plague in the light of Pariset's theory; none of the rich, the exhaustive series of facts but is perfectly congruent with the theory; the pieces fit together like the elements of a jigsaw puzzle. Yet we all recognize now that Pariset's theory is false. The condition that a hypothesis shall describe all the available facts is necessary to its validity but is not sufficient to guarantee it more than a provisional value. We have to bear this in mind when we seek to interpret the vast complex of industrial phenomena. We are to remember that an industrial community attracts to itself immigrants both from the non-industrial districts of the country within which it is situated and from other countries, and subjects these migrants to a new form of environmental selection.

In Dr. Perry's study of one of the great seats of the American cotton manufacturing industry it is shown that the incidence of mortality upon workers of different races varies enormously. The general death rate per 1,000, at ages 15-45, over the period studied (1908-12) was 6.97 amongst Americans, 8.31 amongst English, and 17.26 amongst Irish (p. 238). This is perhaps an example of the consequences of introducing an "unsalted" population to factory life of which I shall speak later. But as the supply of home-born labourers increases and migration relatively decreases it might be that the incidence of excess mortality would be shifted to the later ages. It might be that the phenomenon to which I have drawn attention is rather due to a change in the character of the population than in the nature of their environment. To study this matter we should need data which do not exist; the possibility can be stated, its probability cannot be measured. Still there is one set of facts which, though by no means decisive, is yet of importance.

I have already commented upon the unfavourable comparison between our mortality in later ages and that of Sweden, and the favourable contrast between our adolescent mortality and that in the Scandinavian countries. More will be said of this; now I would remark that, in the opinion of many Swedish medical men and statisticians, the extremely unfavourable position between the ages of 15 and 25 is attributable to industrial employment. It is noteworthy that Swedish industrial legislation for the protection of young persons in the matter of length of hours, night employment, etc., is still less stringent than our own and only became really effective within the last twenty years; that is to say, that the rising importance of Swedish industries which has been associated with a stagnation of mortality at adolescent ages did not, as did the Victorian growth of factory industry, produce either so early or so complete a legislative interference in the interests of national hygiene as we have experienced. Again I repeat the caution that other explanations are possible. Still it is a fact that the country in which growing industries were accompanied by hygienic control of juvenile labour experienced a declining juvenile mortality; the country which introduced such control late in time has had a stationary juvenile mortality.

EXCISION OF THE HEAD OF THE FEMUR IN ARTHRITIS DEFORMANS (OSTEO-ARTHRITIS) OF THE HIP-JOINT.*

BY

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THE variable terminology of chronic joint diseases has been productive of much confusion, but it is well recognized that the chronic "non-specific" joint diseases of adult life fall into two great groups—the rheumatoid and the osteo-arthritis—each presenting a clinical picture and a train of morbid joint changes of a distinctive type. Both were formerly included under the term "arthritis deformans," but should properly be regarded as separate clinical and pathological entities; if the term is retained it is more applicable to the osteo-arthritis class alone, for it is here that bony deformation of the articular ends is a conspicuous feature.

We may thus define osteo-arthritis of the hip-joint as a chronic monarticular lesion, the dominant pathological changes being of a hypertrophic nature as indicated by the development of marginal osteophytic deposits with expansion

and mushrooming of the femoral head, but with no tendency towards the production of true ankylosis. The term "morbus coxae senilis," often applied to this affection, is a misnomer. The clinical, pathological, and radiographic pictures of osteo-arthritis of the hip may be seen at varying periods of life: in the adolescent, in the young adult, in middle life, and in old age. It is, however, in the middle-aged individual that we encounter the fully matured arthritis with its consequent serious crippling and disablement.

ETIOLOGICAL CONSIDERATIONS.

A review of some forty cases under observation and treatment during the past few years seems to show that osteo-arthritis of the hip can be classified into three more or less arbitrary groups.

1. *Infective*.—In this group there is definite evidence of the continued existence over a long period of time of some active focus of infection, this in the majority of instances being sepsis in connexion with the mouth or nasal passages. In these patients the joint changes are often far advanced in early middle life.

