STUDIES IN PALÆOPATHOLOGY.¹

ARTHRITIS DEFORMANS AND SPONDYLITIS
IN ANCIENT EGYPT.

By the late Sir ARMAND RUFFER, C.M.G., M.D.

(PLATES VII.—XII.)

PREFATORY NOTE BY LADY RUFFER.

WHEN starting in December 1916 on a mission which was evidently attended by dangers and which finally proved fatal to my husband, he left with me instructions as to various unfinished papers at which he and I had worked together.

It was his written wish that the present part of his "Studies on Palæopathology" should be submitted to his friend and former assistant, Captain J. G. Willmore, R.A.M.C., who has kindly devoted his short leave during the summer of 1917 to assisting me to prepare this paper on "Arthritis Deformans." We have decided to eliminate certain short passages wherever we had doubts as to Sir Armand's intention, rather than give a possibly erroneous impression. We have not, however, attempted to write a summary or conclusions, such as my husband would certainly have given, since the paper speaks for itself, and we preferred not to add any matter which he had not time to prepare.

Captain Willmore undertook the arduous task of supplying references, which my husband left to be filled in, searching for suitable illustrations, etc.

My very sincere thanks are due to Captain Willmore for this labour of love, undertaken for his former chief in the Quarantine Service of Egypt. Without his valuable help, I might never have been able to give to the world this part of Sir Armand Ruffer's "Studies in Palæopathology."

ALICE RUFFER.

December 1917.

INTRODUCTION TO THE STUDY OF ARTHRITIS IN
ANCIENT EGYPT.

ARTHRITIS DEFORMANS is a chronic, painful, debilitating disease, which in many cases goes steadily from bad to worse. The lesions in the neighbourhood of the articular surfaces cause pain in the joints and tendons, together with muscular spasms whenever the articulations are moved.

The vertebral lesions of spondylitis deformans gradually disqualify a patient from earning his living by agricultural pursuits, hunting,

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netting fish, or indeed by any manual labour, or any pursuit requiring even moderate physical exertion.

The pain in many of the Ancient Egyptians whose lesions have been described must have been very severe. As the lumbar spine was the part most frequently involved, it follows that these people suffered severely from lumbago, sciatica, pains and cramps in the lower limbs. The skeletons do not show any lesions, proving that the spinal nerves were pressed upon, but the osseous lesions are only a fraction of the pathological alterations present during life, and the vertebral lesions were undoubtedly surrounded by a wide area of inflammatory exudate which pressed heavily on the spinal nerves (Plate VII. Fig. 1) and possibly caused intense pain during life. The sleepless nights due to the pain coming on suddenly during sleep, the alterations in the general nutrition due to the intense suffering, must have sufficed to alter profoundly the physical and mental well-being of the Ancient Egyptians.

The limitation of movement caused by the pressure of spondylitis deformans was very great in some cases, and the aspect and carriage of the patient must have varied according to whether the intervertebral cartilages had been absorbed or not.

When the absorption had taken place in the lumbar or cervical regions, the favourite places for such alterations, the collapse of several intervertebral spaces undoubtedly caused marked deformity. When, on the other hand, there was no absorption of the vertebral cartilages, considerable stiffness unaccompanied by deformity was the result. A large number of Ancient Egyptians, therefore, were considerably crippled, the majority of these by changes in the vertebral column, and a minority by lesions of the peripheral articulations.

The pathological lesions in the dorsal region, though not conducive to much deformity, were very important on account of their interference with respiration. When the costo-vertebral articulations were attacked, as was often the case (Plate VII. Fig. 2), the pain on respiration must have been extremely severe, and the thoracic movements rendered almost impossible. Moreover, the periarticular lesions of the costo-sternal articulations undoubtedly added to the difficulties in respiration. Abdominal respiration also was occasionally rendered difficult and perhaps painful by the lesions on the anterior surfaces of the vertebræ having involved the tendons of the diaphragm.

Respiration then was difficult and painful, but must have been almost impossible whenever any bronchial or lung attack called into play the muscles which are only used in forced respiration, the attachment of which, as has been shown often, were extensively ossified. Cough was extremely painful, and any disease causing even moderate dyspnoea must have proved fatal in people whose respiratory muscles were unable to respond to the extra strain put upon them.

The lesions of arthritis deformans in peripheral joints gave rise to

pain, limitation of movement, etc., and were in themselves sufficient to prevent any active exertion on the part of the patient. When the temporo-maxillary joint was attacked, difficulty in taking nourishment became an important and distressing symptom.

In a paper ⁽¹⁾ on the lesions of teeth in Ancient Egyptians, I drew attention to the very common occurrence of pyorrhœa alveolaris in people with spondylitis and other manifestations of arthritis deformans, and dental disease added to the joint lesions must have rendered the patient's life well-nigh unbearable.

In spite of these serious and unsatisfactory conditions of health, some of the patients lived for a long time. Even in the Pre-dynastic period many lived long enough to have the vertebral column ankylosed from end to end. For instance, the old woman from Thebes ⁽²⁾, whose case has been put on record, was certainly confined to her bed for months or years before septic poisoning from a huge bed-sore proved fatal to her.

Every Nubian or Egyptian village contained within its walls a fairly large number of people, chronic invalids, who could do little work, and a few completely crippled who were unable to earn their living by agricultural pursuits. Some may have engaged in light pursuits, such as cooking, tailoring, etc., which required little exertion, but in an agricultural community only a very small proportion could have earned their living in that way. The rest, when not wealthy, were dependent on the charity of their friends, and as they lived a long time in this crippled state, it follows that to assist one's friends and neighbours was already a duty in Pre-dynastic times.

Lesions such as we have described could not have occurred in uncivilised people, for the patients would have died of inanition before the changes could have proceeded so far, and their existence is the best possible proof of the high degree of civilisation to which Ancient Egyptians had attained.

Chronic articular and periarticular disease, therefore, has existed in man and animals for many thousands of years.

In this paper I intend to give an account of chronic, non-suppurating, articular, and periarticular disease as it occurred in Egypt and Nubia during the last eight thousand years or more.

The material is the same as that on which my paper on the pathological lesions of the teeth of Ancient Egyptians was based, namely—

1. Skeletons and mummies, dating from various periods of Egyptian history, given me by the late Sir Gaston Maspero, Professor Flinders Petrie, Mr. Wainwright, Professor Breccia, and others.
2. The large collection of Pre-dynastic and later skeletons in the Museum of the Medical School in Cairo.
3. Fragments of skeletons from Merawi (Sudan) and Faras (Nubia), kindly handed over to me by Professor Griffith (Oxford).

4. Skeletons of the Macedonian soldiers buried at Chatby, in Alexandria.

5. Skeletons of Alexandrians (Greeks, Egyptians, etc.) from the catacombs of Kom-el-Shougafa and Ras-el-Tin.

6. Coptic mummies.

7. Last, but not least, the field notes of Dr. Wood Jones, published in the "Archæological Survey of Nubia: Report on Human Remains," vol. ii., and Professor Elliot Smith's papers.

The existence of arthritis deformans and spondylitis in Ancient Egyptian skeletons has been noted by Elliot Smith, who described ⁽³⁾ a male body of the Ancient Empire from the Giza Pyramids with complete bony union of every vertebra in the entire column.

Wood Jones ⁽⁴⁾ has given a complete and excellent account of this disease as it existed among Ancient Nubians. It was found that the disease might exist in every joint, including the temporo-maxillary articulation.

Disease of the knee-joint was perhaps less common than might have been expected. He states that in by far the greater number of affected joints (knee-joints) eburnation is not a conspicuous feature, whereas the irregularity of the articular surface is marked. "It would seem," says Wood Jones, "that the disease may take one of two forms: one in which the bony outgrowth and a great roughening of the articular surfaces are the most notable features; and one in which the eburnation of the opposed ends of the bones is most pronounced. The first form tends in a very great number of cases to bony ankylosis of the affected joints." I would rather, instead of speaking of two forms of the disease, look upon these two forms as two "stages" of the disease.

He describes the changes found in the elbow, head of the humerus, hands, hips (including coxa vara), etc., and points out that the periarticular changes and lesions of parts of the bone away from the joint are as important, if not more important, than those in the articulations themselves. Further, he gives a very accurate description of the changes found in spondylitis deformans.

In several cases spondylitis deformans coexisted with arthritic disease in other parts of the body.

Wood Jones' memoir is, further, very interesting on account of the field notes which are a perfect mine of information.

The type of the disease in Ancient Egypt was distinctly peripheral; that is, the chief changes were in the ligaments, the capsules of the joints, but not in the joints themselves. Whether the articulating surfaces of the vertebral column, the hip-joints, knee-joints, or the smaller joints be examined, the larger number of cases show no alterations whatever in the articulating surfaces. When the latter are eburnated, or simply show signs of wearing, as in the acetabular cavity of the hip-joint, then, in every case, the lesions of the disease

at the periphery of the joint were intense, and the lesions of the articular surfaces appeared to be late lesions coming after the periarticular changes had prepared the ground, so to speak.

Very possibly the articular lesions during life were very marked and left but little trace after death. Profound changes in the synovial membrane, in the ligaments, in the cartilages even, may have been conspicuous in the living and yet have left no trace in the skeleton.

All that can be said for certain, therefore, is that although, very possibly, the articulations and articular surfaces during life may have been the seat of extensive lesions, these left no trace after death in the bony structure. The peripheral changes, on the other hand, were extremely marked and in themselves must have produced extremely severe symptoms.

The question now arises as to what variety of arthritis deformans, as varieties exist now, the Egyptian form belongs.

Thomas M'Crae (⁵) divides arthritis deformans into three groups:

1. A form in which the changes predominate in the structures, apart from the bony parts of the joint, although the cartilages are frequently involved to some extent. The degree of change varies greatly. This group is termed "periarticular" and is the commonest of all.

2. A form in which the chief change consists in marked atrophy of both bones and cartilages. With this there are usually marked atrophic changes in the muscles. This is termed the "atrophic" form, and appears to be comparatively rare.

3. A form in which hypertrophic changes are the most prominent. There may be marked bony overgrowth, which may occur at the edges of the articulating surfaces especially, or in the spine, involving the cartilages and ligaments. This is termed the "hypertrophic" form, and is commoner than the second, but not as common as the first.

These forms, however, are not so fixed that one can always say with certainty that a given case belongs to one group rather than to another; these forms may pass into one another. Moreover, it is by no means clear what is meant by bony overgrowths at the edges of the articulating surfaces, or in the spine, involving the cartilages and ligaments. As we have seen, such bony overgrowths (leaving out the cartilages) are common in our cases, but they appeared to us to be more of the nature of a deposit of bone in inflamed tissue than an osseous overgrowth from pre-existing bone.

Very difficult, also, is the diagnosis of this disease in the spine. The term spondylitis deformans, which I have used throughout this paper, denotes (M'Crae ⁶) an arthritis of the spinal joints, changes in them which are frequently associated with proliferation of bone, atrophy of cartilages with its replacement by bone, and osseous changes in the ligaments. These last are apparently involved very frequently, perhaps the anterior lateral ligament most often of all. The extent of involvement varies greatly, and the process may extend

along several vertebræ, making practically a solid column for some distance, or a process of one vertebra may be joined to that of the next one. The transverse processes are not infrequently involved. The lesions may be symmetrical or asymmetrical; in the lower spine, the process is frequently most marked on one side, in the cervical region much more often on both sides.

This condition of the spine may be the only manifestation of spondylitis deformans, or may be associated with arthritis of the peripheral joints. M'Crae states that in thirty-nine out of eighty-one cases of spondylitis the spine alone was involved, and in forty-two this was associated with arthritis elsewhere.

He also maintains (*loc. cit.* p. 529) that the joints of the vertebræ may be involved in a general polyarthritis, and apparently no permanent change of any degree be left. This form of arthritis need not be described now, as, for obvious reasons, the pathological changes of this polyarthritis would not be noticeable in skeletons.

One point, which is not usually mentioned in the papers on spondylitis, has obtruded itself, and that is the very important lesions at the points of muscular attachments on the skeleton. These lesions in some parts of the body, as, for instance, in the lumbar and pelvic regions, were so severe that they must have crippled the patient almost completely. A man whose vertebral groove was filled with ossified muscles would have had a "poker spine" even in the absence of any other lesions (Plate VII. Figs. 3 and 4). Similarly, the man whose muscular attachments to the pelvic or to the upper part or lower ends of the femur or upper end of tibia were more or less ossified must have had his movements considerably impaired. The lesions, moreover, which are seen in the skeletons are probably slight, as compared with those which existed during life, but left no trace in the skeletons after death. It is practically certain that the inflammatory process which gave rise to roughness and osseous deposits at the point of attachment of the muscles spread for some distance along the tendon and even into the muscular fibre. When both ends of a muscle were attacked, as was sometimes the case, the action of such muscle must have been considerably interfered with. It may be that the atrophy of muscles—an atrophy which does not appear to be caused by mere disuse—may be due in some cases to these lesions, but there is no proof of it; moreover, the fact that this atrophy is sometimes marked in cases in which the chief change is advanced atrophy of bones as well as cartilages—a change which did not exist in our cases—is distinctly against this theory.

On the other hand, the involvement of the muscles may perhaps account for the severe pains of obscure origin, which many of these patients suffer from. It seems to me very probable that many cases of so-called muscular rheumatism, associated or not with arthritis deformans, may be due to such changes.

The lesions of the vertebral column leave no doubt regarding the nature of the disease. The cases were typical cases of spondylitis deformans, or poker spine.

The only difference between the disease in modern and ancient people lies in the fact that in modern people the cartilages are often ossified, whereas in the few mummies examined by me and in skeletons no evidence of ossification of the cartilages could be obtained.

