on respiration. The sensation in the right arm was much impaired, but the muscular strength remained about the same as the other side. The other joints were not involved. A Thomas collar, to support the head, gave very marked relief in this case.

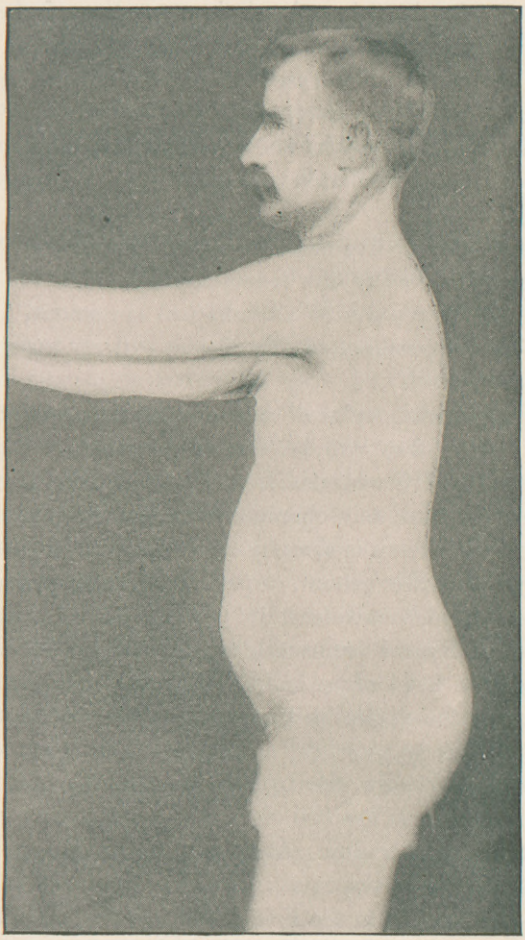
Apparently in this case there have been two separate attacks of the disease—one early in life and the other one thirty years later.

CASE IX. M. J. K., a man, thirty-four years of age, by occupation a currier, was seen by me at the Massachusetts General Hospital with Dr. John Homans. The patient had been well previous to five years ago; at that time he had an attack of pain in the shoulder, the left knee, and the right foot. Soon after this he noticed that his back was somewhat stiff. Three years ago the pain became acute in the right heel, and since then this has caused him the most trouble. One year ago he had another attack of the so-called rheumatism, in which the neck was affected. He was in bed at that time for six months, and since then the back has been much stiffer, and it has been difficult for him to breathe freely.

When seen by me he was well nourished and developed. The spine was straight, and was ankylosed from the pelvis to the

cervical region. The ribs moved but slightly with respiration, the breathing being almost entirely abdominal. The other joints were in fairly good condition, except the right heel, which was

FIG. 4.



painful, and the X-ray picture showed a similar osteo-arthritic process. The position of the spine is shown in Fig. 4, and is interesting as showing that the rounded back is not necessarily characteristic of the disease.

CASE X. Mary S., thirty-five years of age, came to the Carney Hospital about three years ago because of trouble with the back and neck. The history as given was that a few months previously she made a change in the underclothing and took cold. This was followed by a sudden pain in the neck, which prevented her from being about. At that time the slightest motion of the head was extremely painful. No other joints were involved. The arms for some time could not be used freely, the left one being worse. Under general treatment the patient gradually improved, so that at the present time, except for the rigidity of the upper dorsal and lower half of the cervical spine, she is well.

In all about thirty-five cases have been reported previously, or forty-five cases, including the ten of my own. Beside this there have been several reports of pathological specimens, illustrating the pathological appearance of the disease entirely apart from the clinical history.

In analyzing such a series of cases certain facts are at once suggested, but before they can be studied to much advantage they must be distinctly differentiated from the other type of rheumatoid disease, which is chronic in character and also leads to joint ankylosis, but in which there is atrophy of all the joint structures, with no tendency to nodular growth or osseous deposit, as is seen in the type of disease under consideration.

Both of these diseases are usually considered together in the text-books under the head of arthritis deformans, which accounts for the variation in the clinical picture as it is presented by the various writers.

As the cases are seen side by side there cannot be the slightest question but that there are two distinct diseases or two very widely divergent types of the same disease, and it is because of this that much of the confusion has arisen.

In a paper published in the *British Medical Journal*, Bannantyne and Vollman have carefully described the two types, and in a paper entitled the "Treatment of Joints Disabled by the So-called Rheumatoid Diseases," published by the writer in the *Boston Medical and Surgical Journal*, January 29, 1897, the two types were described and illustrated. In that paper the descriptive term

"arthritis deformans" was used to designate the whole class of these so-called rheumatoid diseases. Rheumatoid arthritis was used to designate the cases in which joint inflammation and atrophy, resulting in ankylosis and marked distortion, were the chief features, while osteo-arthritis was the term used for the cases in which the nodular deposits about the articulations were the most prominent features.

