arterial circulation and the venous and lymphatic return and possibly by improving muscle function and balance in the legs and feet. I use the Pavex machine combined with faradic foot baths and Buerger Allen exercises. As the hospital lies at the top of a hill we have familiar landmarks by which to judge clinical improvement.

My question is: Why is it that the stiff and painful shoulder or "shoulder-hand syndrome" in some patients responds immediately and dramatically to stellate ganglion block and that in others there is no response? Sometimes the skin temperature of the upper extremity may rise several degrees immediately following such a block but this objective response and the presence of a Horner's syndrome are not necessarily seen in those patients who respond favourably to treatment.

**Dr. L. C. Hill,** in reply: While I agree with Dr. Blomfield that in some cases of prolonged arterial obstruction pathological changes, such as he describes, can be found, the round celled infiltration is quite different from that which we now regard as typical of rheumatoid arthritis, and which we constantly find in a muscle biopsy study.

I am inclined to agree that there is in rheumatoid arthritis a raised vasomotor tone, which is constantly observed in the less affected areas and contrasts with the relative vasodilatation over affected joints, but I am not yet ready to regard this as a fundamental factor in the ætiology of this disease. This contrast may well account for the œdema over active joints.

In reply to Dr. Bach I am afraid that my own experience with the stellate ganglion block has been limited to the study of peripheral vascular problems, and I have no experience of its use in the "shoulder-hand syndrome". It seems fairly clear, however, that the so-called "shoulder-hand syndrome" covers several different conditions.

**Dr. Donald Wilson,** in reply to Dr. Shulman: Clinical observations on the effect of smoking in these cases are not definitely conclusive. The harmful effects reported by some observers are not confirmed by others. Replying to Dr. Bach's query, I have noticed frequently the same phenomenon. In cases where vasospasm plays a great part in this production of symptoms, such as thoracic inlet syndrome, Sudeck's atrophy and reflex dystrophy, sympathetic block, either by surgery or drugs, may produce a rapid alleviation of symptoms. In these cases I have found that paræsthesia is a prominent symptom. However, in patients where the symptoms of the "shoulder-hand" syndrome are due to sub-deltoid bursitis then the production of vasodilatation by heat or by interference with the sympathetic supply may not only fail to alleviate the pain but it may increase its severity. I regard the use of tetra-ethyl-ammonium bromide as a useful measure in assessing the probability of a successful result following the injection of a stellate ganglion.

[*December* 8, 1948]

## DISCUSSION ON DIAGNOSTIC RADIOLOGY IN RHEUMATIC DISEASE

**Dr. G. D. Steven:** *Analysis of Radiographic Appearances in Chronic Arthritis*

### Introductory

A textbook knowledge of the radiographic features of rheumatoid arthritis, osteoarthritis and gout makes us familiar with the following points:

(1) *Rheumatoid arthritis.*—Rheumatoid arthritis produces one or more of the following changes in bones and joints according to the severity and stage of the disease:—osteoporosis, loss of cartilage, erosion of articular surfaces, subluxation and ankylosis. Smaller joints are predominantly affected. The changes are of atrophic or subacute inflammatory type.

(2) *Osteoarthritis.*—O-A is characterized by outgrowths from the joint edges or osteophytic formation. This is associated with diminution of cartilage and increased density or osteosclerosis in the adjacent bone. The changes are more pronounced in larger weight-bearing joints and are of degenerative type with compensatory reaction.

(3) *Gout.*—In gouty arthritis there is evidence sooner or later of typical punched-out areas in the bone.

We must approach the subject with a knowledge of the fundamental processes which maintain the radiographic appearance of normal bone and follow this with a more detailed study of the structural form or pattern which may result from disturbance of these processes by any particular disease.

*Normal bone.*—The fundamental processes involved are (1) bone absorption, (2) formation of new osteoid tissue, and (3) bone deposition. These are continually at work throughout the living skeleton, old bone being removed and new bone laid down in its place. In child-

hood and adolescence bone deposition outstrips the absorptive process with resulting growth of bone. During adult life the processes are perfectly balanced and no macroscopic changes are seen in the radiographic appearances. In old age, bone absorption is in the ascendancy and there is a gradual change to the senile type of osteoporosis due to thinner trabeculæ with correspondingly wider intertrabecular spacing and to a thinner cortex which becomes shell-like in outline at the articular ends of the bone.

(1) Bone absorption is not due to lysis or solution of calcium but to an active cellular process of removal performed by osteoclasts.

(2) Osteoid tissue is a non-opaque quickly growing tissue which acts as a medium for the process of bone deposition. Before new bone formation takes place osteoid tissue acquires a high calcium content.

(3) Bone deposition is performed by osteoblasts. Bone may be laid down fairly quickly, in the form of an irregular woven bone which is seen in callus formation or in repair of local bone damage, but the final stage of lamellar bone with Haversian systems is reached much more slowly.

*Central control.*—A complicated central control mechanism is obviously involved in keeping these processes in step and in bounds to meet the needs of the body. Endocrine secretion and the autonomic system are linked up with this.