This objection is probably of little value, for several reasons. In the first place, the cases in which the cartilages were still present were so few that no conclusions could be drawn. In the second place, marked ossification may have been present, but unless the cartilage was so completely ossified as to form a solid block, nothing of it would be found in the sand more or less filling the grave.

It has been shown in the course of this paper that in some skeletons there were distinct signs of ossification of the fibrous part of the intervertebral disc, and that in others, especially in the cervical region, the cartilages had evidently been absorbed during life,—the vertebræ falling together. It is evident, therefore, that some very serious changes had taken place in the cartilages, the lesions being of such a nature, however, as to leave no trace in the skeletons. In the cervical and lumbar regions the vertebræ occasionally fell together, the deformity implying a disappearance of the cartilages through some profound pathological change.

The disease in Ancient Egyptians was perivertebral rather than vertebral, that is, as in modern people, the ligaments, and more especially the anterior common ligament, were most affected.

The material at our disposal was not such as would easily settle the question as to whether the spondylitis deformans was or was not accompanied by arthritic or periarthritic changes in other parts of the body. It was but seldom that the whole skeleton was obtained, and in most cases only a few bones were present, so it was not possible to say whether other joints besides those actually discovered suffered or not.

Certain it is, however, that whenever a complete skeleton was discovered with lesions of spondylitis deformans, so often were one or more of the distant joints affected. In many cases, therefore, spondylitis was complicated by peripheral articular disease, as it is at the present day.

I.

MATERIAL EXAMINED AND ITS CHRONOLOGY.

The first skeleton to be described is that of Nefermaat, discovered by Wainwright (1910⁷) in a IIIrd Dynasty Mastaba at Meydum. The tomb had been rifled at the time of burial by the workmen, who

had desecrated the body and considerably damaged the skull and many of the bones.

The body had been enclosed in a coffin, which had disappeared, and some time after burial the tomb had been filled with mud which had penetrated into all the foramina of the bones, and it was supposed that the body had been first dismembered and the bones then wrapped up in bandages. The bones, extremely fragile, were covered with thick incrustations of salt, and the mud still filled all the spinal foramina and the interstices between the bones. There was nothing to show that the salt had been added as a preservative, and most probably it had crystallised out of the surrounding mud and been deposited on the bones during the four thousand years or more which had elapsed since burial.

The spinal column from the fourth cervical vertebra to the coccyx had been converted by disease into a rigid block, which at some time or other after death had been accidentally broken into several pieces.

The atlas, axis, and third cervical vertebrae were absent. The first piece consisted of the cervical vertebrae, from the fourth down to the first dorsal inclusively. The vertebrae of this first piece were firmly tied together by solid new bone which had developed in the anterior common ligament, and this osseous bridge formed a distinct arch over each empty intervertebral space. The intervertebral discs were never ossified, the surfaces of the bodies of the vertebrae were smooth, and the empty intervertebral spaces were not narrowed. So much could be seen through the gaps left here and there. The posterior common ligament, completely ossified, did not bulge into the canal, and therefore did not press on the spinal cord. Numerous osteophytes developed from the inferior-anterior border of the first dorsal, to form a bony bridge with similar prolongations from the superior border of the second dorsal vertebra.

The whole dorsal region displayed similar lesions, the anterior and posterior borders of the vertebral bodies being firmly bound together by the ossified anterior and posterior common ligaments, and the articulating surfaces with few exceptions solidly united by periarticular osseous overgrowths. Most of the spinous processes were broken off; the few still present were normal, with the exception of the eleventh and twelfth, which were connected by a strong, bony bridge.

Similar alterations were present in the lumbar region. The right vertebral groove opposite the twelfth dorsal and first and second lumbar vertebrae was filled with a mass of somewhat spongy bone, about 3 cms. broad, extending laterally over the articulating surfaces, which were covered everywhere with thick new bone. A similar mass, somewhat smaller, occupied the left vertebral groove. The posterior spinous processes were not ossified. The fifth lumbar vertebra was firmly fixed by new bone to the sacrum, which was otherwise normal.

The pathological changes in the acetabula were limited to the formation of a few small osteophytes at the junction of the articular and non-articular portions (Plate VII. Fig. 5).

The head of the right femur was broken off post-mortem. A slight deposit of new bone at the junction of the head and neck showed that this bone also had suffered. The lesions of the right femur also were limited to slight thickening of the anterior border of the articulating surface of the knee.

The scapulae, which were the only bones of the upper extremity that were

discovered, were healthy except for some very slight roughness due to chronic inflammation round the scapulo-humeral articulations.

The manubrium sterni showed curious lesions. On the right side the first rib was firmly ankylosed with it, and about $1\frac{1}{2}$ inch from the sternum it had evidently been badly broken, and, owing to want of surgical knowledge, perhaps, a false joint had been the result of the accident.

Enough of the costal cartilages was left to prove that they had been completely ossified.

The few bones of the skull which were left showed no alterations, except that the internal surfaces of both condyles had been rendered uneven by old periarticular inflammation.

The skeleton of this man therefore exhibited the signs characteristic of severe spondylitis of the vertebral column throughout its whole length.

The lesions were especially marked in the anterior and posterior vertebral ligaments, but whereas in the former the inflammatory process had led to the formation of large bulging osteophytes, the surface of the latter was even and smooth, and very probably therefore the spinal cord had not been pressed upon. The intervertebral discs had certainly not been ossified, and the upper and lower surfaces of the bodies were apparently free from disease.

The articular surfaces, on the other hand, were practically immobilised by the complete ossification of the fibrous tissues round them, and all these changes had made the whole vertebral column incapable of flexion, extension, or lateral movements. This condition, sufficiently serious in itself, had been aggravated by the extension of the disease to neighbouring tendons and muscles. The vertebral groove in the lumbar region being filled by a mass of spongy bone, and the dorsal and cervical regions being affected by lesions similar, though less severe, the muscles originating from the lumbar region—the latissimus dorsi, serratus posticus inferior, spinalis dorsi, erector spinæ, interspinal muscles, etc.—have been considerably interfered with. Similarly, the attachments of the dorsal and cervical muscles were not normal, and their efficiency being lessened thereby, the movements of the arms, neck, and thorax were certainly rendered more difficult. The movements of the head also had been affected by the extension of the disease to the internal borders of the condyles.

Respiration, already impeded by the rigidity of the vertebral column and the pathological changes in the spinal muscles, was impeded still further by the ossification of the costo-vertebral articulations and costal cartilages and by the old fracture of the first right rib. The patient's misery had been increased by the pain accompanying the movements of the pelvis, hip-joints, knee-joints, shoulder-joints, and of several other articulations. The head, neck, back, and limbs were motionless, and the man, unable to turn round on his couch, to sit up, to attend to any necessities of life without assistance, was a typical chronic and helpless invalid for years before death.

Perhaps in this case the disease did not extend to the smaller articulations, in contrast to the following case, in which the smaller articulations had been undoubtedly attacked. The fragments of this second skeleton, found by Professor Flinders Petrie in a tomb of the IIIrd Dynasty near the Fayoum Pyramid, were those of a short adult,

whose age and sex are not ascertainable, and were remarkable on account of the gravity of the pathological lesions.

Some osseous overgrowth existed at the point of attachment of the cervical transverse ligament, and was most marked on the left side, where the new bone formed a kind of cushion about 4 mm. long, 3 mm. broad, and 3 mm. thick, projecting upwards from the anterior arch on the same side. The tubercle on this arch was greatly thickened, whereas the superior articulating surfaces were normal. The odontoid process of the axis was very irregular in shape and was capped by an osteophyte quite 5 mm. long. The inferior-anterior border of the body was prolonged into a spear-shaped point. The articulating surfaces were normal.

The fourth (?) cervical vertebra was much thickened round the body, especially anteriorly. The inferior-anterior border sent off a thick prolongation downwards, and the worm-eaten and rough appearance of the body suggested that there were some pathological changes in the intervertebral discs also. The cervical vertebrae (fifth and sixth) were firmly joined by the anterior and posterior common ligaments. The disease had not extended to the articulations.

Only two of the dorsal vertebrae were found, and both showed great thickening on the anterior and lateral borders of the body, where the new bone measured as much as 4 mm. in thickness. The only lumbar vertebra present, namely, the first, had a mass of new bone, 8 mm. thick, occupying the superior left lateral border.

Only one metatarsal bone and two phalanges were discovered. The metatarsal bone was greatly thickened at both ends, and the second and terminal phalanges of one finger were firmly ankylosed in a fixed position.

The pathological changes in this skeleton resemble those of the first. The anterior and posterior common and periarticular ligaments were ossified throughout the whole length of the vertebral column, and the articulations of the smaller bones of the hand and foot of the second skeleton were attacked also. The disease had probably attacked many of the small joints, as the only two bones that were found showed severe pathological alterations.

Although both these bodies dated only from the IIIrd Dynasty (2980-2900 B.C.), osteo-arthritis existed long before that period in Egypt and in Nubia.

The specimens next to be described were discovered in the necropolis of Kawamil⁽⁸⁾, and were examined by my friend the late Dr. Fouquet, who described under the name of Mal de Pott the typical pathological alterations of spondylitis deformans.

Kawamil is situated 515 kilometres south of Cairo, and the district contains many necropoles and Kjoekken-Moeddings dating from the Neolithic and the first Pharaonic periods. Two cemeteries near the village of Aoulad-Haroun are of special interest: the first on the north side, with some thousands of native tombs and pottery characteristic of the Neolithic epoch; the other more to the south, with graves less ancient, containing bodies skeletonised before inhumation in cysts made of clay or crude bricks, or in large pots.

Kjoekken-Moeddings with worked stone implements, fragments of bones, vases, and small bronze objects, are found in the desert between

the two cemeteries, and one little hillock is made up of an enormous quantity of droppings of antelopes and gazelles.

The age of the bones discovered at Kawamil is therefore somewhat uncertain, and the difficulty is increased by the fact that in his papers Dr. Fouquet did not say in which cemetery the bones described by him were found. In conversation, however, my late friend told me that the bones came from the Pre-dynastic cemetery on the north. An estimate of 6000 years for the age of these bones is therefore not exaggerated.

The bones to be first described belonged to a man supposed to have been approximately 40 years old at the time of his death. The specimen consisted of two lumbar vertebræ, the bodies of which were strongly united by massive bilateral bridges of bone and by an anterior median band, "*séparant 2 ouvertures d'abcès par congestion, dans le canal desquels on aperçoit des bourgeons osseux en voie de formation.*" These layers of new bone were fairly thick with powerful exostoses, whereas the transverse and spinous processes were normal.

The drawing illustrating Fouquet's paper shows no sign whatever of an "*abcès par congestion.*" There is no appearance of ulceration nor of any lesion of the bodies of the vertebræ, and the new bony growth is confined entirely to the ligamentous structures binding together the vertebræ. The intervertebral space was not narrowed, and appeared to be normal.

The second specimen also consisted of two lumbar vertebræ, enclosing a patent and not narrowed intervertebral space. The bodies of the two vertebræ were immobilised on the right side by an irregular bony bridge and by a similar narrow, smooth, and very prominent bridge on each side in front, whereas the articular surfaces were fixed by irregular, thin, narrow, osseous bands. The vertebral bodies were solid and resistant and the spongy tissue was not rarefied. In several places, and especially anteriorly, there were depressions hollowed out by small vessels, around which there were doubtful traces of suppuration. The specimen apparently came from a man (?) who died young. The third specimen also presented lesions similar to those of the first, that is, lesions typical of spondylitis deformans.

On the whole, therefore, the lesions of the Kawamil vertebræ, dating from the epoch of chipped flints, greatly resemble those of the vertebræ from the IIIrd Dynasty.

The remains of many of the Nubian skeletons of the Late Pre-dynastic and Early Pre-dynastic periods had lesions typical of spondylitis deformans, and so common was this disease in early Nubian epochs that "in the prehistoric cemetery in the main street of Shellal, near Assuan, no adult body failed to show some traces of its presence." The lesions naturally differed greatly in severity, varying from a mere lipping of the adjacent edges of individual to the involvement of several vertebræ, and even to the ankylosis of a series (Plate VII. Fig. 6).

Very commonly, two or more lumbar vertebræ of prehistoric skeletons were held together by connecting, irregular, osseous bridges, which however were sometimes limited to one side of the anterior surface (Plate VII. Fig. 7).

Proof has already been adduced that, in Egypt, the disease appeared very early, but the extent of its spread cannot be estimated. For example, the fifteen Pre-dynastic bodies unearthed in Tourah, near Cairo (⁹), were normal; and of the IIIrd Dynasty skeletons from the same place only one showed "lipping" and "absorption" of the vertebræ from the second cervical vertebra downwards. The old pyramid builders paid their tribute to spondylitis, and in one case the whole spinal column was found converted into a solid block.

The evidence regarding the existence in the Delta of this disease in very ancient times is not forthcoming, because, for obvious reasons, ancient skeletons have not been found in the Delta, but, considering it was not rare in that part of the country during the Greek, Roman, and early Christian periods and is fairly common now, it is more than probable that it was not rare during the Dynastic era. The frequent occurrence of spondylitis deformans in Nubia during the early periods has been alluded to already, but it must not be assumed, as has been done more than once, that every Nubian was thus afflicted.

The new cemetery (17) at Shellal, for instance (¹⁰), situated on the east bank of the river at Khor Baha, contained the remains of people of the Early and Middle Pre-dynastic times, which were in a poor state of preservation, and skeletons of Early Dynastic times (A-group) and Late Ancient Empire periods (B-group). Of the 104 graves, six contained fragments, six contained children, and three were occupied by dogs, and not by human skeletons. Four cases of spondylitis were found in the eighty-nine graves remaining, and of these one had arthritis of the knee and other articulations as well.