The importance of this differentiation is mentioned because several of the cases which have been published as spondylitis deformans are undoubtedly cases of rheumatoid arthritis, and are not osteo-arthritis, which explains the discrepancy in the clinical picture.

It is evident, in the first place, in the analysis of the cases, that the disease is essentially a disease of adult life, but not necessarily a disease of old age, as is often stated. Some of the worst cases have developed in the period of late adolescence, while in very few has the process started in old age. The disease as it is seen in old age is not so definitely localized in the spine, but, as a rule, the other joints are more or less involved.

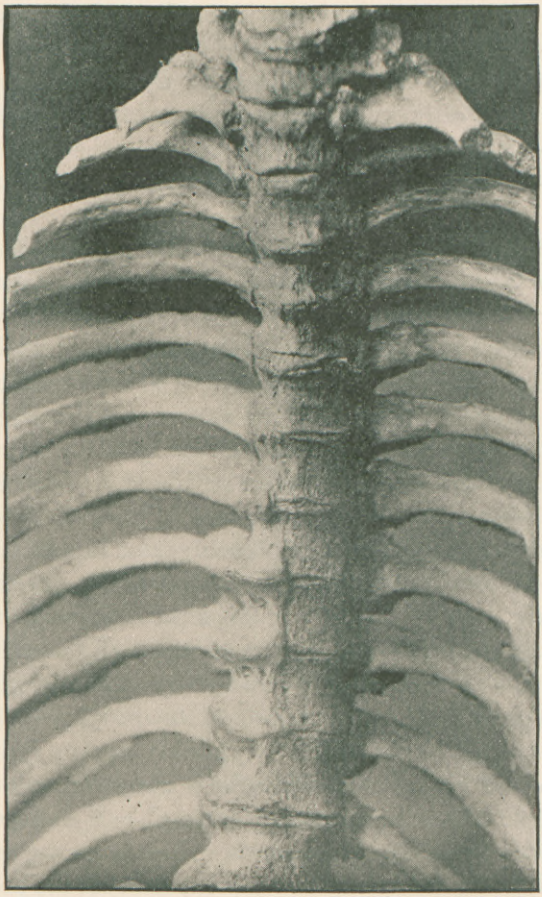
Another feature which is also noticeable is that there is no one cause of definitely recognized etiology to explain the onset. Gonorrhœa has been mentioned as a probable cause in a certain number of instances, but in a much larger number this is not suggested as a possibility. In the majority of cases the cause seems to be some exposure or the rapid change in temperature of the affected part. These influences are recognized and accepted as etiological factors in similar phenomena in other parts of the body, and their importance in spondylitis deformans is probably equally certain. Exposure to wet or cold, or occupations which necessitate sudden changes from heat to cold, such as "firing" or "engineering," are the causes most frequently met with. Bechterew suggests trauma and heredity as possible causes. Beucke believes the process to be due to senile and mechanical causes.

Most of the other writers, however, either do not express an opinion as to etiology or else accept exposure and gonorrhœa as most probable.

Still another thing which is evident is that the disease is not peculiar to this generation, and that it also is not peculiar to the

human race. Bland Sutton reports a specimen illustrating this disease in a mummy taken from the pyramids, while Sutton reports the disease in oxen and horses, and Bricon mentions a similar condition in cats.

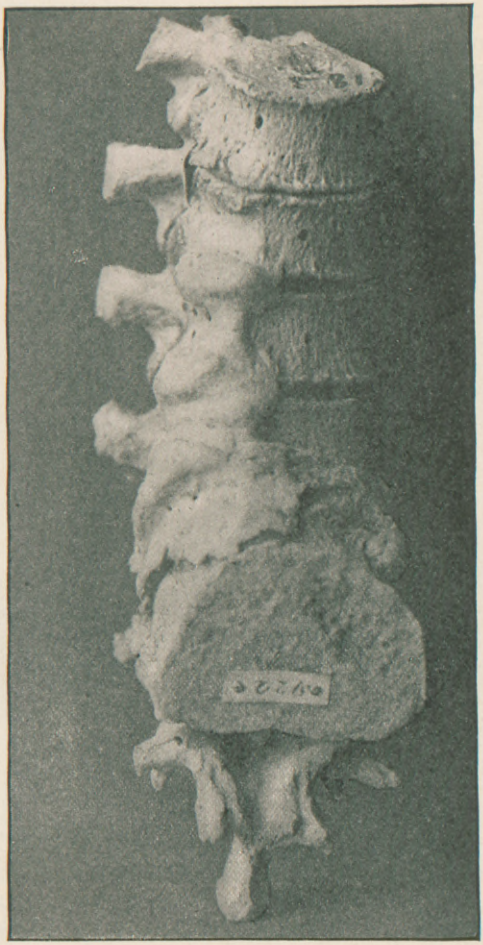
FIG. 5.