*Local influences.*—We know that local infection stimulates granulation tissue formation with increased activity of the osteoclasts. Conversely we find that local stresses, strains and pressure will increase osteoblastic activity and, incidentally, it must be remembered that this process will come into operation in late stages of any disease which has caused damage to joint structures and altered the lines of stress and strain.

*Blood supply.*—A general disturbance will show predominant effects, at least for a time, in the more vascular areas of bone, with abnormal distribution of densities and local patterns. These are only a feature of the abruptness of the change due to any particular disease and not a characteristic of the disease itself.

We have, therefore, only a few fundamental processes involved in any bone changes, but they are sufficient to produce a multiplicity of effects according to whether the disturbance is central, local, or both, and whether one or more processes are stimulated, one or more inhibited and one or more unaffected.

## Abnormal Bone

(1) *Aseptic necrosis.*—An area of aseptic necrosis offers a good example of what happens if the blood supply fails. In the affected area the activity of both osteoclasts and osteoblasts ceases and the bone retains its normal X-ray appearance. Osteoclastic activity takes place in the surrounding normal bone and attacks the aseptic area at its margins or along the line of any invading vascular granulation tissue. The surrounding bone itself may show osteoporosis.

(2) *Hypervitaminosis D.*—The changes produced by the generalized osteoporosis are abrupt enough to produce local patterns in the more vascular spongy bone and might wrongly be considered diagnostic of rheumatoid arthritis which is another member of this group.

Hyperthyroidism is also capable of producing this effect although usually to a less marked extent.

(3) *Rickets.*—Osteoporosis in rickets will show as an excessive zone of non-opaque osteoid tissue at the growing ends of the long bones. This will serve to differentiate the osteoporosis from that of rheumatoid arthritis or Still's disease.

(4) *Fibrocystic disease.*—In hyperparathyroidism there is an osteoporosis which is due to excessive development of non-opaque intertrabecular soft tissue associated with actual widening of intertrabecular spacing and true structural deformity. This is also seen in Paget's disease where there is in addition a rather purposeless coarsening of the trabecular structure which cannot be fitted in as due entirely to stimulation of osteoblasts by changes in stresses and strains and lines of force.

## Rheumatoid Arthritis

(1) *Osteoporosis.*—Experimental work has shown that a material loss of bone calcium takes place before osteoporosis is detected in a radiograph. Early detection of osteoporosis is most important as it is the first radiographic change in rheumatoid arthritis and, although not diagnostic in itself, it forms an important link in the clinical-pathological-radiological chain of evidence which may establish the early diagnosis. Fallacy must be excluded in technique since faulty processing, over-penetration or exaggerated contrast can simulate both generalized osteoporosis and disturbance of bone density distribution.

Standardization is achieved by taking a diagnostic radiograph of both hands in all cases of chronic arthritis. The thickness of the hands is about the same in all adults and requires no alteration of the special technique used.

In a well-established rheumatoid arthritis the patterns produced in more vascular areas are easily detected. In the lateral knee, for example, two distinct translucent zones are seen on either side of the fused epiphyseal line. In late chronic or quiescent stages there is partial recovery of bone shadowing and a return to the more normal distribution of densities in the ends and shafts of long bones. If no other signs are detected the appearance may then be mistaken for osteoporosis of senile type.

(2) *Loss of cartilage.*—Loss of cartilage in rheumatoid arthritis presents certain distinctive features. There is multiple joint involvement chiefly affecting smaller joints such as the hands, wrists, feet and ankles, with subsequent spread in many cases to larger joints. The destruction of cartilage is of noticeably uniform character.

In established invasion the joint space is more or less uniformly diminished. The presence of uniform loss of cartilage remains a feature worthy of suspicion which may prevent one from assuming, for example, that an associated general osteoporosis is of senile type. In joints which have suffered from complete erosion of cartilage by granulation tissue we may find that reaction and repair take the form of ankylosis. This is obviously not a disease process but a purposeful and orderly repair with main trabeculations directed along lines of force across the joint.

(3) *Erosion of articular surfaces.*—The presence of erosion of articular surfaces adds considerably to the diagnostic value of the radiographic signs in rheumatoid arthritis, especially if certain characteristic features are noted and appreciated. Erosion in rheumatoid arthritis is associated with local invasion of joints by granulation tissue. In addition to spreading over the surface of articular cartilage, the invasion of granulation tissue is also directed from the articular margin between the cartilage and the articular cortex. The presence of this vascular tissue is revealed in the radiograph by the stimulating effect it has on local osteoclastic activity. The result is a loss of the normal sharp density of the articular outline in the region of the joint margin. This appearance can easily be overlooked if not fully appreciated, but it is an extremely important local sign if there is no obvious loss of cartilage or frank erosion. It is best seen when comparing the cortical outline of the corresponding bone in the other hand or in other similar joints. The heads of the metacarpal bones are the surfaces most commonly and clearly affected, especially the head of the second metacarpal bone (*see* fig. 1).