The cemetery of Dabod contained a series of Archaic remains, ranging from the Late Pre-dynastic period on to the Middle Empire, and a group of bodies dating from the New Empire.

The Archaic series included bodies belonging to the late Pre-dynastic and Early Dynastic (A-group), to the Archaic Nubian Middle Empire (or C-group), and the characteristics of these bodies closely agreed with those of the remains of similar dates found near Shellal. The Late Pre-dynastic and A-group skeletons conformed to the Pre-dynastic Egyptian type, whereas the Archaic and Middle Nubian people had been evidently tinged with Negro blood.

An analysis of the notes showed that in thirty-four undated graves three skeletons showed lesions of spondylitis. The lesions of the vertebræ were complicated by osteitis of the pelvis and arthritis of the knees in one case, and by arthritis of the metatarsals in another.

After a large number of burials had been eliminated, because they contained either children or animals, there were left—

Twenty-five Archaic bodies with ten cases of spondylitis.

Seven Middle Nubian bodies with two cases of spondylitis.

Twenty-seven New Empire bodies with three cases of spondylitis.

Forty per cent. of the Archaic inhabitants therefore had been attacked by spondylitis, sometimes complicated by other severe arthritic lesions, such as arthritis of the knee (Plate VIII. Fig. 8) and osteitis of the pelvis, arthritis of the left shoulder-joint (Plate VIII. Fig. 9), accompanied by great eburnation, and ankylosis of the pelvis (Plate VIII. Fig. 10).

Cemetery 30, on the eastern side of the river, included skeletons from the Middle Pre-dynastic and Early Dynastic period, and from the Middle Empire C-group and the New Empire group. The Pre-dynastic bodies were in a fair state of preservation, in contrast with those of C-group and New Empire date, which were not so useful for our purpose.

The New Empire graves need not be considered, as there are no notes concerning them; four cases are also useless for other reasons; and there remain notes of five Archaic skeletons, of which three had spondylitis, and of twelve Middle Nubian bodies with four cases of spondylitis.

Cemetery 40 included burials from the Early Dynastic, New Empire, and Christian periods, but the Notes of the Early Dynastic series alone are available for our purpose. Of the twenty-nine bodies mentioned, two must be eliminated, and there are then left twenty-seven skeletons with nine cases of spondylitis.

The incidence of this disease during Pre-dynastic and Dynastic times in Upper Egypt is not known, but for reasons to be explained afterwards it can be assumed that the incidence was probably very great.

It will be convenient here to study this disease as it appeared in Nubia, and in Alexandria during the period beginning at the time of the Greek occupation 332 B.C. to about 300 A.D., that is, roughly 600 years. The huge gap this left in our historical study will be filled up later on, as far as possible (see p. 172).

The examination of the mummies found in Cemetery 3, on the island of Hesa, in Nubia, gives an idea of the conditions prevailing in Nubia during the Ptolemaic period. The mummies had been put into coffins of stone or pottery, which had been buried in chambers carved out of a granite hill. The bodies were those of the priests of Philæ and of their women and children, who lived during the second or third century B.C. The information concerning the pathological lesions in these people is not very satisfactory, as, owing to the bad preservation of the bodies, complete examination of them was impossible. Still, the fact remains that five skeletons with spondy-

litis, sometimes very severe, were found among sixty-four skeletons examined.

Farther south, in a Roman cemetery (14), which contained but few bodies, several skeletons with spondylitis were discovered. A young man, whose lumbar vertebræ showed much lipping, had also characteristic arthritis of the knee and elbow. Two lumbar vertebræ of another man with extreme spondylitis were firmly ankylosed, and he had suffered also from some inflammatory process in both tibiæ and fibulæ.

In the Romano-Nubian group (X-group) of Cemetery 13, situated higher up on the river and dating approximately from the second to sixth century A.D., several cases of spondylitis were found.

On the west bank of the Nile, opposite the island of Markos, the field notes referring to a group of twenty-four bodies (Cemetery 42), dating from the Byzantine period, mention one case of extreme spondylitis and one of arthritis of the knees.

A few personal observations made at Meroë in the Sudan and at Faras may be mentioned here, although they refer to a somewhat earlier period, namely, to that of the Meroitic Kingdom.

During the winter of 1913, the writer had an opportunity of witnessing for a few days the excavations then in progress at Merawi (Sudan). Professor Griffith of Oxford, who was directing the work, gave every facility for studying the skeletons still in the graves, and the skulls and bones which he had collected at Merawi, and also the specimens which he had dug up at Faras in 1912.

Merawi is situated on the Nile (18° N.) close to the ancient Napata, and must not be mistaken for another village of the same name which is situated farther south: Faras lies a few miles north of Wady Halfa, not far from the Second Cataract of the Nile.

At Merawi, owing to the very bad state of the bones, no case of arthritis was met with, until at length three lumbar vertebræ with marked lipping of the anterior borders of the bodies were found in one grave. Two lumbar vertebræ in another grave showed some lipping of their borders, and were held together on one side by a strong bridge of new bone, measuring about 15 mm. in width and about 5 mm. in thickness.

At Faras, the vertebræ were very few and badly preserved. Three sacra, however, showed signs of spondylitis deformans. The disease, therefore, existed at Merawi and Faras, two of the hottest and driest places in the world.

The skeletons from Alexandria, with the coldest and wettest climate of Egypt, came from many graves and belonged to various nationalities.

The first part of this material was found at Chatby, near Alexandria, about two minutes' walk from the sea, in the tombs of the Macedonian soldiers of Alexander the Great and Ptolemy I. In

view of the constant growth of the modern town, which will soon extend over the whole of this region, the Municipal Commission ordered an archæological survey of this site. The work was entrusted to Professor E. Breccia, who gave Dr. Rietti and myself permission to examine most of the bones found in the Necropolis, and to be present during the excavations. Professor Breccia has since given a full account of his work in two magnificent volumes ⁽¹¹⁾.

Owing to a lawsuit the work has been suspended for a time; this delay is specially unfortunate, because the names of the tombs to be yet opened indicate that these contain the skeletons of the ladies of pleasure who accompanied the Greek army. Here, if anywhere, evidence of gonorrhœa and syphilis should be found, if venereal disease really existed at that period.

The bodies were in rock-hewn graves, the first grave being an ossarium, measuring about 2 cubic metres, filled with sand and bones, and closed with a stone slab, the edges hermetically sealed with mortar. The bones, after the bodies had undergone decomposition elsewhere, had been thrown pell-mell into the ossarium, and evidently little care had been taken, for the femur of a horse was found among the human bones.

The other sepulchres were horizontal shafts, $3\frac{1}{2}$ feet high, 6 feet deep, and about $3\frac{1}{2}$ feet wide, cut into the sandstone rock in the same manner as the ossarium. Very rarely, such a tomb contained but one body lying on a layer of sand about 6 inches deep; as a rule several skeletons, five, six, or even more, were present. The small size of the shafts was proof positive that the bodies had not been put in together, and that putrefaction had destroyed the soft parts of the first body before the second had been introduced.

Funereal urns filled with ashes or half-carbonised bones were also discovered. The Greeks of that period therefore were eclectic in their customs, some families burying, others burning their dead.

Unfortunately, the level of the land had sunk several feet since the last inhumation. Hence some tombs were partially filled, others merely infiltrated with sea-water, and the bones were often found lying in thick wet mud. Such skeletons were in very bad condition, and most of the smaller and some of the larger bones could not be found, even when the slush was removed carefully by hand; but although, as might be expected, the bones in dry graves were naturally rather better preserved than those in a wet bed, yet this was by no means the rule. The skeleton of a female, for instance, lying on a bed of dry sand was so fragile that some of the bones were broken when their careful removal was attempted; on the other hand, bones lying in liquid mud were sometimes very hard, while others from the same grave broke as soon as touched.

Sometimes the soldiers had been buried with their wives and children. It is much to be regretted that infantile skeletons were

useless for pathological research, as hardly a single one of their bones was preserved sufficiently well for examination.

A superficial examination sufficed to show that various races were represented. Some of the thirty-two skulls examined had high-bridged noses, others remarkably flat ones; some were brachycephalic, others markedly dolichocephalic, and two were evidently negroid. The variations in stature were also considerable, some men being very tall, others small. These differences are not to be wondered at, considering that from the start Alexander's army was distinctly a "mixed" crew. Of the 30,000 foot soldiers who left Greece with Alexander, only 12,000 were Greeks (Smith's "Classical Dictionary"); the others were foreigners, chiefly Thracians.

It is highly probable that the Greek and foreign soldiers settled in Egypt had intercourse with and often married native women, just as their successors have done in modern times. The present Berberine, especially when coming from Korosko, often boasts that he is a descendant of a Turkish soldier and a native woman; and the term Turk as used by the Berberine, includes Greek, Herzegovinian, Bosnian, Bulgarian, and Serbian—in fact, any one who has served in the Turkish army. Similarly, the population of Alexandria under the Ptolemies included Macedonians, Greeks, Syrians, Jews, Persians, etc., and the nucleus for the future population of Alexandria already existed in Alexander the Great's time.

Mahaffy draws special attention to the false impression given by most authors, that Alexandria was a city in which the Jews and Greeks counted for everything, the natives for nothing. On the contrary, the majority of the poorer classes was from the beginning Egyptian, and to the last the city remained very different from other Hellenistic foundations. The native element, though at first thrust out from power and influence, gradually reasserted itself, and the city that opposed Cæsar was probably far more Egyptian than that which opposed Antiochus Epiphanes.

Old Alexandria, therefore, may be compared to the modern town, where although the greater part of the wealth and power is in the hands of the Europeans, any law repugnant to native ideas or customs speedily becomes a dead letter.

The extent of intermarriage between the various people inhabiting Alexandria cannot be estimated, but that they did live in very close association is shown by the fact that, during the Roman period, many inhabitants had two names, one Egyptian and the other foreign.

The possible influence of race and environment on the pathology of Ancient Egypt may perhaps be discussed on another occasion, but these few lines suffice to prove that an attempt to unravel this question by the study of material collected in Alexandria can lead to no practical conclusion.

The catacombs of Kom-el-Shougafa, situated close to Pompey's

pillar at Alexandria, date from the second century after Christ, and most of the skeletons were those of the members of a mixed Græco-Egyptian population. The tombs contained hundreds of skeletons, most of which, owing to the gradual infiltration of water, were practically useless for our purpose. The supposition that these catacombs contained the skeletons of the Alexandrian youths massacred by Caracalla is disproved by the fact that many skeletons were those of women and children.

The mode of burial was almost identical with that at Chatby. The first body had been placed on a layer of sand about 4 inches thick, and later on it had been pushed aside to make room for a second occupant. The loculi contained fragments of eight and ten bodies, and as the size of the tombs precludes all possibilities of more than two or at most three bodies having been buried at any one time, it follows that this process had been repeated more than once. So far, the writer has seen no trace of cremation or mummification at Kom-el-Shougafa.

In 1912 very few of the skeletons had been examined for pathological lesions. Since then, fragments from over 150 adults have been studied, but the state of the skeletons was such that not a single skull could be reconstructed. Some of the loculi had been rifled by tomb robbers in ancient times and by modern archæologists, and in both cases the result had been the same: the bones had been thrust aside into a heap in one corner of the tomb and most of them had been broken. No statistics, therefore, were available concerning the incidence of any disease.

At Ras-el-Tin, in a garden of His Highness the Sultan's palace, a workman engaged in sinking a well suddenly slipped into a catacomb in which many hundreds of bodies had been placed. This catacomb is made up of a number of passages, lined on each side with loculi containing skeletons. A full archæological account will be given later on by the curator of the Alexandria Museum, who allowed me to remove some of the bones in the short time during which the underground passages remained open.

Archæological observations make it certain that the people buried there were Egyptians, and that the tombs date from the days of Cleopatra. The Egyptian origin of the skeletons is confirmed by the fact that most of the bodies had been embalmed, for the majority of the skulls had been perforated for the removal of the brain, according to the classical Egyptian method. Remnants of embalming material were entirely absent, except for a few very small fragments of plaster masks and mummy cases, and some small amount of gummy material in a few skulls. The bandages wrapped round the body had not been proof against the dissolving action of the wet sand, which in the course of twenty centuries had filled the catacombs. This state of things is to be regretted, the more, since practically nothing is

known of the methods of the embalmer's craft in the Delta ; but as the embalming material disappeared quickly it probably consisted of some easily putrescible substance such as linen, and not of earth, sand, resin, pitch, bitumen, nor any resistant vegetable matter. Whatever the method may have been, it proved a complete failure.

The loculi were roughly 6 feet long and 3 feet high, and 5 or 6 perforated skulls and the remains of a like number of skeletons were discovered in some. By no amount of force could such a number of bodies have been squeezed into that space ; clearly, therefore, the first and second mummified body had fallen to pieces before the third and any of the others were introduced. Another unavoidable conclusion is, that the loculi were in use for a fairly long time, some centuries possibly.

Spondylitis deformans was obviously very common among the people buried at Chatby, though, for reasons just explained, this conclusion cannot be based on accurate statistics. The thirty-two skulls found do not represent the truth, and a larger number were undoubtedly buried, as the number of skulls does not agree with that of the mandibles or right femurs. Judging from the number of the latter, it is certain that at least forty adults or fragments of forty adult bodies were put to rest in the graves examined at Chatby.

One complete skeleton was obtained. It was that of a young woman whose third molars had not quite emerged, and was in a very bad state of preservation, the skull and smaller bones falling to pieces when a careful attempt was made to remove them. The whole spinal column from end to end showed early signs of spondylitis deformans, namely, overlapping of the anterior borders of the vertebræ, and enlargement, eburnation, and ankylosis of the articulating surfaces.