2. *Traumatic*.—Under this heading are included those cases of osteo-arthritis of the hip which appear to follow the infliction of a single severe trauma. In a certain number of cases this has been an actual crush fracture of the neck of the femur without immediate displacement; absence of displacement accounts for the fact that the patient is able to bear weight on the limb almost at once, and in consequence the actual lesion may escape diagnosis. In this class of case there is invariably a latent period between the infliction of the injury and the onset of the subjective signs of arthritis, and it is usual for the patient to consider that complete recovery from the accident had occurred. The age incidence in this group tends to be higher than in the infective class. The end result of this type of incomplete fracture may be contrasted with the hip-joint disability seen in cases of non-union following a complete solution of continuity of the femoral neck.

3. *Secondary*.—The third class comprises those cases in which there is seen to be the development of signs of progressive arthritis in a hip-joint which at an earlier period—in childhood or adolescence—has been the seat of some deforming process, such as pseudo-coxalgia or arthritis deformans juvenilis. These hip-joints from early life have exhibited a structure departing from the anatomical normal, but there has been a period of complete quiescence from symptoms until in later life certain influences, such as infection, trauma, or chronic strain, provide the necessary etiological factors to initiate a renewal of active arthritis.

The separation of these different groups is somewhat artificial, for it is probable that in the majority of cases of osteo-arthritis of the hip-joint the actual etiology is complex and represents the interplay of a combination of factors.

CLINICAL CONSIDERATIONS.

I shall not give a long description of the ordinary clinical features, pathological changes, and radiographic signs characteristic of osteo-arthritis of the hip-joint, but will content myself by briefly emphasizing certain important clinical aspects of the typical case.

Early Stages.—In the early stages the outstanding symptom is the long persistence of severe pain localized to the region of the hip-joint, and referred along the distribution of both the sciatic and anterior crural nerves. Many of these patients are diagnosed as suffering from so-called sciatica, and receive the whole gamut of inappropriate treatment for a long time before the underlying lesion is discovered; it is therefore important that an early efficient physical examination of such a patient should be made. There are certain difficulties in the way, for at this period the early bone changes may be relatively inconspicuous or invisible even in the best radiograms; again, in obese individuals it is no easy matter to obtain good hip-joint skiagrams. It should be unnecessary to insist on the futility of interpretations derived from the examination of a radiogram of one hip-joint alone without comparison with its fellow. In the earlier stages of the disease the limitation in the mobility of the joint is comparatively slight; it usually affects the range of abduction only, but in some cases the movements of flexion and internal rotation also. The patient himself is often soon aware that a restricted mobility has developed because of his inability to bend down in comfort to take off or lace the boot on the affected side.

* Read before the Manchester Medical Society, March 22nd, 1922.

Later Stages.—In the later stages there is a progressively increasing fixation and deformation of the hip-joint structures. Although the resulting fixation of the hip-joint may appear at first sight to be complete, it is even in an advanced stage dependent partly on the existence of muscular spasm, as examination under an anaesthetic will prove. The hip-joint follows its usual plan of reproducing the classical malposition of flexion and adduction. By this time the radiographic signs are gross enough to be apparent at the first glance, and they confirm the knowledge derived from clinical examination, that in spite of an advanced deformation of the joint surfaces true fibrous or bony ankylosis has not occurred. From the patient's point of view it is a pity that ankylosis is not reached in a short time, as it would lead to cessation of the intolerable pain.

I have indicated the course of the average severe case in which the resulting disablement is dependent on a combination of two dominating factors—namely, a continuance of severe pain and a steadily increasing fixation of the hip-joint in malposition. It is not every case, however, which advances to such a marked degree of deformation; in some patients the bony changes are arrested at an early phase, and associated with these changes of lesser magnitude the clinical features are often relatively mild.

TREATMENT.