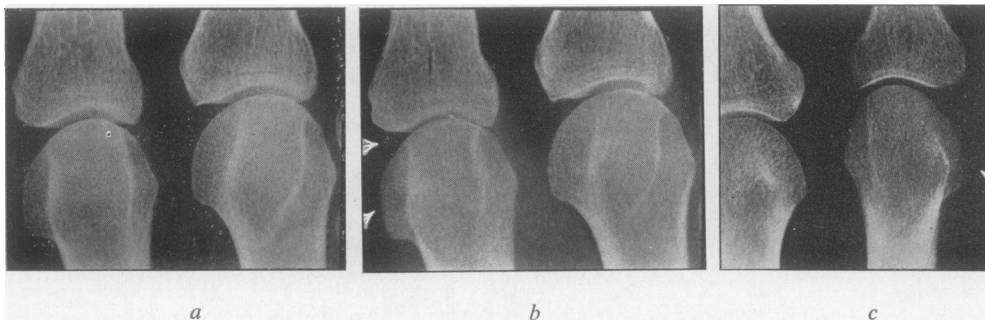


FIG. 1.—Rheumatoid arthritis. (*a*) Early changes. Generalized osteoporosis with predominance in the more vascular spongy bone. (*b*) Same case one year later. Typical local joint changes now seen with uniform loss of cartilage resulting from the formation of a pannus of granulation tissue over the articular cartilage. Subchondral invasion is also demonstrated by loss of the sharp articular outline. A marginal erosion is present but not shown in profile. (*c*) Another case showing loss of the normal sharp articular outline due to subchondral invasion by granulation tissue with stimulation of osteoclastic activity in the adjacent cortex.

Exactly the same process is responsible for characteristic features in frank erosions of rheumatoid type. These are most commonly found at the vascular articular margins, and if seen in profile—as they are likely to be in one or other joint of the hands—one can detect that the eroded trabeculæ are affected by the increased osteoclastic activity as there is a local zone of osteoporosis adjacent to the erosion. This appearance is quite different from an erosion of gouty origin.

In early lesions one may see a small scooped-out area at an articular margin with or without loss of density in the articular cortex, but certainly with osteoporosis of the exposed trabeculæ. Loss of density of the articular cortex may, on the other hand, be the first sign of local joint invasion. In an established joint lesion the erosions are deeper and may also be present along the articular cortex, with local osteoporosis of exposed trabeculæ. In late chronic

or quiescent stages the normal processes of repair come into operation and the eroded surfaces are covered with a thin layer of new bone which may make the lesion indistinguishable from pseudocystic areas of late gout or osteoarthritis. By careful search at this stage in other joints which are less prominently affected one may still see features which are associated with active rheumatoid arthritis (*see* fig. 2).

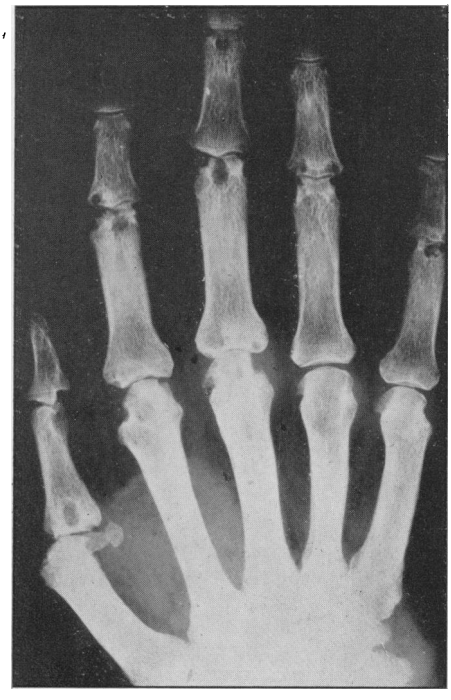

FIG. 2.—Rheumatoid arthritis. The prominent healed erosions might wrongly be interpreted as being of gouty origin. Less prominent but more active lesions reveal features of a typical rheumatoid arthritis. There is evidence of local joint invasion by granulation tissue with stimulation of osteoclasts in the eroded trabeculæ. Generalized osteoporosis is also noted.

(4) *Subluxation.*—Subluxation is a common sequel to any disorganization of joint structures. In rheumatoid arthritis there is a rather typical deviation of the fingers to the ulnar side. This may be associated with the fact that erosions are usually more marked on the anterior and radial aspects of the heads of the metacarpal bones.

### OSTEOARTHRITIS

(1) *Loss of cartilage.*—Loss of articular cartilage is the main factor in joint changes of the disease called osteoarthritis. Loss of cartilage spacing appears in joints subject to greatest strain or pressure and for that reason is usually most marked in larger weight-bearing joints such as the hips and knees—although in some workers it may be very marked in small joints of the hands. The loss of cartilage is usually uneven, with the narrowest space at the site of greatest strain. This produces a tilt in a hinge joint or slight subluxation in a ball and socket joint and alters the direction of lines of force in the bones.