In other graves many vertebræ were found ankylosed, or, when separate, in such a position that there could be no doubt that they belonged to the same body. A few typical examples of these lesions are now given.

Ankylosis of the articulating surfaces between the axis and the third cervical vertebra was the characteristic lesion of one skeleton. Moreover, the posterior borders of the bodies were firmly bound together by new bone which had developed in the posterior common ligament. The odontoid process was very rough, especially at the lower borders of the groove for the transverse ligament, and its rough and asymmetrical tip was capped with newly formed bone (Plate VIII. Fig. 11). The inferior articulating surface of the third vertebra was greatly enlarged and surrounded by osseous outgrowth, and a long spur of bone projected from the inferior-anterior border of the body.

The third, fourth, and fifth cervical vertebræ of another skeleton were firmly joined together. The upper and lower borders of the bodies, especially those of the sixth, though somewhat thickened, were otherwise practically normal. The disease was chiefly confined to the articular surfaces, which with two exceptions were almost double their normal width, flattened and fixed to one another by thick new bone.

Similar changes disfigured the dorsal region of many spinal columns. One osseous block consisted of three dorsal vertebræ.

The upper border of the body of the highest vertebra was thickened, especially in front, where the new bone was at least 5 mm. thick. The right lower border had thrown out a flat osteophyte, 10 mm. long and 20 mm. broad, which met another osteophyte projecting upwards from the vertebra below, and the upper and lower articulating surfaces were very rough, irregular and enlarged. Similar lesions were present in the next vertebra, and, further, the border of the surface articulating with the tubercle of the rib was deformed. The roughened superior-anterior border of the last vertebra had thrown out a strong osteophyte which met a similar projection from the preceding vertebra. The superior and inferior articulating surfaces showed all the changes characteristic of spondylitis deformans. The costo-vertebral articulating surfaces were enlarged, rough, and almost worn away.

Such ankylosed masses were of common occurrence, and the large majority of the dorsal and lumbar vertebræ showed more or less profound inflammatory changes. Two lumbar vertebræ, for instance, were firmly bound together by a strong mass of new bone extending right round the bodies of both, and strong prolongations at each extremity proved that the disease extended to the vertebræ both above and below.

The disease also attacked the sacrum and pelvis. Firm ankylosis between the sacrum and the right iliac bone existed in two cases, and in two others the fifth lumbar vertebra and the sacrum were firmly joined by strong osteophytes. In another skeleton a strong osteophyte extended upwards from the left anterior superior border of the sacrum to the fifth lumbar vertebra.

Typical spondylitis deformans, therefore, existed among the Greeks and other settlers in Egypt at the time of the Ptolemies.

The manifestations of the disease in the mixed population buried at Kom-el-Shougafa were not less interesting. Two tombs containing eight adult bodies were examined in the first investigations of this catacomb, and no less than four skeletons exhibited typical lesions of spondylitis deformans.

One skeleton resembled that of the IIIrd Dynasty described above, the whole vertebral column having been converted into a rigid block. The anterior, posterior, and lateral common ligaments in the cervical and lumbar regions were so completely ossified that a glimpse into the intervertebral spaces was obtainable here and there only. Similarly, all movements of these regions were arrested owing to the articulating surfaces being tightly held by dense new bone. The spinous processes of the cervical vertebræ were normal, whereas those of the lumbar vertebræ were connected by a strong bridge of bone which had developed in the supraspinous ligament. The lesions of the dorsal region, though severe, were on the whole less serious than those of other parts of the vertebral column. The limitation of movements due to the strong osseous bridges connecting the bodies of the vertebræ anteriorly was undoubtedly very great, but there was not that complete ossification of all the ligaments which was conspicuous both above and below that region. In fact, the borders of the bodies of the dorsal vertebræ were free from disease for more than two-thirds of their lengths. The

articulating surfaces also were not so tightly bound together, though bony excrescences due to severe inflammation were conspicuous. The costo-central and the costo-transverse articulating surfaces were normal, whereas the peri-articular ligaments were ossified more or less completely.

Other tombs of Kom-el-Shougafa, cleared in 1913, yielded the fragmentary remains of over 200 adults, and ten axis vertebræ, out of forty which were collected, showed distinct pathological changes. The articulating surface of the odontoid process with the atlas was sometimes enlarged and sometimes eburnated, the tip was often capped by new bone, very irregular in shape, and sometimes curved like a Phrygian cap.

The sacrum was affected by osteo-arthritis in the same proportion, namely, 25 per cent., and the proportion of diseased cervical, dorsal, and lumbar vertebræ was nearly 40 per cent.

The contemporaries of Cleopatra buried at Ras-el-Tin, two centuries previously, were similarly affected. The whole lumbar and dorsal vertebræ of one case were firmly bound together by osseous bridges, and in consequence the curvature of the vertebral column was such that the patient must have been doubled up when he stood (Plate VII. Fig. 3). More probably, however, he could not stand up at all. Numerous osseous blocks were found consisting of two, three, or more vertebræ from various parts of the vertebral column (Plates VIII. and IX. Figs. 12 and 13), and from an examination of a considerable number of fragments, the conclusion was reached that the incidence of this disease was not less than 30 per cent., and was probably somewhat higher.

About eighty miles west of Alexandria, the traveller finds the ruins of the ancient sanctuary of Abou Menas, which, during the Early Christian period, was a pilgrimage place visited by sufferers. The crowds of sick pilgrims brought back to their friends holy water contained in special bottles, which have been discovered as far as Mainz in Germany, and in England, France, etc., and this fact clearly proves the high esteem in which the Abou Menas water was held. The exact date of the foundation of this ancient Lourdes is not known, but it was certainly not later than the fourth century A.D., and the popularity of the shrine lasted until its destruction by the Arabs.

The archæologist who brought these ruins to light, laboriously noted every bit of glazed pottery or fragment of stone, etc., which littered the site, and recorded his observations in a very elaborate illustrated work. His soul, however, was clearly above such trifling things as human remains, for, one year after he had left, a number of skulls, vertebræ, and limb bones were found thrown about the passages and elsewhere, but most of the contents of the graves are lost for ever. A similar state of things exists at Abousir, where the graves near the sea, dating from a perhaps slightly earlier period, have also been rifled almost completely. A few bones alone had been left *in situ* by the tomb robbers.

This neglect is all the more regrettable in that many skeletons must have been those of patients who suffered from some chronic disease for which they had sought relief at this miraculous spring, and an examination of their skeletons would have revealed curious facts concerning the pathology of Early Christian times.

Among the very few vertebræ discovered at Abou Menas were—(1) An axis, with a typical cap of new bone of the odontoid process, and signs of inflammation on the outer border of the inferior articulating surface. (2) A cervical vertebra, probably the fifth, with its left upper articulating surface greatly enlarged and eburnated, and much osseous overgrowth round its inferior border. The right lower articulating surfaces showed similar changes (Plate IX. Figs. 14 and 15). (3) Three dorsal vertebræ from one grave with marked thickening of the anterior borders, and inflammation round the costo-vertebral articulation. (4) Four lumbar vertebræ with great thickening and formation of osteophytes of the anterior borders. The interspinous ligaments had also been affected, for the spinous processes were very rough.

It has been shown that spondylitis deformans existed in Nubia from the earliest periods down to the Christian era, that is, for a period of eighty centuries at least. In Lower Egypt, that is, round Alexandria, it has been traced from the time of Alexander down to the time of Abou Menas, that is, for another period of 800 years. The data regarding the incidence of this disease in Upper Egypt may now be examined (refer to p. 164).

Facts previously enumerated prove that the disease existed in the Pre-dynastic period, at the time of the pyramid builders and in the IIIrd Dynasty, and, indeed, the case of Nefermaat (refer to p. 158), a rich man of that dynasty, is one of the most typical on record.

The lesions now to be described were observed in the skeleton of a mummy of the XIIth Dynasty (2000–1788 B.C.), given to me by the late Sir Gaston Maspero.

This woman had died at an advanced age, for the sutures of the skull, with the exception of the squamous suture, were ossified. The teeth were deeply worn, and the alveoli of the left maxillary, first premolar, and all three left molars, and the right second and third molars were obliterated. The left maxillary canine was carious.

The first four cervical vertebræ were normal; on the fifth there was a strong osteophyte growing from the anterior-inferior part of the body. The sixth cervical was normal, whereas a strong osteophyte occupied the left anterior-inferior border of the seventh.

The dorsal vertebræ were healthy, with the exception of the ninth and tenth, the adjoining borders of which were united in the middle line by a thick osteophyte about 15 mm. long and 3 mm. broad at its base. The second and third lumbar vertebræ showed some lipping. The spinous processes from the tenth dorsal to the second lumbar vertebra were joined together by a bridge of new bone.

The lesions therefore, though not severe, were typical.

Skipping a period of a thousand years, let us now examine a skeleton from the XXnd Dynasty (945–743 B.C.) given me by Pro-

fessor Flinders Petrie. The vertebral column showed the following changes:—

The atlas was normal except that a flat osteophyte, almost 10 mm. long, surrounded nearly half the outer border of the right upper articulating surface. Another small osteophyte protruded from the posterior border of the left upper articulating surface.

The extremity of the left transverse process of the atlas was much thickened, and was longer and broader than its fellow of the right side. The foramen for the left vertebral artery was not completely closed.

Distinct rough new bone extended along the inferior-posterior border of the body of the fifth cervical vertebra, and all round the superior and inferior borders of the body of the sixth. Each vertebral foramen was divided into two unequal parts by a thin spiculum of bone.

Seventh cervical.—New bone extended round the upper border of the body, and was more marked on the right side. The foramen for the right vertebral artery was narrowed by osseous growth to one-fourth the size of that on the left side.

First dorsal (Plate IX. Fig. 16).—Rough new bone along the superior-anterior border, extending for about 3 mm. down the body of the vertebra. The left costo-vertebral articulating surfaces of the first, tenth, and eleventh dorsal vertebrae showed marked signs of inflammation.

First lumbar.—Distinct thinning of the body.

Second lumbar.—Distinct roughening and formation of osteophytes on the borders of both superior and on the right inferior articulating surfaces.

Third lumbar.—New bone round the anterior part of superior border. A thin ridge of bone was prolonged on the left of the middle line along the anterior part of the body into a thick osseous excrescence which almost surrounded the lower border; this was especially marked on the left side. The right superior articulating surface was very rough, and its borders were surrounded by a ring of new bone (Plate IX. Fig. 17).

Fourth lumbar.—A very thick layer of new bone extended round the anterior border, especially on the left side, and in the middle for some distance on the body of the vertebra down to the left lower border. Much new bone had formed at the base and behind the left superior and inferior articulating processes.

Fifth lumbar.—New bone right round superior border extending downwards along body nearly for 10 mm.

We now again skip a period of approximately 500 years, and examine a skeleton dating from the time of the Persian occupation of Egypt (about 500 B.C.).

All the vertebrae were present, except the axis and the seventh cervical, which could not be found.

Atlas.—The facet for the odontoid process was surrounded above and laterally by a strong layer of rough new bone. From the shape of the facet, it was evident that the odontoid process, instead of pointing directly upwards, was bent slightly backwards. The right tubercle for the attachment of the transverse ligament and the bone just below the right condylar process were slightly roughened. The foramen in the right transverse process was not completely closed.

Third cervical vertebra (Plate VIII. Fig. 11).—The upper and lower surfaces of the body were deeply hollowed, especially the former, the hollow of which was nearly 10 mm. in depth. Its upper surface was very rough. Some formation of new bone along the anterior lower border, where the new bone was approximately 2 mm. thick. The whole body was very thin, measuring about

5 mm. in thickness, and there had been a good deal of absorption of bone on the inferior surface laterally.

Fourth cervical.—This showed the same lesion, but the osteophyte along the anterior-inferior border was stronger and irregular. The body was distinctly atrophied and less than 5 mm. thick.

Fifth cervical.—Marked hollowing of upper surface of the body. Formation of new bone along the upper anterior border, and, to a less extent, along the upper posterior borders. Lower surface practically normal. Thickness of vertebra = 6 mm.

Sixth cervical.—No new bone; the body about 12 mm. thick.

Seventh cervical.—Missing.

Sixth dorsal.—The left lower articulating surface very irregular in shape, rough, and nearly double the size of its fellow, on account of the formation of new bone round it.

Seventh dorsal.—The right upper and lower articulating surfaces very irregular in shape and double the size of their fellows. The bodies of both these vertebrae were somewhat thinner on the right side.

Eighth dorsal.—The left inferior articulating surface was greatly enlarged and very irregular, with some thick new bone growing round it. The anterior-superior border of the body was somewhat rough. The inferior border of the body was rough and there was an osteophyte 3 mm. thick and about 10 mm. long on the right side. Both upper articulating surfaces were very irregular and rough, owing to formation of new bone, especially on the left side.

Right side of body distinctly atrophied.

Ninth dorsal.—Lower articulating surface was very rough and irregular, especially on the left side. Upper articulating surfaces fairly smooth but very irregular in shape. Upper border of the body has thrown out an osteophyte (25 mm. long and 10 mm. broad), which met a similar osteophyte projecting from the vertebra above. Distinct atrophy of the right side of the body of the vertebra. Lower border of body has thrown out an osteophyte similar to that from the upper border, the two being joined by a strong pillar of new bone. The upper costo-central facet was enlarged, rough, surrounded by new bone and so altered as to be almost unrecognisable.

Tenth dorsal (Plate IX. Fig. 18).—On the right superior border, a strong osteophyte met one descending from the vertebra above. Upper articulating surfaces irregular, but almost normal otherwise. Distinct atrophy of right side of body. Some slight formation of new bone along the right inferior border of body.

Eleventh and twelfth.—Practically normal.

First lumbar.—Normal, except for some slight thickening round the left superior articulating surface.