It is illogical to suppose that the administration of this or that drug combined with the local application of the various forms of balneotherapy or physiotherapy can influence the train of morbid changes in a hip-joint already the seat of arthritis. It is not denied, however, that such measures are efficacious in producing temporary relief of the subjective signs. Given the recognition of early arthritis, a period of complete rest with immobilization of the hip-joint in the correct position of abduction, followed later by the provision of a suitable walking splint designed to eliminate full weight-bearing, will tend to prevent or at least arrest the development of gross deforming bony changes. It is assumed also that if the determining etiological factor is infection, complete eradication of every discoverable focus will be carried out.

In the practical handling of osteo-arthritis of the hip-joint, however, the critical period at which the ideal early preventive treatment is applicable is often long past, and we are called upon to deal with the serious disablement of the later stages. It is then that the question of the value of operative treatment becomes of paramount importance to the patient.

Operative Treatment.

Four main classes of operative procedure have been employed: (1) Manipulation under anaesthesia; (2) the simple removal of osteophytic deposits; (3) surgical fixation of the hip-joint—that is, arthrodesis; and (4) simple excision of the head of the femur. Great care and judgement must be exercised in choosing patients for operation, and it is necessary in each case to have a clear conception of what constitutes the essential disability from the patient's own point of view. This may be either pain or progressive deformity, or a combination of the two. Within certain limits age alone does not constitute a standard of suitability or unsuitability. In my own series excision of the head of the femur has been performed in an individual aged 61, and in another aged 65, with results quite as satisfactory as in younger patients. Patients for operation should be robust or "wily," capable of tolerating the minor discomforts of post-operative immobilization and of early post-operative physiotherapy, and endowed with a determination to collaborate with the surgeon in the long period of after-treatment which may be necessary.

1. **Manipulation under Anaesthesia.**—In the early or middle phases of the arthritic process, when the infiltration and thickening of the joint capsule is slight, when the osteophytes are scanty and plastic, and when the femoral head shows little or no deformation, forcible manipulation particularly directed towards the achievement of the full range of abduction is a therapeutic manoeuvre of extraordinary value. This procedure is eminently suitable for patients in whom pain has not been a prominent feature, but who are more especially concerned about the increasing limitation of mobility in the hip-joint. Sir Robert Jones has long employed this form of treatment in picked cases with striking success. More recently Petró of Lund¹ has commented upon the undoubted efficacy of forced movements, which in his view should be powerful and painful! Manipulative treatment has no permanent curative effect, but from a symptomatic point of view its beneficial effects may last for several years, or even indefinitely where the arthritic process has undergone spontaneous arrest at an early stage.

2. **Excision of the Osteophytic Outgrowths.**—This operation is in some measure the open equivalent of the bloodless manipulation.

Its rationale is founded upon the view that the limitation of mobility is chiefly dependent on the mechanical obstacles afforded by the presence of osteophytes. Removal of the hypertrophied lip of the acetabular roof was advocated as a definite limited operative procedure both by Sampson Handley and De Courcy Wheeler some years ago, and has been termed "cheilotomy." Occasionally the osteophytic growths in the acetabular region assume a somewhat bizarre form, and arise from the floor of the cavity itself, thereby producing greater interference with mobility than the commoner hypertrophied acetabular margin. Their operative removal has been recorded by Brackett of Boston, who also in a number of cases carried out independently an operation of a similar nature to the cheilotomy of Handley and

Wheeler. On the whole the operations in this category are of very limited application. The operative exposure of a good many of these hip-joints has impressed on me the fact that the ordinary osteophytic deposit on the acetabular rim plays a small part in producing limitation of mobility.