(2) *Osteosclerosis.*—Osteosclerosis is the natural reaction to increased stress and strain or pressure in bone. Local osteoblastic activity is stimulated with formation of denser bone structure and coarser trabeculation of orderly and purposeful character along new lines of force in the bone.

(3) *Osteophytic formation.*—Osteoblastic activity is also stimulated at articular edges where joint surfaces approximate to each other as a result of cartilage degeneration. Outgrowths or osteophytes are formed in the line of the joint surfaces as if to extend the area on which the increased pressure falls. These osteophytes are spur-shaped and dense in structure. Osteophytes of somewhat different character are commonly seen in some joints, such as the spine, without any sign of loss of cartilage. These result from exaggerated stress and strain of ligamentous attachments just beyond the joint edge, and as they grow in size they follow the line of the capsular ligaments instead of extending out in the line of the joint surface.

They may form curved beak-shaped projections on either side of a joint which approximate to each other but seldom unite. Although generally accepted as changes of osteoarthritic type these osteophytes may be an accidental finding in a very athletic individual in late adult life. They are also of secondary character to local stress and strain of ligaments in cases of faulty alignment in the spine of developmental or traumatic origin. They begin as tiny spikes of uniformly dense woven bone quite distinct from the bone structure to which they are attached, but as they grow in size they may present an appearance of organized lamellar bone structure and trabecular formation continuous with the parent bone. They tend to limit the amount of movement of the joint and are often associated clinically with fibrositis.

(4) *Pseudocystic formation.*—Translucent areas in bone are frequently seen in osteoarthritis. They are pseudocystic in character and are separated from the adjacent trabeculæ by a thin wall of uniform bone density. They may encroach on the articular surface at a point of greatest stress across the joint. Occasionally they are seen without accompanying loss of cartilage or gross osteoarthritic changes, and may in such cases be due to trauma. Usually they are associated with advanced osteoarthritic changes and may vary in size from surface pitting to multiple endosteal pseudocystic areas close to the joint. These translucencies are sometimes almost indistinguishable from healed erosions of rheumatoid arthritis and gout where secondary osteoarthritic changes are present.

(5) *Heberden's nodes.*—Marked osteoarthritic changes of characteristic type are sometimes found in the terminal interphalangeal joints of the hands. There is uneven loss of cartilage with faulty alignment of the terminal phalanx. The articular surfaces are densely sclerosed and pitted. Marginal outgrowths are large and prominent and obviously of very chronic type, consisting of organized lamellar bone which produces a true hypertrophic appearance at the base of the terminal phalanx. Separate ossicles are also seen in the capsule opposite the joint. (These small ossicles may be present at a much earlier stage of osteoarthritis.)

## Gout

(1) *Punched-out areas.*—To recognize the appearance of a typical punched-out area in gout it is necessary to appreciate how it is formed. After a number of attacks which may be free from any obvious bone change, small deposits of sodium biurate may form in bone, especially close to a joint margin. Osteoclastic activity continues undisturbed and bone is removed in the normal way, but osteoblasts are inhibited by the presence of biurate crystals in the adjacent intertrabecular spaces and there is complete failure of new bone replacement in the affected area. A tophus or erosion formed in this way is characterized by the fact that the inhibitory action is localized to close contact and no fault is seen in the trabeculæ at the edge of the erosion which presents a characteristic chiselled-out appearance very distinctive from rheumatoid arthritis. A similar abrupt change from complete translucency to normal shadowing is sometimes seen in a thin shell of articular cortex projecting over a marginal tophus. It may even be detected in the trabecular margin of an endosteal tophus although somewhat obscured by other bone shadowing. Large endosteal tophi are sometimes crenated in outline and honeycombed in appearance from fusion of a number of affected areas of varying sizes. Small punctate translucencies may appear under an articular cortex with characteristic freedom from any local osteoporosis in adjacent bone structure.

Sodium biurate crystals in a tophus may eventually be dissolved away and replaced by inactive material. This is followed by disappearance of the characteristic feature described. Slight increase in density becomes apparent in the eroded trabeculæ and the tophus becomes pseudocystic in appearance with the formation of a thin lining wall of new bone. This appearance is also seen in osteoarthritis and late rheumatoid arthritis, but careful search may reveal an earlier lesion with characteristic features of the disease concerned.

(2) *Articular tophi.*—A feature of an articular tophus is the fact that the eroded bones are separated by a wide translucent space represented by the tophus. In erosions by granulation tissue these surfaces would be in close contact. When a small articular tophus becomes quiescent it may be invaded by granulation tissue with resulting ankylosis.

(3) *Secondary osteoarthritic changes.*—Secondary osteoarthritic changes appear in late stages of gout when there is quiescence in the local lesion. These changes are of the usual type, but the osteosclerosis tends to be more marked and the trabeculation coarser and wavy or irregular as a result of architectural damage to the inner bone structure from earlier gouty deposits in the bone. An additional feature noted in gout is a hazy shadowing in the soft tissues and sometimes multiple spotted areas of calcification in old tophi of the soft tissues (*see* fig. 3).