Fourth and fifth lumbar.—Some thickening around upper border of body.

The lesions in these three skeletons, though not so marked as in others already described, are quite typical and prove the existence of spondylitis in Egypt during the period of roughly 1500 years, extending from 2000 to 500 B.C.

We will now pass over another thousand years and examine some Coptic bodies found at Antinoë, and dating from about 500 A.D.

In the first, the spondylitis was limited to the first five cervical vertebrae. The atlas showed slight thickening of bone on the anterior side round the facet for the odontoid process. The axis was normal, except that the tip of the odontoid process was covered by a cap of new bone measuring 3 mm. x 3 mm. The upper articulating surfaces of the third cervical vertebra were enlarged as compared with the corresponding lower ones, the left upper

surface being only slightly enlarged, whereas the right measured 15 mm. by 13 mm. Bone had been deposited on the borders, and the articulating surface itself had a worm-eaten appearance. The right upper and left lower articulating surfaces of the fourth cervical and the left upper articulating surface of the fifth were greatly enlarged and honeycombed, whereas the lower articulating surface of the fifth and the vertebral column generally were normal.

In the next case, in which arthritic lesions in other parts of the body were severe, the alterations in the spinal column merely consisted of some lipping between the adjoining borders of the second and third, and between the sixth and seventh cervical vertebræ, and in the dorsal and lumbar regions from the seventh dorsal to the fourth lumbar. The lesions were most marked in the dorsal region where the new bone formed a thick irregular festoon round the anterior border. The last lumbar vertebra, the sacrum and coccyx, were normal. Another case was that of a very muscular man, whose ensiform cartilage showed a curious defect in ossification (Plate IX. Fig. 19).

Cervical vertebræ, Atlas.—Formations of new bone from superior border of anterior arch, so that the tip of the odontoid process was overlapped (Plate IX. Fig. 20), by bone growing from the atlas. Inferior articular facets of the third cervical vertebra greatly enlarged especially on the right side, where they were rough and irregular, with a thin line of new bone on the inner border. The superior articular facets of the fourth cervical vertebra were correspondingly enlarged, especially the right one, which measured 20 mm. from above downwards. The third dorsal vertebra had a strong anterior median ridge of new bone projecting for about 12 mm., which fitted in with a similar ridge on the fourth. Similar lesions existed from the sixth to the ninth dorsal vertebræ both inclusive, and were especially marked on the two last, where these ridges formed a lateral prolongation, 10 mm. broad at the base and projecting externally for 12 mm.

The lesions of osteo-arthritis in the vertebral column of Copts were sometimes slight, consisting merely of some lipping of the anterior borders of two, three, or more vertebræ. The lesions in one vertebral column were limited to periarticular inflammation of one (twelfth) costo-vertebral articulation, which was enlarged, white and ivory-like. The head of the corresponding rib was enlarged and showed strong periarticular exostoses.

To sum up: spondylitis deformans has existed in Nubia and Upper Egypt during the Pre-dynastic periods, in the Early, Old, Middle, and New Dynastic and Ptolemaic Kingdoms, during the Roman occupation, and later.

II.

LESIONS IN THE VERTEBRAL COLUMN.

Osteo-arthritis of the vertebral column having been proved to exist in Egypt from the earliest times, the more minute description of the lesions in the vertebral column may now be proceeded with. No attempt to deal with the subject in a chronological order will be made, as the facts just enumerated have shown that, in the main, the lesions of chronic articular or periarticular disease present the same characteristics in Archaic Nubians as in Pre-dynastic, Dynastic, and Ptolemaic Egyptians, the inhabitants of Alexandria during the Greek and Roman

periods, and the Copts of Early Christian times. The pathological anatomy of spondylitis did not vary during this period of 8000 years. Further, it is clear that geographical distribution did not influence the course or incidence of the disease, since specimens from Lower Egypt, Upper Egypt, and Nubia showed that the frequency, nature, and severity of the lesions were unaffected by varying climatic conditions.

Probably the earliest and certainly the most characteristic lesion was the growth of an osteophyte from the anterior-lateral borders of the body of one or more vertebræ. As a rule, three, four, five, or more were attacked, although very occasionally the disease was limited to one or two vertebræ. When the disease had started from the borders of two neighbouring vertebræ, the osteophytes thrown out from each ultimately met, forming an osseous bridge (see pp. 159, 163, and 170); whereas the bases of the osteophytes on the vertebral borders were from 2 mm. to 3 mm. broad, and were prolonged for a few millimetres only on the bodies of the vertebræ. This intervertebral bridge formed an arch, the concavity of which was turned towards the intervertebral spaces (Plate IX. Fig. 21). The new bone was rather soft and spongy and not eburnated, even when it attained a considerable size. The osteophytes were usually situated unilaterally or bilaterally, hardly ever centrally; and the posterior border of the vertebræ was never attacked until the disease had made considerable progress elsewhere.

This manner of onset was the rule for the dorsal and lumbar, but not for the cervical vertebræ, the periarticular borders and articular surfaces of which were often attacked when the bodies were still normal.

At a later stage the bases of the osteophytes spread on the vertebral bodies until those from the superior and inferior borders coalesced. In bilateral disease the osteophytes sometimes extended from each side until they met in or near the middle line, so that the anterior and lateral surfaces of the bodies were covered by a thick ring of bone (Plate VII. Fig. 4 and Plate X. Fig. 22).

When the posterior border of the body was attacked, the layer of new bone along the vertebral canal was never more than 1 mm. or 2 mm. thick, and therefore could not have pressed on the spinal cord during life. Sometimes the layer thrown out from the posterior borders coalesced with those coming from the anterior round the vertebræ and intervertebral spaces.¹

Admitting, then, that the pathological process attacked the ligaments chiefly if not solely, it is logical to consider whether the

¹ NOTE BY J. G. WILLMORE.—It has already been pointed out (p. 158) that in Ancient Egyptians as in modern races, the disease began and spread in the ligaments, *i.e.*, that in its inception, at all events, it was perivertebral rather than vertebral. Analysis of the specimens already described affords, I think, sufficient ground for this contention, since it was invariably the ligaments, and more especially the anterior common ligament, which were the first to be attacked and showed the most advanced pathological changes.

immunity of the central parts of the bodies may not be explained by the anatomical connections of the vertebral ligaments. In this connection it may be remembered that the superficial fibres of the anterior common ligament extend from one vertebra to the fourth or fifth below, passing over the bodies of one or two vertebræ without touching them, whereas the deepest fibres are attached to adjacent vertebræ; and also, that the fibres adhere more closely to the intervertebral discs than to the bones, and are stretched across the transverse depression over the middle of the bodies without being attached to the latter. Some thin and scattered fibres on the sides of the bodies reach from one bone to the other. Lesions of the anterior common ligament starting in the superficial fibres would be most evident, firstly, near the upper and lower borders of the vertebræ; and, secondly, opposite the vertebral discs, where the anterior common ligament adheres most closely to the bodies of the vertebræ; that is, just where, as a matter of fact, the lesions are most marked. During life, or before putrefaction has proceeded far, slight lesions of the anterior common ligaments would probably have been discovered opposite the bodies of the vertebræ; but in the graves, these small and delicate osteophytes, not being in close contact with the vertebræ, doubtless fell to pieces and were lost. In severe cases, on the other hand, the lesions still subsisted thousands of years after death.

The fact that the disease generally started from the anterior border laterally, and not centrally, may perhaps be explained by the very close adherence of the ligamentous fibres to the lateral vertebral borders; whereas the slightness of the lesions near the transverse process was perhaps due to the thinness and scarcity of the ligamentous fibres in that neighbourhood.

The intervertebral discs, which, though shrunken, were found in mummified or dried bodies with severe spondylitis, were apparently normal, and as a rule the intervertebral spaces were not altered in size or in shape. For example, a vertebral column from a "pan grave" at Ballalish, dating from the XIIth to XVIth Dynasty, showed very severe lesions of spondylitis (Plate X. Fig. 23), and yet the intervertebral discs, though shrivelled from desiccation, were not otherwise altered. When moistened, the discs were easily split up into two thick laminæ, enclosing a smooth-walled cavity, and there was no trace of new bone.

The laminæ of a normal disc, which are arranged concentrically, consist mainly of parallel fibrous bundles, running obliquely between the vertebræ and attached firmly to both. The outermost layer is made up of ordinary fibrous tissue, the deeper and more numerous laminæ of cartilage, and the central part of a pulpy and elastic material. A thin cartilaginous layer on the lower and upper surfaces of each vertebra gives attachment to the discs, which are thickest in the lumbar region, thinnest in the intervals from the third to the

seventh dorsal vertebræ, and form together about one-fourth of the length of the movable part of the column. The curvature of the cervical and lumbar portions of the vertebral column is due principally to the form of the discs, which are much thicker in front than behind.

In cases of spondylitis among Ancient Egyptians no part of the discs was ossified, except the ring of fibrous tissue and cartilage in contact with the borders of the vertebræ. Nevertheless, some of the intervertebral discs were occasionally absorbed, with the result that the vertebræ fell together; and, owing to the anatomical peculiarities noted above, the removal by disease of the cervical and lumbar discs caused very severe deformities, such as the falling forward of the head on the chest (Plate VII. Fig. 3).

The articulations of the vertebræ were characteristically affected. Each articulation presents a synovial cavity surrounded by a fibrous capsule composed of ligaments, which are longer and looser in the cervical than in the dorsal and lumbar regions.

The periarticular borders of these articulations were often studded with large osteophytes which developed in the fibrous capsule. They doubtless caused great inconvenience, for the extent of the movements of the vertebral column, other than extension and flexion, are determined chiefly by the position of the articular surfaces. In the dorsal region, these allow a certain degree of rotation; in the lumbar region, lateral flexion but not rotation is possible, although by combining this lateral with antero-posterior flexion some degree of circumduction is produced. Severe lesions of the articular surfaces in several regions of the vertebral column, therefore, immobilised the whole of the spine, and, when limited to the cervical column, they prevented all movements of the head and neck, even when the other parts of the vertebræ remained healthy. New osseous tissue might surround the joint, and yet the articulating surfaces often remained untouched by disease, except in the instance which will be described further on.

The articulating surfaces of the atlas with the skull were generally normal, even in the rare cases when the borders of the condyles were distorted by periarticular inflammation, so that ankylosis of the head with the atlas was rare. In 6000 bodies examined in Nubia ⁽¹²⁾ only one case of ankylosis of the occipito-atlantal articulation due to spondylitis was discovered.

In this case complete fusion existed between the right occipital condyle and the corresponding articular surface of the atlas, and the left atlantal facet was fused partly to the condyle, and partly to the lower surface of the jugular process of the occipital bone. The skull in this last case was firmly ossified with the upper cervical vertebra, and the resulting deformity was very great. The spinal canal formed an obtuse angle with the foramen magnum, and the man's chin must have almost touched his chest. On the other hand, the articular surfaces between the atlas and axis were often enlarged, irregular, eburnated, and immobilised by a powerful ring of new bone. The surfaces for the insertion of the occipito-atlantal ligaments often showed inflammatory changes.

Very peculiar were the alterations in the articulating surfaces of the

odontoid process and of the atlas. The articulating surface of the process, and the facet for the latter on the arch of the atlas were eburnated and their borders rough, ragged, and irregular; the rounded tubercle for the attachment of the transverse ligament was similarly altered.

A very striking product of chronic inflammation was the little cap of osseous tissue frequently crowning the tip of the odontoid process. This little bony prominence, resembling a Phrygian cap (Plate X. Fig. 24) nicely balanced on the tip of the process, was doubtless what remained of the attachments of the bands of the more or less ossified ligaments which united the process firmly with the neighbouring parts, and certainly interfered considerably with movement. The atlanto-axial articulation allows the movements of rotation of the head and of the atlas on the axis, with the odontoid process as a pivot, the movements being checked by ligaments; while the occipito-atlantal articulation allows only very slight rotation but considerable flexion and extension of the head upon the vertebral column. As the axi-atlantal articulations were frequently attacked while the atlanto-occipital articulations usually escaped, rotation of the head was often abolished when nodding movements remained free.

A further impediment to the lateral movements and rotation of the head was the ossification of the transverse and cruciform ligaments at their points of attachment, and especially the very severe lesions of the articulation between the odontoid process and atlas. The movements of the head were hindered most by the pathological changes in the odontoid process; and the small cap of new bone, often crowning this process, at the point of attachment of the anterior and posterior occipito-axial, occipito-atlantal, and atlanto-axial ligaments, bears witness to the gravity of the pathological alterations in these important structures. The movements of flexion and extension of the head, therefore, were sometimes interfered with, but rotation was probably more often and more completely abolished when the atlanto-axial articulation was ankylosed.

The periarticular and articular changes also interfered with freedom of movement, for even in unilateral disease the neck was immobilised and the patients assumed the curious, bird-like attitude of sufferers from cervical spondylitis deformans.

When the anterior part of the vertebral bodies and the transverse processes were involved, the action of the muscles, such as the longus colli, attached to the bodies and transverse processes of the cervical vertebræ was certainly interfered with.

The bodies of the cervical vertebræ often appeared to be atrophied—an illusion caused by the growth of strong osteophytes on the anterior and posterior borders, which made the concavity and the upper surface appear deeper and the bodies thinner than they really were. One peculiarity of the disease in that region was that it was sometimes limited to one or two articulations on one side.

The shrinking of the intervertebral cartilages, accompanying or resulting from these lesions, inevitably produced several deformities. In the first place, the patient's height was diminished. In the second place, owing to the greater thickness of the anterior part of the normal cartilage, shortening was more marked anteriorly, and the head easily followed its natural tendency to fall forward on the chest, the patient then assuming the attitude usually supposed to be typical of old age.