Pathologically, the disease consists of a nodular enlargement of the edges of the articular cartilages, with the subsequent ossification of these nodes and an extension of the process into the ligaments which have their origin or insertion near by. With this hypertrophy at the edges of the cartilage the centres or areas of pressure

usually undergo atrophy. In the atrophy the interstitial tissue is the last to be absorbed, which explains the granular appearance as it is seen at times; but as the process continues this interstitial

FIG. 6.



substance is absorbed, and either the two surfaces of bone fuse or remain in apposition. In the other joints in which there is free motion the bare surfaces of bone frequently become polished and increased in density.

The process in the spine usually begins upon one side anteriorly and extends up or down along the anterior lateral ligament. It may remain as a comparatively local process involving only a small portion of the ligament, as is shown in Figs. 5 and 6, or it may cross over to the other side and extend up and down until the whole spine is invaded. When this occurs the chief deposit or new formation of bone is along the lateral ligament, the change in the median line consisting simply of a fusion of the vertebræ, as shown in Fig. 7 and also in Fig. 8, in which the lumbar spine had become joined to the sacrum.

FIG. 7.

At times, even though the hypertrophic change is quite active, that which develops from adjoining vertebræ does not fuse, and a more or less free joint remains. This is distinctly shown in Fig. 7 and also in Fig. 9, in which an intermediate joint remains mobile (*a*), even though the osseous deposit has been so extensive as to entirely overlap the articulation in front (*b*).

As the disease goes on in the ligaments and cartilages the intervertebral substances atrophy, and if the process is slow the entire intervertebral disk may be absorbed before ankylosis takes place.

If this be the case, naturally the back is rounded and the spine becomes very much arched, as shown in Fig. 10. If, on the other hand, the process is more active the vertebræ may become ankylosed before the disk has been absorbed, and, consequently, no deformity is produced. If this be the case the disk ultimately is replaced

FIG. 8.

by osseous tissue and the ankylosis rendered more complete. The condition is shown in Fig. 9. If the process is more active on one side than the other it is easy to see that lateral deformities may result, and, naturally, this is more commonly seen in the cervical region, where the spine has more flexibility. The condition is well shown in Fig. 11.

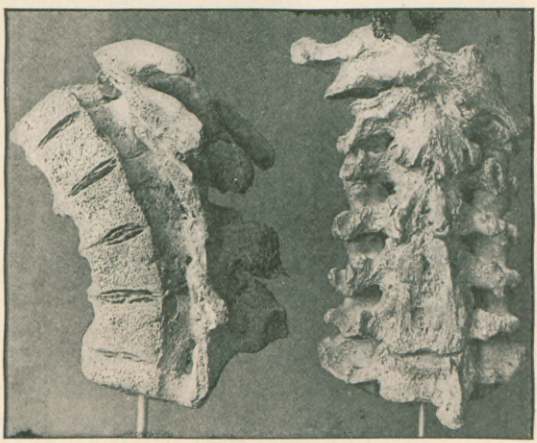
While these changes are taking place in the anterior portion of the spine, similar changes take place in the ligaments and articula-

FIG. 9.

b *a*

tions at the back, so that the transverse and rarely the spinous processes are affected. It is the disease in these regions that causes

FIG. 10. FIG. 11.



most of the symptoms of paralysis or disturbed sensation, by narrowing the foramina through which the spinal nerves pass.

Clinically, as the disease is seen, the subjective symptoms are usually slight in comparison to the actual pathological change, and frequently there has been so little trouble with the back, and the change has taken place so gradually, that the patient is not conscious of any special limitation, the condition being discovered by accident. More often, however, there is considerable pain, which is referred to the back, and which is aggravated by change of position. When quiet the pain is so much relieved that the patient frequently does not seek treatment until the disease is far advanced, or even if treatment is asked, it is often excused without examination as a "touch of rheumatism," and the therapeutic suggestions made accordingly.

If the disease is seen early, before much actual change has taken place, there is usually a definite region in the spine to which the pain is referred, and in this region the motions are restricted, at first, of course, by muscular spasm, but later by osseous change. At this time, when the process is so definitely localized, the portion of the spine affected may appear more prominent than normal, suggesting the beginning deformity of Pott's disease, and at this time a positive diagnosis may not be possible. The onset is suggestive, and also the reference of the pain to the back at the exact seat of the disease rather than the referred or abdominal pain of Pott's disease, but it may require some weeks before the true nature of the process can be determined. Case IV. was at first thought to have Pott's disease, and it was only after seeing him several times that the correct diagnosis was made.