## Ankylosing Spondylitis

Radiographic appearances in ankylosing spondylitis are distinctive enough to permit a brief description of characteristic features found in this disease, but an explanation of why the changes take place is still to be found.

(1) *Osteoporosis.*—Osteoporosis in ankylosing spondylitis is a local change in the bones on either side of affected joints. It is noticeably absent, however, in the subarticular region itself where a narrow zone of normal density and somewhat woolly character is seen on either side of the articulation. The joints usually detected first of all in a radiograph are the sacro-iliac joints which show bilateral involvement.

In very chronic cases the contrast between the osteoporosis and zonal density is less striking. In active cases it is quite marked. In late stages of continued activity the osteoporosis is seen to invade and break up the denser subarticular zone. Spread of involvement


FIG. 3.—Gouty arthritis. The changes seen are in some respects similar to those illustrated in fig. 2, but study of the more active lesions reveals features typical of gouty erosions with a chiselled-out effect produced by local inhibition of osteoblastic activity from the presence of biurate crystals. Erosion is by normal osteoclastic activity without extra stimulation from granulation tissue. There is no generalized osteoporosis. Arrows indicate: (c) loss of cartilage; (o) osteophytic formation marginal and articular tophi.

of the disease is usually centrifugal, with a spread up the spine and later also to other joints of the pelvis and lower limbs (less commonly to the upper limbs). Osteoporosis is not present in the hands except in late stages with extensive involvement of joints.

(2) *Ankylosis.*—Ankylosis is produced in this disease by the formation of relatively fast-growing woven bone across the margins of the joint and not between the articular surfaces. The line followed corresponds to the inner aspect of the capsule as distinct from osteoarthritic bridging which follows the line of outer capsular ligaments. The line of ossification is thin and fairly uniform at first. It broadens outwards as time goes on, with its maximum thickness opposite the cartilage and not at the articular margins. This produces the typical "bamboo" shape which is sometimes seen in later stages in the lumbar spine. The ankylosis appears to be purposeful and orderly, and the ankylosing new bone usually shows better bone density and trabeculation in late stages than is seen in the bones of the affected joints. This accounts for another striking appearance called "tram lines" which is produced by ankylosis between the interarticular processes of the spine.

**Dr. Jacques Forestier:** The development of tomography [3, 4], which has already been employed for chest examination, has now been used with great advantage for the examination of bones and joints. The methods now used involve (*a*) more elaborate positioning, especially for the spine; (*b*) development of "stato-dynamic" radiography.

### Examination of the Spine

The most outstanding survey which has been made in the last decade, of the data to be obtained by radiography in the diagnosis of the diseases of the spine, has been published by Jean Saidman, 1948. Every aspect of rheumatic diseases of the spine, and of the other diseases which can be confused with them, have been described by him with great clarity and accuracy [6].

*Cervical spine.*—Routine examination of the cervical spine in anteroposterior and lateral views often fails to demonstrate the causes of root compression [3, 4]. Oblique views will usually do so. The technique is simple, the pictures being taken as usual in the erect posture; control of the positioning is made under fluoroscopy, when the intervertebral foramina of the opposite side appear quite clearly. By means of this technique any thickening of the postero-lateral margins of the bodies can be easily seen. The shape of the foramina may sometimes be altered to the form of an hour-glass. These films are of great value in cervico-brachial neuritis to demonstrate the level of the root compression.

*Dorsolumbar spine.*—Backache is one of the most common syndromes. In films taken in the erect posture it is easy to detect whether the roofs of the acetabula are, or are not, on the same level. Similar observations may be made on the iliac crests and the base of the sacrum. By reference to the vertical mid-line, the correct position of the pubic symphysis, the symmetry of the sacrum, and the verticality of the dorsolumbar spine in the antero-posterior view can all be checked. Lateral films demonstrate the normal or abnormal curvature of the dorsal and lumbosacral regions as they are in everyday life.

The radiologist should be shown, as accurately as possible, the levels at which special information is required. Large films, covering a long segment of the spine, are useful only to detect gross changes such as areas of destruction, important deformities or displacements.

To determine the proper angle at which to take the film, the first film should be taken laterally in the erect posture, centred on the region to be examined; the centring may be done by fluoroscopy. Once this angle is established for each intervertebral space the anteroposterior view will then be taken with an obliquity depending on the level to be examined. Oblique pictures may similarly be used to show the isthmus and the articular facets.

In some instances it may be an advantage to put the film for anteroposterior views on the abdomen, the tube being at the back. In the case of the lumbar spine, on account of its concavity due to the normal lumbar lordosis, several intervertebral spaces may be seen very clearly on one film [5].

Lipping of the vertebral angles may be associated with a regular thinning of the disc, giving the picture of what the author described with Robert and Certonciny under the name of "Arthrose ménisco-somatique isolée, lombaire et lombo-sacrée" [7], which particularly affects middle-aged women and is the cause of chronic lumbar pains. Similar changes may appear in the lumbar discs in connexion with static troubles where the first two elements, spondylolisthesis and retrolisthesis, are the consequence of the softening of the disc, associated with postural abnormalities.