The lesions of the cervical vertebræ, even when limited to the neighbourhood of the articulating surfaces, were almost always extremely severe. From being roughly oval, the articulating surfaces became irregular in shape, often enormously enlarged and, owing to the formation of new bone, almost convex, with a "worm-eaten" appearance due to enlargement of the blood vessels. Eburnation of these surfaces was more common than in any other region, and the fibrous capsule was often converted into a ring of dense new bone, which effectually put a stop to all movements. All these lesions finally converted all the structures composing this part of the cervical column into a rigid block, obliterated the normal curvature of the cervical spine, and thus led to great deformity of that region.

The spinous processes of the cervical and dorsal regions, rough in some cases, were usually normal. The supraspinous ligament between two or three lumbar vertebræ was often ossified, and occasionally this alteration extended to all the lumbar vertebræ; on the other hand, the ligamenta subflava, composed of yellow elastic tissue, always remained free. The muscles lying in the vertebral groove suffered severely; an imposing mass of new bone sometimes filled up the whole groove, and firmly bound together the smaller muscles and the tendons of the muscular masses attached to the vertebræ.

The disease in the dorsal region was often limited to the bodies of the vertebræ, the osteophytes on the posterior and anterior borders being sometimes almost as thick as the antero-posterior diameter of the vertebral bodies themselves (Plate VII. Fig. 7).

The costo-central and costo-transverse articulating surfaces were often normal, even when, as often was the case, their borders were disfigured as the result of intense inflammation followed by deposit of new bone.

In other cases these articulations were the site of lesions which are of special interest in view of their severity.

In some specimens the morbid process, proceeding as far as marked eburnation, extended to the articulating surfaces; but these articular lesions were always accompanied by very marked periarticular changes and appeared to be secondary to them.

The costo-central articulation unites the heads of the majority of the ribs with two vertebral bodies in two distinct synovial joints, supported by ligaments which complete the capsule of the joint. An interarticular ligament divides the articulation into two parts, each

lined by a separate synovial membrane. The costo-transverse articulation unites the tubercle and neck of the rib to the corresponding transverse process in an arthrodial joint; the neck of each rib is also united by a powerful ligament to the transverse process of the vertebra above. The articulation of the ribs to the spinal column behind and to the sternum in front allows a double movement of these bones (¹⁸), but every such movement produces some friction in the costo-central and costo-transverse articulations. On the other hand, the muscles which elevate the ribs in respiration (external intercostals, scalenus anticus, serratus posticus superior, and the levatores costarum) were apparently not often involved. The lesions in the tendons of the diaphragm will be discussed with those of the lumbar region.

The lesions of the articular surfaces and periarticular borders, though more common, were hardly ever as severe as in other parts of the spine. The movements of the dorsal vertebræ being limited in extent, profound changes in the anterior and posterior ligaments did not necessarily interfere with the movements or posture of the body, and the health of the patient suffered only from difficulties in respiration due to the involvement of the costo-vertebral articulations.

Pathological lesions of the intervertebral discs of the dorsal region were absent even in cases otherwise severe.

The lumbar region was most often and most characteristically attacked. Complete ossification of the anterior and posterior common ligaments was not rare, resulting in the lumbar vertebral column being converted into an immovable mass. Further, in severe cases, the upper and lower articulating surfaces were surrounded by mushroom-like, bony excrescences; the transverse processes were covered with flat stalactites of osseous tissue (Plate X. Fig. 25), the vertebral grooves were filled with masses of spongy bone enclosing all the muscular attachments in that region, and the spinous processes were rough and firmly held together by the completely ossified supraspinous ligament. The intervertebral discs alone usually escaped.

As flexion and extension in the lumbar spine are comparatively important movements, and as ossification of the anterior and posterior ligaments was often extensive just in that part, the movements of the whole body were considerably interfered with; the ossification of the supraspinous ligament alone was sufficient to prevent any approximation or separation of the spines of the vertebræ; that is, all movements of extension or flexion. Lateral flexion also was rendered difficult, nay impossible, by periarticular inflammation and secondary changes in the articulating surfaces.

Very far-reaching in their effects were the pathological changes in the tendons of the muscles attached to the lumbar spine. The diaphragm, the most important of these muscles, on account of the part it plays in respiration, is attached to the spine by its crura or pillars, which lie on both sides of the aorta on the bodies of the lumbar

vertebræ. These, at their origin, are tendinous in structure: the right crus, larger and longer than the left, arising from the anterior surface of the bodies and intervertebral substances of the three and four upper lumbar vertebræ; the left from the two upper, both blending with the anterior common ligament of the spine (¹⁴). As it was precisely the anterior ligament that was most often ossified, the crura of the diaphragm were necessarily involved in many cases, and difficulty in respiration, with all its attendant evils, was the result (*vide* p. 153).

The pathological alterations in the many muscles attached to the lumbar vertebræ were of the greatest importance. The bending of the thigh on the body, and of the body on the thigh, all very important movements, were rendered difficult by the lesions in the attachments of the psoas to the transverse processes of the bodies and to the intervertebral discs of the lumbar vertebræ.

The erector spinæ, a large muscular mass, was not infrequently involved, and in some cases all the attachments of this muscle were ossified, so that it was practically put out of action. Similarly, the disease involved the multifidus spinæ, which occupies the vertebral groove by the side of the row of spinous processes from the sacrum to the axis, and which is attached also to the spinous processes of several vertebræ. The smaller *rotatores dorsi*, *interspinalis* and *intertransversalis* muscles often shared the same fate.

The muscles of the back come into play simultaneously in extension of the head and, on one side only, in lateral flexion of the column. The oblique muscles rotate the head and spinal column, and when the spine is fixed, some of the erector muscles may depress the angles of the ribs, and thus assist in forced expiration. Ossification of the attachments of these muscles interfered to some extent with all these movements. The capsular ligaments not infrequently showed lesions severe enough to immobilise the lumbar spine.

The lesions of the anterior parts of the bodies of the vertebræ often extended so far down the spine that a strong osseous bridge joined the anterior-inferior border of the fifth lumbar with the anterior-superior border of the first sacral vertebra. Complete ossification of the sacro-lumbar and ilio-lumbar ligaments was not rare, and must often have interfered with movement, even when the sacro-iliac articulation was normal.

III.

LESIONS OF THE PELVIS AND LOWER LIMB.

Each of the two surfaces entering into the formation of the sacro-iliac articulation is covered with a layer of cartilage; these layers, though closely applied to one another, are not united except by fine transverse fibres in front. Occasionally, especially in elderly

people, the rough and irregular articulating surfaces are separated by small spaces containing glairy fluid (Plate X. Fig. 26). The sacrum and iliac bone are held together by the anterior and posterior sacro-iliac ligaments, and the articulation is further strengthened by the great and small sacro-sciatic ligaments.

As a rule, these articulating surfaces in Ancient Egyptians were smooth and regular even in the skeletons of people who died at an advanced age. The majority of skeletons with spondylitis deformans had sacro-iliac articulating surfaces unworn by friction and with no trace of eburnation; this immunity is, doubtless, due to the absence of wear and tear in this articulation, for not only does very little movement take place between the bones, but almost the entire weight of the body rests on the posterior sacro-iliac ligament, from which the sacrum is in great part suspended, so to speak. The rough space above the auricular surface of the ilium, and the depressions on the back of the lateral mass of the sacrum to which the posterior sacro-iliac ligament is attached, were often distinctly rough in cases of spondylitis deformans, whereas the surfaces of attachment for the anterior sacro-iliac ligaments were usually normal. The surfaces for the attachment of the great sacro-sciatic ligament on the posterior-inferior iliac spine and the side of the sacrum and coccyx were generally quite normal, while the inner margin of the ischial tuberosity, the margin of the ischial ramus, and the obturator fascia often showed very marked pathological changes. The strain due to the weight of the body being borne, chiefly, by the sacro-iliac ligaments, the loss of power consequent on the involvement of these structures certainly affected the carriage of the trunk in the standing position.

Two cases of severe disease of the left sacro-iliac articulations were observed. The first was discovered in a mummy of the XXIst Dynasty, and had been partly described by Elliot Smith, who wrote as follows :—

“In the case of an extremely emaciated old woman, called Nesi Tet-Nab-Taris, a curious state of affairs was revealed. Large open ante-mortem wounds, possibly bed-sores, were found on the back, between the shoulders and on each buttock. These had been made use of for the purpose of packing the back, and two square sheets of fine leather (gazelle skin?) had been applied to cover the upper wound and the whole buttock respectively.

“These sheets had been sewn to the healthy skin beyond the sores and the edges hidden by strips of linen, which were smeared with a resinous paste. A large opening, probably an abscess or sinus, extended transversely from the left pudendal labium outward into the buttock; this had been sewn up with string.

“A long ulcer on the back of the leg had been covered up by a sheet of linen soaked in a solution of resin.”

Evidently this old woman had been long bedridden. Professor Elliot Smith obligingly gave me the pelvis and lower limbs, in the hope that histological investigation might throw light on the nature of the chronic disease from which she had suffered. The histological examination threw no

light on the etiology of these sinuses, though we discovered that the peroneal arteries were completely ossified.¹

The remains of the pelvis and the lower limbs having been macerated, the following pathological alterations were discovered:—

Right femur (Plate X. Fig. 27).—Thick deposit of new bone round head of femur. Surface of great trochanter very rough, owing to deposits of whitish, spongy-looking bone, specially thick at upper extremity of diagonal line. Depression for the ligamentum teres irregular, and deeply pitted at bottom.

Left femur (Plate X. Fig. 27).—Neck about 1 cm. shorter than that of right femur, owing to absorption; this process having taken place more rapidly at the back, the neck had partly collapsed and the head of the bone looked almost directly backwards. All round the head, especially anteriorly, new bone had been deposited. Great trochanter roughened by deposit of new, spongy bone, thickest superiorly and anteriorly. Fossa for the ligamentum teres deeply pitted and much enlarged.

Pelvis.—Complete ankylosis between sacrum and right os innominatum. In right acetabulum, separation between articular and non-articular parts was almost obliterated by friction. The term ankylosis is badly chosen, for it cannot be shown that the sacro-iliac articulation was attacked at all, it being entirely surrounded by new bone. The two bones were bound together firmly by the completely ossified anterior and posterior sacro-iliac ligaments.

On the left side, no trace of inflammation, except on the ischial tuberosity, which was rougher than usual. In the acetabulum a layer of new bone existed at the junction of the articular and non-articular parts. The latter had been so much worn away by friction that it was of transparent thickness.

The bones of the leg were normal.

The second specimen showed, among other points of interest, the iliac bones firmly ankylosed to the sacrum.

The anterior sacro-iliac ligament was completely ossified as far as the lower border of the first sacral vertebra, and posteriorly the bones were united by two strong bridges of osseous tissue, separated by a small interval. The articulation appeared to be normal. The whole length of the external surface of the ischial ramus, especially near the inferior border, was covered with thick, rough, new bone, thinner, though still very noticeable, near the ramus of the pubis—the margins of the obturator foramen, the superior ramus of the pubis, and ilio-pectineal eminence were roughened by stalactites of inflammatory osseous tissue. The process, therefore, had attacked the sacro-iliac ligament and all the tendons at their points of attachment with the ischium and pubis.

The stalactite formations round the left obturator foramen were even more marked. The non-articular portion of the right acetabulum was normal, whereas a strong ridge of new bone, thickest on the outer side, lined the upper border of the articular portion.

The right ischial tuberosity, especially its external and inferior border, showed signs of very severe chronic inflammation, and the left acetabular cavity was much worn, without any formation of new bone.

It remains doubtful whether the sacro-iliac articulation was involved, in spite of the almost complete ossification of the anterior and posterior sacro-iliac ligaments, owing to the fact that here, as elsewhere, the disease was periarticular and not articular.

The pubic articulation, which is hardly movable in the normal, non-pregnant person, occasionally showed changes which may have

¹ NOTE BY J. G. WILLMORE.—“Calcified.”

been caused by osteo-arthritis. A curious lesion found in one Coptic body may be described here, although its etiology is uncertain.

The external surfaces of the right ramus of the pubis and part of the body were covered with a layer of new bone, which was smooth for the most part, except where it had a worm-eaten appearance. This plate of bone measured 40 mm. by 45 mm., and was about 7.5 mm. thick in some places; it was sharply limited superiorly by a ridge and a deep groove, and there had evidently been some periostitis along the lower border of the ramus of the pubis, as far as its junction with the ramus of the ischium.

The articulating surfaces of the symphysis pubis were smooth and appeared healthy, and on each side of the joint on the internal surface there was a layer of new spongy bone, 5 mm. broad, and about 2.5 mm. thick on the right, and 1 mm. thick on the left side. The left innominate bone was otherwise healthy, and there was no trace of any suppuration round the pubis. An interesting point was that on both dorsal and lumbar vertebræ, there was a small amount of lipping due to deposit of new bone along the upper and lower anterior borders of the bodies. The intervertebral discs and the ligaments were not ossified.

It is certain that, possibly owing to the lesions described, this person had long been bedridden, as a huge bed-sore occupied the lumbar region, in which numerous micro-organisms were seen with the microscope.