3. **Arthrodesis.**—The operation of surgical fixation of the hip-joint for osteo-arthritis has been warmly advocated by Albee and given a very efficient trial by Brackett. Designed to transform a painful progressively stiffening hip into a painless fixed hip ankylosed in the position of maximum utility, the operation is, in theory, exceedingly attractive. An investigation into the end-results of a series of hip-joint arthrodeses performed in Boston and published recently has shown that a good many results have been disappointing, owing to the difficulty of obtaining solid bony ankylosis. Where complete fixation has failed the adduction malposition has returned and the functional result in such cases has been comparatively poor. Most surgeons who have attempted to perform arthrodesis on many hip-joints have experienced the same technical difficulty. Bony ankylosis can be ensured only after the complete removal of the whole of the smooth sclerosed bony tissue which represents the articular surfaces in these joints after the disappearance of the cartilaginous covering. The period of post-operative fixation must be prolonged and full weight-bearing postponed until it is determined by clinical and radiographic tests that true ankylosis has been secured. The scope of the operation and the necessarily prolonged after-treatment render it suitable only for younger individuals.

FIG. 1.—The shaded area of the femoral head indicates the amount which is removed at the operation; the line of section for the temporary elevation of the great trochanter and the elevation of the aponeurotic flap from the vastus externus are also shown.

FIG. 2.—Illustrates the conformation and position of the hip-joint at the end of the operation.

Excision of the Head of the Femur.

I now come to the operation which has engaged my special attention for some time past. Excision of the hip-joint or excision of the head of the femur has for a long time been one of the standard operations of surgery for many affections. Of late years it has fallen into disrepute, and deservedly so, for as performed in the old manner with complete lack of correct after-treatment the usual end-result was an unstable pathological dislocation. The operation flourished in the surgical epoch of excision of joints when surgeons were primarily concerned with the eradication of disease and operations were less commonly conceived in terms of function. The operation here designated "excision of the head of the femur," as applied to osteo-arthritis of the hip-joint and carried out in the manner to be described, is a somewhat different proceeding. It is fundamentally reconstructive, and not destructive, in type.

In brief, the operation involves the following steps: (a) The removal of the overhanging mushroomed portion of the femoral head, leaving the stump of the neck of a reasonable length and with a slightly expanded upper end rounded off so as to simulate a new head; (b) the stump of the neck is brought deeply into the acetabulum by fully abducting the limb; (c) the great trochanter, which has been detached as an integral step in the exposure of the hip-joint, is re-attached to the femoral shaft at a lower level, thus acquiring a position of mechanical advantage (Figs. 1 and 2). This latter manoeuvre is an important feature of the operation. I have used it only in my later operations and before I was aware that it had been already introduced by Royal Whitman of New York as part of his reconstructive operation on the hip for old fractures of the neck of the femur. There are other technical details of importance and interest. In removing the femoral head it is necessary to use a wide osteotomy with a curved shaft in order to reproduce the rounded stump of the neck. The surface of the cancellous tissue thus exposed, after being smoothed off by filing, is thoroughly impregnated with Horsley's wax. The same procedure is carried out in the raw area left by the detachment of the trochanter. In addition, this latter area is covered by a small aponeurotic flap elevated from the vastus externus and turned upwards, leaving bare the femur in the region where the trochanter is to find its new site. With regard to the approach to the hip-joint used in this operation, in my experience the posterolateral route described by Brackett² is of all methods the most adequate.

After the operation the patient is nursed for six weeks on an abduction frame; the hip is completely immobilized by means of a fixed extension for the first three weeks only; after that gentle massage and active movements through a small range are given each day. In the intervals of treatment the patient is encouraged to repeat the attempts at active movement, the foot now being anchored to the lower part of the frame by a slack clove-hitch bandage. At the expiration of the six weeks' recumbency, if the patient has moved the hip with fair comfort (and this is usual), a calliper walking splint is applied and he is allowed to get up on crutches. A few weeks later full weight is borne on the calliper ring and the crutches discarded. The physiotherapeutic treatment is continued for some months, and the calliper splint is retained for at least six months; but in my experience the hip-joint is stable after three months, and the natural tendency of the patient is to discard the calliper at an early date.