All the conditions described above are focal changes in the spine, which may be contrasted with the osteophytic changes which occur in elderly people and are in most cases symptomless [8, 9, 10 and 11].

In X-ray examination of the spine it is important to recall a fact which is often overlooked by radiologists in many countries and which is essential to early diagnosis of ankylosing spondylitis. For more than fourteen years G. Scott, myself, and other writers have repeatedly pointed out that the earliest radiological signs of this serious disease are *not to be found in the spine, but in the sacro-iliac joints.* The description of these early changes, which are very distinctive and even when unilateral are easily recognized, has been given on several occasions [12]. Too often the onset of ankylosing spondylitis may not even be suggested when a young man complains of repeated vertebral pains, because no vertebral changes are visible. It must be repeated here that in the early stages of ankylosing spondylitis the sacro-iliac changes are, as a rule, not associated with local clinical signs, and they precede any ligamentous ossification by several years [13].

### Examination of the Hip-Joints

Under the name of hip-joint arthritis several different diseases are generally described. X-ray examination is of major importance, not only to distinguish true osteo-arthritis from other diseases, but also to indicate precisely the morbid anatomical changes present. In order to classify radiological reports and to provide practical deductions for diagnosis and treatment, the Second International Conference on Rheumatic Diseases, held at Aix-les-Bains in June 1948, established a classification of the different types of radiographic changes in hip-joint arthritis, which may be of use to the radiologist, the rheumatologist,

and the orthopædic surgeon, and serves to distinguish incipient from advanced cases.

As a basis of classification, this scheme takes into account the centring of the head of the femur in relation to the acetabulum, and the presence of cystic formations. If the head of the femur is concentric with the acetabulum the femur is said to be centred, otherwise it is decentred. The following changes may thus be classified (*see* Tracings, figs. 1 to 9):

FIG. 1.

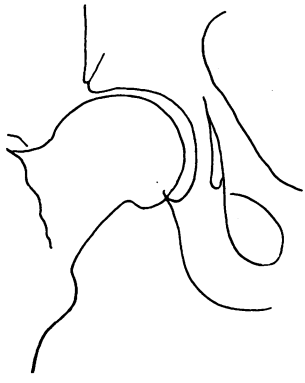

FIG. 2.

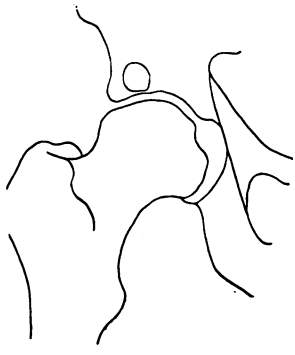

FIG. 3.

FIG. 4.

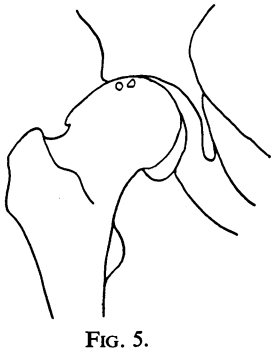

FIG. 5.

FIG. 6.

FIG. 7.

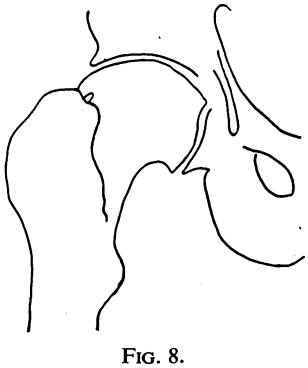

FIG. 8.

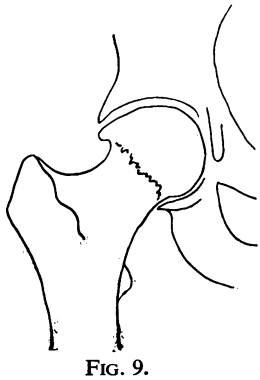

FIG. 9.

*Tracings* (figs. 1 to 9).—Classification of radiographic changes in osteo-arthritis of the hip. Adopted by the Second International Conference at Aix-les-Bains, June 1948.

A.—*Initial Stages.*

1. Centred—Thinning of articular cartilage at upper pole.
2. Decentred—Slight outward displacement of the head of the femur and thickening of the inner part of the acetabulum.

B.—*More Advanced Stages.*

3. Centred—with cyst formation in innominate bone.
4. Centred—with cyst formation in innominate bone and in head of femur in pressure areas.
5. Subluxated—with thickening of the inner part of the acetabulum (French "Double Fond").
6. Subluxated—with femoral cysts.
7. Subluxated—with pelvic and femoral cysts.
8. Hypertrophy of head of femur.
9. "Encircling type" (to be distinguished from protrusio acetabuli).

It seems most desirable that, in future, radiographic reports on such cases should adopt an international classification such as the above.