Far more important than the changes in the sacro-iliac and pubic articulations were those on the points of attachment of the muscles arising from the iliac bones and pelvis. In a skeleton from Kom-el-Shougafa, for instance, the rami of the ischium and pubis, the tuberosities of the ischium, and especially the spaces between the inferior curved line and the upper border of the acetabulum were covered with small round osseous elevations (Plate X. Fig. 28). Very often, the crest of the ilium was disfigured from end to end by jagged new bone, which testified to previous severe, chronic inflammation. Of course, this crest is always rugged, but in these cases important bone stalactites sprang from the internal and external lips and from the intermediate ridge. The attachment of the gluteus maximus was thus involved in the disease, and therefore extension, abduction, and rotation of the limb, the maintaining of the erect position and the regaining of it after stooping, were probably rendered difficult; let it be noted that the last is the most painful and difficult movement for sufferers from "muscular rheumatism" of the back. The attachments of the latissimus dorsi were also attacked, and as this muscle plays an important part in inspiration, walking, climbing, and in movements of the arms, the lesions of its attachments to the pelvic brim helped to make all these movements difficult and painful. Similarly, the disease involved the attachments of the abdominal obliquus externus and internus, which keep the abdominal cavity tense and act as expiratory muscles when the vertebral column is fixed; thus the changes seen at their attachments perhaps rendered the bending and the rotation of the thorax somewhat distressing, as is

sometimes the case now in patients with chronic muscular rheumatism. Lesions of the tendon of the gluteus medius, where this muscle is attached to the pelvis, must have interfered with the abduction of the thigh and the maintenance of the erect position of the body.

From the posterior part of the iliac crest arise the quadratus lumborum and erector spinæ, and the pathological changes in the attachments of these muscles must have caused the maintenance of the spine in the erect posture and the bending of the trunk backwards to be painful and distressing.

Very important were the lesions of the surfaces for the attachments of the tendon of the rectus femoris muscle on the anterior-inferior iliac spine, and of its reflected tendon just above the acetabulum (Plate XI. Fig. 29). Both places were sometimes covered with small mammillated exostoses, developed partly in the periosteum, and doubtless in the tendinous muscular attachments as well. As this muscle, together with the psoas and iliacus, supports the pelvis and trunk upon the femur, or bends them forwards, lesions in this situation checked the maintenance of the erect attitude of the trunk, and probably also impaired the other actions of this muscle.

Disease of the rami of the pubis and ischium might involve the tendinous attachments of the obturator externus, adductor gracilis, and quadriceps in front; of the obturator internus, levator prostatae, transversus perinei, erector penis, and compressor urethrae behind; of the pectineus, rectus abdominis, and pyramidalis near the angle of the pubis, and of the levator ani on the posterior surface. All the movements of the thigh therefore, and especially progression, were to some extent checked by disease in that region, for many of these muscles assist in drawing the limb forward. Similarly, the maintenance of the body in an erect posture, flexion of the pelvis forwards upon the femur, movements of the thigh on the pelvis, of the pelvis on the thigh, of the leg on the thigh, and *vice versa*, were obstructed by the lesions described above.

The attachments of the hamstring muscles, semi-membranosus, semi-tendinosus, biceps, gemelli, coccygeus, and levator ani to the ischial tuberosity and its neighbourhood often suffered severely; in consequence, flexion of the knee, rotation of the tibia outwards by the biceps, semi-tendinosus and semi-membranosus, together with extension of the hip, were impeded, and doubtless occasioned great distress to the patient. The lesions of the attachments of the gemelli interfered with the support of the hip-joint posteriorly and with rotation and abduction of the limb. forcible expiratory and other expulsive efforts were checked by the changes in the coccygeus, levator ani, and other muscles of the perineum; the lack of support to the pelvis must have caused unpleasant symptoms, such as difficult evacuation of the rectum.

In such cases, therefore, the movements of the back, lower and

upper limbs, micturition, and defæcation were embarrassed and rendered painful by the implication of the attachments of the upper extremities of voluntary muscles; and it will be obvious presently that matters were often rendered worse by the implication of many of the inferior attachments of these same muscles.

The lesions of the hip-joint were perhaps the most important of all, because even when slight they interfered, more than any other lesions, with the maintenance of the erect posture and progression forwards or backwards.

The cotyloid ligament, a thick fibro-cartilaginous ring round the margin of the acetabulum, which, as the transverse ligament, bridges over the gap of the acetabular border, suffered less than one would have expected. Even with severe lesions of other parts of the articulation, the margin and immediate neighbourhood of the acetabulum were often smooth and to all appearance healthy. Sometimes, however, the margin of the acetabulum was topped by a ring of new bone, so fragile as to be usually more or less broken by post-mortem injuries; but occasionally this hyperostosis was sufficient to increase the depth of the joint (Plate XI. Fig. 30). In cases still more severe, the inflammatory area extended to neighbouring parts, even, as we have seen, to the attachment of the reflected tendon of the rectus.

The transverse ligament was never completely ossified, though severe changes at its attachments were often recognisable; the osseous borders which the ligament unites often displayed distinct post-inflammatory hyperostosis, and it was unfortunate that the ligaments themselves had been destroyed by post-mortem changes. One important lesion was represented by a festoon of new bone formed by the thickening of the lower border of the articular portion of the joint, most marked at the point of attachment of the ligamentum teres (Plate XI. Fig. 29). Further, while the pit for the ligamentum teres on the head of the femur is normally a small, smooth, round depression, in femora with lesions of chronic osteoarthritis, this pit was more or less completely obliterated by new bone which, like melted wax (Plate XI. Fig. 31), had filled it and then flowed over the neighbouring surfaces. The lesions at both ends of the ligament indicate that most probably the whole was ossified, and as flexion, adduction, or rotation of the hip must necessarily stretch this ligament, these movements must have been greatly impeded.

A more advanced lesion was the gradual wearing down of the lower brim of the articular portion of the acetabulum, until at one particular point the division between the articular and non-articular portions was obliterated. This point was almost opposite to the transverse ligament but slightly posterior to it (Plate XI. Fig. 32). The top of the head of the femur was always normal except for the

changes in the fossa for the ligamentum teres. Eburnation was never seen.¹

The lesions in the attachments of certain parts of the capsule were serious, especially those already described at the point of origin of the upper extremity of the ilio-femoral ligament, on the lower anterior spinous process. The maintenance of the erect position puts a strain on the ilio-femoral ligament, and inflammatory lesions at the point where it is attached to the anterior intertrochanteric line were among the most common lesions. The whole length of this bony ridge was in some cases studded with small rough exostoses, and the lesions of this important ligament, by impeding the extension of the joint, produced a certain amount of pain and made the standing position almost impossible (Plate VIII. Fig. 10).

The upper attachments of the femoral ligament band opposite the outer head of the rectus, and the lower attachment to the upper and fore part of the great trochanter and neck of the femur often exhibited similar changes, which during life doubtless impeded movement, more especially adduction of the hip-joint. Whereas the upper attachment of the pubo-femoral band was generally intact, the lower end connected with the neck of the femur, level with and in front of the small trochanter, was frequently the seat of osteophytes which interfered with movement of the hip-joint, particularly with abduction of the limb.

Perhaps the most important lesion of the capsule was that affecting the bands of transverse fibres, which is about as wide as the middle finger, and arches like a collar round the neck of the bone. At this point, just below the neck of the femur, there was often a pad of bone, generally about 30 mm. long, 15 mm. wide, and perhaps 2 mm. thick, which represented this ossified ligament; and it was clear that the longitudinal as well as the transverse fibres of the capsule had been involved in the pathological processes.

¹ NOTE BY J. G. WILLMORE.—In the late Sir Armand Ruffer's manuscript we found at this point a note to this effect: "Put here paragraph on Coxa Vara."

The limited time at my disposal unfortunately precluded us from making anything like a complete examination of the mass of material upon which Sir Armand based the conclusions given in this paper; but, as far as I have been able to determine, his results would seem to agree with the findings of Wood Jones, who stated (^{1b}) that many examples of coxa vara were found by him among skeletons exhumed from the cemeteries at Shellal, above the First Cataract.

Wood Jones drew attention to the absence of any of the cardinal signs of the bony manifestations of rickets in any single instance, out of the large number of skeletons of young people, of all ages up to puberty, which he had examined; at the same time later bone-changes, in which it has been customary to invoke rickets as the causative factor, were by no means uncommon. He therefore suggested that the origin of these later bony changes lies in some factor other than rickets.

Sir Armand appears to have arrived at the same conclusion: an idea which is strengthened by the fact that the femora which I have been able to examine show merely shortening of their necks due to atrophy and absorption of the bone, without any of the deformity due to bending and twisting of the bone which is typical of coxa vara of definite rachitic origin (Plate XI. Fig. 33).

To sum up: The pathological changes in the hip-joint were most obvious where the ligaments were attached, whereas evidently the acetabular cartilage was involved later. The head of the femur, where it was covered by cartilage, was never the seat of disease, except at its periphery and at the point of insertion of the ligamentum teres.

The extra-articular changes in the superior extremity of the femur come next in order. The surfaces of the great trochanter were often the seat of severe lesions. The whole trochanter, for instance, might be covered with rough new bone without any recognisable ligaments or tendinous framework; on the other hand, the structure of the tendons inserted in that situation was in some cases still so plainly visible that occasionally the whole, but more often only the anterior surface of the great trochanter, looked as if delicate tendinous fibres had been frozen on to it. The muscular attachments involved were those of the gluteus medius on the external surface, gemelli, pyriformis, obturator internus, and, above all, the tendon of the obturator externus in the digital fossa, which cavity was often filled with remnants of the ossified tendons of this last muscle. All these lesions certainly did not conduce to freedom of movement.

The upper part of the anterior intertrochanteric line to which the capsular ligament of the hip-joint is attached, and the lower part from which some of the fibres of the vastus internus originate, were often extensively altered. The posterior intertrochanteric line suffered less than the anterior, and indeed was rarely the seat of pathological changes; the small trochanter often escaped more or less completely.

The anterior part of the shaft below the anterior-intertrochanteric line, and the lateral parts as far as the proximity of the knee-joint, were practically always normal, and they contrasted therefore with both extremities of the bone.

The two lines of attachment for the gluteus maximus, pectineus, and iliacus were often roughened by many thick, bony outgrowths which might extend to half the length of the shaft. This condition was not due to abnormal muscular development, as it was seen in femurs in which the other muscular attachments were, if anything, rather slighter than the average, but which showed distinct osteo-arthritic changes at their extremities.

A peculiar deformity of the femur is shown in Plate XI. Fig. 34. Here the great trochanter and the intertrochanteric line are capped by an enormous growth of spongy bone measuring about 5 cms. in thickness, which is reflected in a thick layer round the junction of the neck of the bone with the shaft. The neck of the bone itself is practically normal. This enormous growth consists of loose, spongy bone, which, microscopically, shows nothing peculiar. The lower extremity of the femur presents some slight signs of osteo-arthritis round the borders. The shaft of the femur is nowhere enlarged.

The diagnosis in this case must remain doubtful. I thought at first that the specimen was one of osteoma or osteosarcoma. Against this diagnosis it

may be pointed out that the shaft of the femur itself appears to be quite normal, and the surface of the tumour, except over the great trochanter, is everywhere quite smooth. The interior of the growth is composed of normal loose osseous tissue.

Considering that this person had slight osteo-arthritis lesions of the lower extremity and of the head of the bone, it may be argued that the more striking lesions were also of the same nature. Assuming this to be possible, it is not a little strange that the lesions should be almost entirely limited to the part round the trochanters. Unfortunately, the other bones belonging to this skeleton could not be discovered, this lying loose in the "ossarium."

Another interesting femur found in the same ossarium showed the head almost completely worn away, though signs of inflammation could still be seen along its upper and outer borders (Plate XI. Fig. 35). The great trochanter had been badly smashed. In this instance, I do not think the possibility of the lesions having been tubercular can be excluded. Similar changes also existed all along the bony ridge to which the two vasti and the three adductor muscles were attached. It has been shown already that the upper attachments of these muscles to the os pubis were often the seat of pathological lesions, so that both ends of the muscles were involved; consequently, as one or more of these muscles take part in almost every movement of the lower limbs, walking, running, jumping, getting up from the kneeling or recumbent position, and other movements must have been greatly impeded.

The knee-joint was perhaps the articulation most frequently attacked by chronic osteo-arthritis, possibly on account of its size, of the number of ligaments entering into its composition, and of the fact that, more than any other large joint of the body, it is liable to traumatisms of all kinds.¹

The part of the anterior lateral ligament passing over and intimately incorporated with the patella was very often the seat of chronic inflammation, which hardened in pathological ossification. The upper surface of the patella was then striated longitudinally, and the raised borders of these striæ were prolonged into thin osteophytes, which in well-preserved specimens overhung the borders of the bones for a few millimetres. Lower down, where the anterior ligament and the lateral patellar ligament are connected with each side of the tubercle of the tibia, pathological changes were uncommon.

On the back of the outer condyle of the femur, a mass of new bone often indicated the point of insertion of the posterior ligament, and, similarly, the point of insertion of the ligament on the tendon of the semi-membranosus muscle was indicated in the same manner.

The lower end of the femur in many cases was disfigured by a thick rim of new bone which closely followed the borders of both condyles and greatly resembled the narrow brim of an old-fashioned billycock hat (Plate VIII. Fig. 8). The superior-anterior border of the external condyle was often prolonged upwards into a thick spur, an osteophyte which sometimes was nearly half a centimetre long, and which stood out prominently from the neighbouring tissues below.

¹ NOTE BY J. G. WILLMORE.—Another possible factor is that the knee-joints combine great mobility with the support of the weight of the trunk—compare the frequency with which gout attacks the joint of the great toe in modern people.

The borders of the intercondylar notch at the back of the joint did not escape, though the rim of new bone there was less thick and prominent than on the lateral or anterior edges of the articulation. In such cases, the attachments of the capsular ligament being ossified from end to end, the great part of the ligament was very probably ossified during life, and produced great difficulty in the movements of the knee-joint or even immobilised it. The imposing thickness of newly formed bone was proof of the chronic character of the disease, which doubtless had lasted for many years before death.