As the ankylosis of the spine takes place the ribs almost invariably are affected, and the process may prove so extensive that all the articulations become ankylosed, and the thorax is perfectly rigid. In this case thoracic respiration is, of course, entirely lost and the breathing is done wholly by the diaphragm.

Beside the pain in the back and the limitation of motion, neuralgic pains in the arms or legs, together with disturbances of sensation, numbness or hyperæsthesia, are probably the most common symptoms. These are, of course, due to pressure upon the nerve roots, and, consequently, are not seen until the disease is well advanced, or when the onset has been unusually rapid, as in Case I. Following these neuralgic pains, when the disease is well

advanced paralysis may result, the extent of which varies from complete inability to use the part to a slight inconvenience. Rarely are the two sides affected equally, or if both sides are affected the symptoms have developed at different times. This, together with the fact that the paralysis is peripheral in type, is of importance in differentiating it from Pott's paraplegia.

Occasionally, when the disease is very active, the same osseous deposit takes place in the posterior ligament (*ligamentum longitudinum posticum*), and may result in enough narrowing of the spinal canal to produce symptoms of pressure paralysis exactly similar to that seen in connection with Pott's disease. This is not very common, but nevertheless does occur, and must be borne in mind in making the diagnosis. Case I. had this type of paralysis in connection with the paralysis of the arms, due to the pressure upon the nerve-roots. The presence of the two types of paralysis is of assistance in determining the diagnosis.

After the active stage of the disease has passed, with the lessened vascularity and natural shrinking of the non-osseous structures, the direct pressure upon the spinal cord is usually relieved, and the same may be true of the pressure upon the nerve-roots. In my own experience, and, so far as I can learn, from the reported cases, there is no case in which the symptoms due to the direct pressure upon the cord have not been relieved. With the involvement of the nerve-roots, while there has always been some improvement, in many of the cases the recovery was never complete.

The deformity, which is so striking at times, has a wide range of variation. In the most extreme form the rounded back with the protruded head and the flat chest (Fig. 3) is the type usually pictured or described. It is evident, however, that the nature or extent of the deformity must vary with the seat or extent of the disease, and also with the rapidity of its development. In Case IX., Fig. 4, the whole dorsal and lumbar spine is ankylosed, with scarcely any change in the normal curves.

The lateral deformity of such an extreme type as is shown in Fig. 1 is rarely seen, and probably could only occur late in life. It is probably due to osseous deposit and thickening on one side of the spine, with atrophy and softening on the other. A moderate amount of lateral deformity is not uncommon, and

is almost always present when the disease is in the cervical region.

The treatment of this disease is of more importance than is commonly supposed, and is partly medicinal and partly mechanical. As an early diagnosis is, of course, of the first importance, it is at this time, before the deformity has taken place, that the most can be accomplished. The disease is probably a trophic process, and, consequently, all medicines or methods of treatment which debilitate should be most carefully avoided. This naturally includes the various so-called rheumatic remedies, all of which are depressants, and also the various baths or courses of treatment which tend to lower the vitality. The general treatment should be wholly nourishing and stimulating. Extra diet, stimulating bathing, massage of the unaffected parts, electricity in a mild current, all are of value, and also the dry heat, provided it is not used so frequently as to be debilitating, relieves the pain and does much good. For medicines, iron, arsenic, and strychnine are the drugs which are of the greatest value. Cod-liver oil and alcohol in medicinal doses are also useful. For mechanical treatment some form of spinal support should be used at once, partly to relieve the pain by restricting the motion and partly to prevent the marked deformity from developing. Case IV. was under treatment quite early in the disease, and, even with the imperfect general care which it was possible for him to have, he has been kept from becoming more deformed than is shown in his picture (Fig. 2). A plaster-of-Paris jacket was used at first, and this was followed by a leather jacket, which is still worn. The whole spine has been involved and also the articulations with the ribs, and I am sure that without treatment the deformity would have been as great as that shown in Fig. 3. The position of the chest, with the greater room for respiration, has had a very definite beneficial effect upon his general health.

Manipulation of the spine is naturally of little value, and probably would result in more harm than good. Attempts have been made to forcibly break up the ankylosis,[1] but they have been followed, as would be expected, by results which were not satisfactory.

[1] Strümpell. Deutsche Zeitschrift f. Nervenhk., 1897, xi. p. 338.