## Stato-Dynamic Radiography in the Hip-Joint

Since the hips are the most important joints in the movements of walking we have felt for some years the necessity of examining them radiographically in a position as close as possible to that adopted physiologically in walking. Among the different phases of the human progression the most characteristic is when the body is supported on one extremity. In this phase the centre of gravity of the body lies in the medial sagittal plane and an important torque exists in proportion to the distance of the centre of rotation of the femoral head from the medial sagittal plane. If it were not for the powerful action of the abductor muscles of the thigh, the pelvis and trunk would sag down on the opposite side. In this phase, which is the most painful in cases of hip-joint arthritis, the torque has an oblique direction towards the medial plane, the head is pressed against the inner part of the acetabulum and the joint is submitted to much bigger and quite different forces from those which obtain when the patient is standing on both feet.

Owing to deformities of the acetabulum in many cases of osteo-arthritis (principally those associated with external upper subluxation) we felt that it should be possible to demonstrate the abnormal movements of the head of the femur to the acetabulum, as an aggravating factor of the disease. It is obvious indeed that no other location of arthritis in the skeleton suffers such prompt and severe aggravation as that of the hip-joint when the weight of the body is borne alternately on one foot and the other.

*Technique.*—The following technique, which we have described as "L'épreuve d'appui" (weight-bearing test), has now been used in over 120 cases. The patient is placed standing, each foot on a separate footstool. A large film with a vertical grid is placed behind his pelvis covering both hip-joints, the whole pelvis and the lumbosacral joints. The distance from the X-ray tube should not be less than 80 cm., and more if possible [5]. One stool is removed, and the patient is asked to stand on one foot in this position; the first film is taken immediately, with one foot hanging and the weight of the body bearing on the opposite hip. After a short rest the same technique is applied to the second hip. A comparison of the pictures of each hip in the weight-bearing position and in the non-weight-bearing position provides interesting observations.

In normal joints, no difference can be detected between the two films and no changes in the respective positions of the head of the femur and the acetabulum. The width of the articular space remains the same. In osteo-arthritis the weight of the body brings about changes which are immediately apparent, or can be detected by comparison of the two tracings made from the films of each hip obtained as described above. The changes observed are as follows:

(*a*) Thinning of the joint space, sometimes in its inner, upper or lower part.

(*b*) In advanced cases, where no joint space is visible, if the disease is progressing, flattening of the deformed head of the femur against the acetabulum.

(*c*) In subluxated joints, where the head of the femur is only partially pressing against the acetabulum, one would expect an outward displacement, but this was observed only in a minority of cases, the range of displacement being from two to six mm. In most instances no displacement at all was observed. This condition is classically described as an indication for surgical operation—osteoplastic shelf (Butée ostéoplastique)—to prevent the slipping of the head of the femur. These findings contra-indicate this operation in many cases of subluxation and explain why a number of such operations have been unsuccessful (figs. 10 and 11).

(*d*) To our surprise, some pathological hips show an inward displacement of the head of the femur of 2 to 3 mm.; such cases are generally associated with the presence of osteophytes on the lower part of the anterior margin of the acetabulum.

(*e*) In congenital dislocations, important displacements of the head of the femur along the

ilium may reach 2 to 4 cm., and this is frequently associated with a tilt of the pelvis which brings the ischium against the lesser trochanter (figs. 12 and 13).

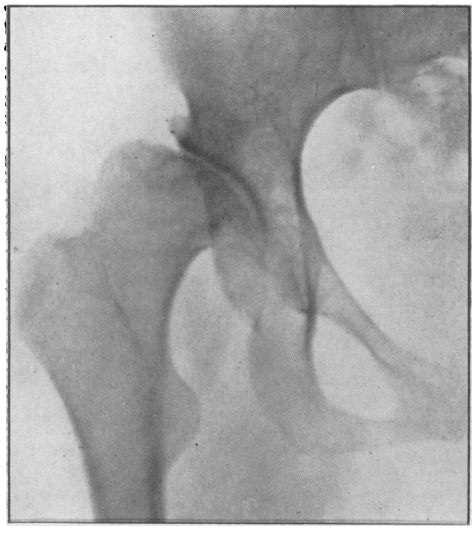

FIG. 10.

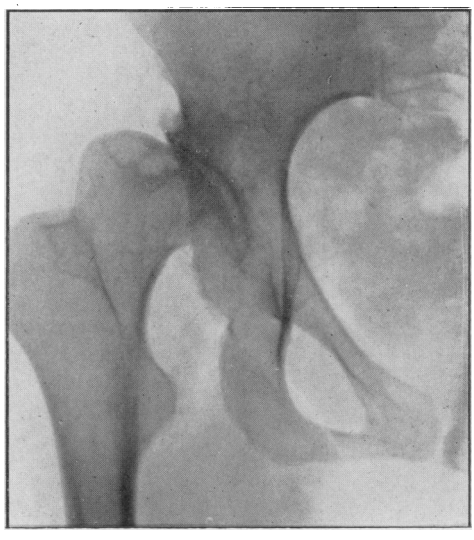

FIG. 11.