The operation here described has given me exceedingly gratifying results, and for this reason has been described in some detail. I believe that it is applicable for the relief of the pain or malposition in moderately advanced cases of osteo-arthritis of the hip-joint at any age, provided the patient is constitutionally fit to undergo a major operation. There are few mechanical difficulties in the way of its fairly rapid performance; it takes less time and is less provocative of shock than an efficiently carried out arthrodesis. It is thus specially suitable for older patients, but my own trend at the present time is in favour of utilizing it also as an alternative to arthrodesis in younger individuals. The operation appears to give complete relief from the intolerable pain, and it also ensures the correction of the malposition. The degree of mobility in the reconstructed joint varies in different cases and under the influence of many factors. To some extent the range of mobility depends on the amount of bone removed in the resection of the femoral head—a factor which, as is well known, so often determines the function of any joint excision or arthroplasty. In a few individuals the range of

mobility, which is free in the early days after the operation, later diminishes very considerably, but this, happily, is not associated with any return of the old pain and discomfort.

It is not suggested that this operation is in any way original either in its conception or its application, but a somewhat intimate acquaintance with the technicalities involved in its performance and personal experience of its effectiveness have urged me to emphasize its place in the repertoire of surgical procedures available for osteo-arthritis of the hip-joint.

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THE ETIOLOGY AND TREATMENT OF DIABETES:

WITH SPECIAL REFERENCE TO THE SIGNIFICANCE OF A STARCH-SPLITTING AND ACETONE-FORMING ORGANISM FOUND IN THE STOOLS OF DIABETIC PATIENTS.

BY

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In the consideration of the pathology of diabetes very little is known concerning the source of the acetone bodies—acetone, diacetic acid, and beta oxybutyric acid—which are eliminated from the body in this disease, and which are considered to be the cause of the acidosis and coma which result from their accumulation. The generally accepted view is that these bodies are derived from the amino-acids of the protein molecule, from the fats of the tissues, or even from carbohydrates, but the tendency is rather to explain their origin from the oxybutyric acid derived from fats.

In other words, there is general confusion on this point, and Adami correctly focuses present-day knowledge concerning them when he says, "we cannot as yet say definitely what is the origin of these bodies, whether from the amino-acids of the protein molecule, from the fatty acids, or from the carbohydrates." No one has, so far as is known, laid down any experimental proof that these bodies may be derived from the carbohydrates by bacterial action within the alimentary canal.

Bacteria capable of producing acetone from starch or other carbohydrates have been known to exist for some time; thus in 1905 Schardinger¹ first described such organisms. Secondly, under the name of "Amylobacter," Bredemann,² in 1909, described acetone-producing bacteria possessing spores. In this country attention was called to the practical application of these bacteria to industry by Fernbach and Strange³ (Eng. Pat., 1912, No. 21,073), who actually manufactured acetone on the commercial scale by the ferment action produced by those bacteria on starchy foods.

It is known that the acetone production from starch is not restricted to the action of one particular bacterium, but it is very likely that there exists a family of the bacteria which have been described generically as "Amylobacter." The difference between the members of the family is not completely understood yet, but there are distinct differences in size—particularly in the width of the different organisms. Chemically, the point of similarity seems to be acetone production, which is common to all, and the point of difference the nature of the alcohol produced along with the acetone. Thus Fernbach's organism produces acetone and butyl alcohol, and this was developed during the war by Dr. Weizmann on account of the value of these two products, the one as a solvent for gun-cotton, and the latter for its use in connexion with isoprene, an intermediate body in the synthesis of india-rubber. In addition to this there is a complete description in the literature of another organism, *B. acetoehtylicum*, described by Northup, Ashe, and Senior.⁴ This organism produces 10 per cent. acetone and 25 per cent. ethyl alcohol and small quantities of propyl and butyl alcohol. It is a much thinner organism than the one described by Fernbach, being only 0.2 to 0.3 μ against 0.8 to 1.0 μ .

A description of the acetone-butyl alcohol fermentation from starch and its technical application is given by Gill⁵ and a description of the organism was published by Thaysen⁶ in