At the back of the external condyle of the femur, a thick patch of new bone sometimes marked the attachment of the anterior or external crucial ligament; a similar new formation in the depression in front of the spine of the tibia corresponded to the inferior attachment of this ligament; a tag of new bone, sometimes 15 mm. long, remained as evidence of the partial or complete ossification of this ligament. Similarly, the hinder part of the depression behind the spine of the tibia, the popliteal notch, and the inner condyle of the femur often presented the lesions typical of chronic periarticular disease, and there was no doubt that both crucial ligaments had been partly or wholly ossified. The ligaments of the knee, therefore, had undergone the same changes as those of the hip; and as most, if not all, of the joints had been attacked in some patients, the articular surfaces remaining normal, it follows that impairment of motion in, or even complete immobility of, the articulation sometimes resulted from periarticular lesions alone. The surfaces of attachment for the articular cartilages of the tibia were sometimes distorted by osseous proliferation, but as these lesions were seen only in those cases in which the periarticular alterations were intense, without any ossification of the cartilages, it follows that in all probability the disease did not attack the cartilages till very late. Sometimes an ivory-white, eburnated patch on one or both articulating surfaces of the tibia had resulted, and the eburnated surface was usually striated longitudinally, elongated from before backwards, and measured from 20 mm. to 35 mm. in its longest, and about 15 mm. to 20 mm. in its shortest, transverse diameter. In the large majority of skeletons no new bone had been deposited on these surfaces of the femur or patella, which are normally protected by cartilages; the latter had been worn through the eburnation of the bone as a consequence (Plate XI. Fig. 35).

Occasionally, the inflammation of the bony articulating surface led to its disfigurement by small round or oval patches of raised bone, studded with numerous small holes, the sites of enlarged blood vessels, which were not infrequently surrounded by eburnated borders. These were evidently the vestiges of inflammatory reaction following on the wearing through of the cartilage. These patches, fairly common on the femur, were rare on the tibia.

The very important changes on the head of the tibia were similar to those on the femur. Contrary to expectation, the attachment of the ligamentum patellæ was normal, even when periarticular lesions of the knee-joint were conspicuous; whereas the anterior parts of the internal and external tuberosities often suffered severely, fragments of the ossified ligaments, as much as 10 mm. long, sometimes remaining as evidence of the severity of the morbid process in the past. The surface of attachment for the semi-membranosus was often thickened by new bone, and as we have seen that in some cases the upper attachments of the muscles had been attacked also, the work of this muscle must have been impeded considerably; on the other hand, the attachments of the lower ends of the sartorius, semi-tendinosus, and gracilis were usually healthy.

The spine of the tibia, close to which the extremities of the semi-lunar cartilages are attached, and the rough depression behind it for the attachments of the anterior and posterior crucial ligaments, were often the seat of obvious lesions (Plate XII. Fig. 37).

Very marked also were the changes in the neighbourhood of the tibio-fibular articulation. The borders of joints otherwise normal were rugged and thickened by new bone, and sometimes it was clear that a complete osseous capsule had surrounded the joint. The external surface of the styloid process of the fibula was usually most affected, and was covered with delicate, bony stalactites, as if fibres of the anterior-superior or posterior-superior ligaments had been frozen on to the process.

The crest, the internal cutaneous surface, the tibial attachments for the tibialis anticus and tibialis posticus were practically always normal. The inferior extremity of the tibia was but seldom seriously altered by lesions. The articular surface with the astragalus was always normal, the periarticular changes were never more than slight.

This immunity, however, did not extend to the lower tibio-fibular articulation, the borders of which were altered like those of the hip or knee-joint. A triangular patch of rough bone, with its base at the inferior extremity, often extended up the tibia for two or three inches, and opposite to it there was a similar patch on the fibula. The surfaces of attachment for the ligaments were frequently rough and aberrant in shape.

The oblique line to which the soleus is attached was the only part of the shaft of the tibia ever involved. It was often considerably thickened and protruded for 3 or 4 mm. with an external edge as much as 2 or 3 mm. broad.

The four borders of the fibula were often extremely rough and uneven, whereas the surfaces of attachment for the muscles of the big toe and foot remained smooth. It would seem, therefore, that the aponeuroses suffered, while the muscles escaped (Plate XII. Fig. 38).

IV.

LESIONS OF THE STERNUM, CLAVICLE, RIBS, AND UPPER LIMB.

The sterno-clavicular articulation is formed by the sternal end of the clavicle, the upper and lateral part of the manubrium sterni and the cartilage of the first rib, and allows limited movements in almost every direction—upwards, downwards, backwards, and forwards, as well as circumduction; the clavicle in its motion carries with it the scapula. The importance of this joint is great because it is the only point of articulation of the supporting arch of the shoulder with the trunk (¹⁸). The result of these connections is that almost every movement of the shoulder produces a corresponding movement in the sterno-clavicular articulation, and therefore pressure on the inter-articular fibro-cartilage. Elevation of the clavicle is principally limited by the costo-clavicular, depression by the interclavicular, ligament. The movements of the costo-clavicular part of the articulation are markedly increased in dyspnoea, and are limited by the anterior and posterior sterno-clavicular, the interarticular and costo-clavicular ligaments.

Complete ossification of adjoining surfaces was never found. The articulating surface of the clavicle was often greatly worn, and sometimes almost eburnated.

The attachments of the sterno-cleido-mastoid, pectoralis major and subclavius muscles, closely connected with the articulation in front, and the attachments of the sterno-hyoid and sterno-thyroid behind, were always normal. The interclavicular ligament also escaped as a rule, although the impression for the rhomboid ligament was often altered by chronic inflammation.

The borders of the small, flattened, oval facet of the acromial end of the clavicle were usually normal, while the articulating surface on the acromion and its periarticular borders and the attachment of the conoid and trapezoid ligaments were often thickened by bony deposits (Plate XII. Fig. 39). In many instances the articulating surfaces looked as if they had been worm-eaten and were distinctly eburnated. Though the movements of the acromio-clavicular articulation were perhaps never entirely prevented by neighbouring lesions, it is certain that any pressure on this articulation, such as that produced by movements, must have caused intense pain.

The lesions of the costo-central and costo-transverse articulations have been already described. The only other frequent change in the rib was extreme roughening of the inferior border near the angle, for about 3 inches in front and behind, but that this attrition was due to arthritis was not established.

It is strange that when most articulations, and especially the large articulations of the lower limbs, were attacked, the shoulder-joint in the large majority of Egyptian cases should have remained

immune. Here the articular ligaments do not limit to the same extent the degree of movement by maintaining the articular surfaces in such close apposition as they do in the hip; and the looseness of the articulation may have been the cause of this comparative immunity.¹

The lesions of the glenoid ligament, the fibro-cartilaginous rim attached to the margin of the glenoid cavity, consisted in the formation of a periarticular ring, and considering the close connection of the tendon of the biceps with this ligament, these lesions must have interfered with the action of the muscle.

The attachment of the capsular ligament to the scapula was seldom if ever attacked, whereas the anatomical neck was often surrounded by a slightly raised border of smooth new bone, never projecting for more than about 1 mm. nor exceeding 3 mm. in breadth. This new border was never disfigured by projecting osteophytes, and gave the impression of having been the result of a very mild chronic process.

Occasionally, the acromion process and the portion of the scapular spine from which the deltoid arises were much deformed by the comparatively large masses of bone deposited on them. The action of the deltoid, one of the most powerful muscles of the arm, was therefore interfered with.

The lesions of the humerus were most marked at the points of insertion of muscles closely connected with the shoulder-joint. New bone was deposited on the greater tuberosity to which the supraspinatus, infraspinatus, and teres minor are attached, on the lesser tuberosity, at the point of insertion of the subscapularis, and on the anterior and posterior bicipital ridges of the bicipital groove, where the pectoralis major, teres major, and latissimus dorsi are inserted (Plate XII. Fig. 40). In many cases, therefore, although the articulating surfaces were perhaps intact, the movements of the arm and shoulder-joint may have been rendered painful, or may have become impeded, or even totally arrested, by lesions of ligaments and of tendons passing over the joint. The lesions in the shaft of the humerus were limited as a rule to the bicipital groove and neighbouring parts. So in the humerus, as in the femur, tibia, and fibula, it is evident that the disease attacked the neighbourhood of the articulation, and the shaft of the bone escaped almost completely.

The changes in the shoulder-joint therefore were identical with those of all the joints studied so far, namely, apparent immunity of the articulating surfaces and involvement of the neighbouring attachments of ligaments and muscles.

The observations just related were made on skeletons from Upper and Lower Egypt. In Nubia (¹⁷), on the other hand, the disease was by no means uncommon in the shoulder-joint, and here the deformity produced in the head of the humerus was often conspicuous. Hard, bony masses developed round the margins of the articular surface of

¹ NOTE BY J. G. WILLMORE.—Further, the shoulder-joint has no weight to support.

the head of the bone, the articular surface itself became frequently displaced, and a considerable impairment of movement must have been the result of this deformity of the bone.

The lesions of the two articulations of the elbow may be described together.

In front, the upper and lateral borders of the coronoid depression were often covered by a ring of dense, almost eburnated, new bone, and the coronoid depression itself sometimes contained a mass of dense, often typically eburnated, new bone, which almost filled it. The same alterations existed in and around the radial depression, which was sometimes almost completely obliterated.

The internal borders of the trochlea and the articulation for the head of the radius were often lined with a thick border of new bone forming a ring round the articular surfaces, which, though less massive than that round the knee-joint, nevertheless must have caused considerable inconvenience (Plate XII. Fig. 41). The olecranon depression was often disfigured by osteophytes, thickest at the apex of the triangle formed by that cavity, that is, on a level with the posterior ligament. Eburnation of the trochlear surface was rarely very marked, and the eburnated surface was streaked with parallel longitudinal lines resulting from the grinding of the articulating surfaces on one another.

The changes in the ulna were peculiar. The inner and outer borders of the lesser sigmoid cavity and of the coronoid process were often greatly thickened; on the other hand, the articulating surface of the greater sigmoid cavity almost always escaped and eburnation was rare.

The subcutaneous part of the posterior surface of the olecranon, covered by a bursa, was always normal, while the top of the olecranon was often capped by a thick layer of new bone, sometimes as much as 5 mm. thick, which had formed in the posterior articular ligament and in the tendon of the triceps. The attachment of the anconeus generally escaped, whereas that of the coronoid head of the flexor sublimis digitorum was often rough.

The borders of the coronoid process of the sigmoid cavity did not escape, and the lesions were most marked on the triangular surface below it, that is, at the point of attachment of the brachialis anticus (Plate XII. Fig. 42). In Nubian (¹⁷) skeletons, the roughening and deformity of the joint outweighed the process of eburnation, so commonly seen in typical modern examples of arthritis deformans.

The head of the radius escaped, except in a few cases in which eburnation was present, though but little bone was worn away. Sometimes the head was capped by new bone which was prolonged into a point at the ulnar articulation.

Eburnation of the lesser sigmoid cavity was very rare even though the borders of the cavity were surrounded by a delicate rim of smooth new bone, possibly an ossified orbicular ligament.

The upper part of the shaft of the radius was practically always

normal except for hypertrophy and roughness of the bicipital tuberosity, which in many cases were doubtless due to powerful muscular development; when the remainder of the skeleton did not point to the presence of mighty muscles, this condition was probably pathological. The attachments of the interosseous membrane between the radius and ulna were always normal.

The pivot formed by the head of the ulna and the lower end of the radius was always healthy, except for some occasional slight thickening round the articular surfaces.

The surfaces of attachment for the anterior and posterior radio-ulnar ligaments also escaped as a rule.

REFERENCES.

1. SIR ARMAND RUFFER . . . "Studies in Palæopathology: Lesions of Ancient Egyptian Teeth," *Journ. Path. and Bacteriol.*, Cambridge, 1913-1914, vol. xviii. p. 149.
2. ELLIOT SMITH "A Contribution to the Study of Mummification in Egypt, *Memoires présentés à l'Institut Egyptien*, 1906, tome v. fasc. 1.
3. " "Archæological Survey of Nubia," *Bull.* No. 2, Cairo, 1908, p. 59, footnote.
4. WOOD JONES "Archæological Survey of Nubia, 1907-8: Report on Human Remains," Cairo, 1910, vol. ii. pp. 273 f.
5. OSLER AND M'CRAE . . . "System of Medicine," vol. vi. p. 505.
6. M'CRAE *Loc. cit.*, p. 535.
7. WAINWRIGHT "Meydum and Memphis, III," "Report of British School of Archæology in Egypt," 1910.
8. DE MORGAN "Recherches sur les Origines de l'Egypte," Paris, 1897.
9. DERRY *Denkschr. d. k. Akad. d. Wissensch. in Wien*, 1912.
10. ELLIOT SMITH AND WOOD JONES. "Archæological Survey of Nubia, 1907-8," Cairo, 1910, vol. ii. p. 116.
11. E. BRECCIA "Le Necropoli di Sciatbi."
12. WOOD JONES "Archæological Survey of Nubia, 1907-8," Cairo, 1910, vol. ii. p. 244.
13. SCHÄFER "A Text-Book of Physiology," p. 275.
14. GRAY "Anatomy."
15. WOOD JONES "Archæological Survey of Nubia, 1908," Cairo, 1908, *Bull.* No. 2, p. 57.
16. GRAY "Anatomy."
17. WOOD JONES "Archæological Survey of Nubia, 1907-8," Cairo, 1910, vol. ii. p. 275.

LIST OF ILLUSTRATIONS.

PLATE VII.		Figs. 1-7.
PLATE VIII.		Figs. 8-12.
PLATE IX.		Figs. 13-21.
PLATE X.		Figs. 22-28.
PLATE XI.		Figs. 29-35.
PLATE XII.		Figs. 36-42.

(The Description of the Figures will be found in the Text.)

1.

2.

4.

3.

5.

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