FIGS. 10 and 11.—*Subluxation of the right hip.* In fig. 10, the hip-joint is "hanging" without any weight upon it. In fig. 11, the patient stands exclusively on the right leg. In spite of the obliquity of the roof of the acetabulum, there is no outward displacement of the head of the femur.

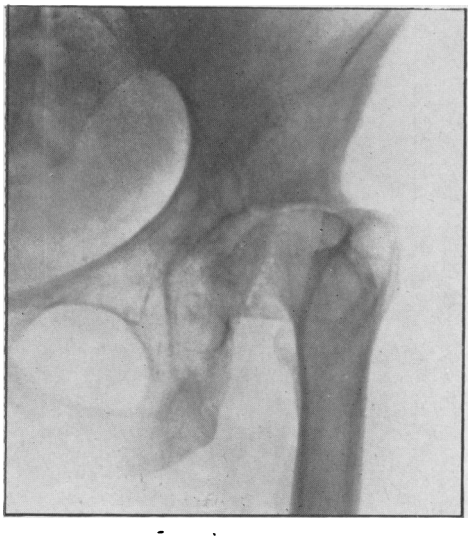

FIG. 12.

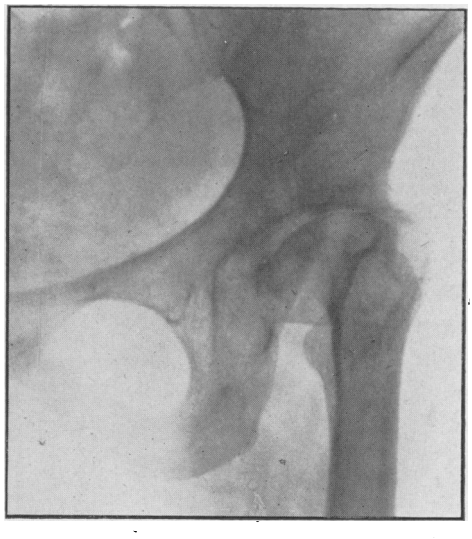

FIG. 13.

FIGS. 12 and 13.—*Coxa vara of the left hip-joint.* In fig. 12, the hip-joint is "hanging". In fig. 13, the patient stands exclusively on the left leg. In the latter attitude a definite inward displacement of the head of the femur occurs.

(*f*) After plastic operations or after treatment of fractures of the neck of the femur, control of the proper bearing on the head of the femur is obtained much better by our method than by the ordinary routine radiographic examination in the supine posture.

This technique provides for stato-dynamic examinations of the pubic symphysis, sacro-iliac and lumbosacral joints in the frontal plane. We have also started the examination of

the hip-joint in the lateral view, to study the displacements of the head of the femur in the sagittal plane.

It is interesting to note that, at about the same time as this technique was evolved, the functions of the abductor muscles have been studied in the United States from a purely physiological point of view by V. T. Inman [14].

*Rheumatic osteolysis.*—Among the various eventualities which may affect the long bones in the course of rheumatoid arthritis, osteolysis of the articular ends is a rare condition. We have observed it mostly in the phalanges, the metacarpal bones, the elbow and the femoral head. In the latter case it is associated with an enlargement of the acetabulum. We do not know the origin of the osteolysis, but we have observed a case of rheumatoid arthritis in which this condition has taken place in one hip-joint and protrusio acetabuli has occurred on the opposite side without any bone resorption.

*Some uncommon skeletal conditions.*—As a consequence of the German occupation in France and the food restrictions which ensued, a great many cases of hunger osteopathy were observed in the second part of the last war and the following years. They were characterized by intense decalcification of the different elements of the skeleton, affecting particularly the vertebral bodies. In extreme cases plastic changes, and collapse of several vertebræ bodies, were observed. Women of middle or advanced age were mostly affected. Another form of these osteopathies was the occurrence of pseudo-fractures occurring in different parts of the body, especially the pelvis and long bones (Looser, Milkman and Debray).

It is remarkable that most of these cases responded quickly and completely to intense recalcification therapy.

## Prolapse of Intervertebral Discs

In the course of radiographic examination of rheumatic cases it may be possible to detect and to locate prolapsed intervertebral discs. For the past two years we have used a new method which consists in the introduction of an iodized oil of low viscosity (''Discolipiodol'') in the epidural space, through the sacro-coccygeal hiatus. To avoid the dispersion of the oil, a thin ureteric catheter is passed through a trocar up to the level of the suspected disc. 5 to 10 c.c. of the oil are then injected under fluoroscopic control, and anteroposterior and lateral films taken as required. Prolapsed discs can thus be detected when the opaque medium is either blocked or deviated from its normal course, or when a radicular sleeve cannot be mapped out (Forestier, Sicard and Œconomo. Unpublished). This examination is completely harmless.

## Conclusions

The value of X-ray diagnosis in the study of the rheumatic diseases has been extended in the past few years by the introduction of osteoarticular tomography, by the use of new positions, and by the examinations of the joints in action instead of at rest (stato-dynamic radiography).

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