justifiably be accepted as affording satisfactory and conclusive evidence of the principle of the alteration of the state of tension on the normal lens-capsules in the act of accommodation, and of the influence which the various drugs experimented with may normally have upon this tension.

PHYSIOTHERAPY IN THE TREATMENT OF ARTHRITIS.

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For the purpose of the present article it is proposed to limit the field of discussion to acute and chronic infective arthritis of non-tuberculous origin, climacteric arthritis of metabolic origin, periarticular fibrositis and bursitis, and osteo-arthritis. The forms of physiotherapy to be discussed are massage, active and passive movements, stimulation by the faradic and galvanic current or the Bristow coil, radiant heat, ionization, and diathermy. Hydrotherapy, in all its forms, is deliberately omitted, as it forms a separate study, and the numerous other forms of electrical and mechanical appliances are not referred to because it is very doubtful if anything can be effected by them which cannot be done by the simpler methods enumerated above. Moreover, with the possible exception of radiant heat and diathermy, these are usually within the reach of any practitioner even in country districts; but heat can, in fact, be applied by methods other than radiant heat, and ionization will serve much the same purpose as diathermy, if the latter is not procurable. Those skilled in massage and physiotherapy are available almost everywhere, and portable faradic and galvanic batteries are relatively inexpensive. Ionization can be given adequately with the latter, provided a milliamperemeter is attached.

Acute Infective Arthritis.

In this condition the joint is exquisitely tender and swollen and the skin over it is hot and red. If the condition is prolonged the muscles round the joint waste rapidly, and this, coupled with the swelling and consequent stretching of the ligaments, may ultimately result in a lack of stability of the joint. This causes a serious disability later, when the patient should be able to resume an active life.

The first indication for treatment in this form of arthritis is to keep the joint at rest until the inflammation has subsided. As there is a possibility that an acutely inflamed joint may become fixed, it is important that it should be kept at rest in the optimum orthopaedic position. Thus, in the event of this unfavourable result a maximum of useful movement can be obtained through the shoulder girdle and pelvis in the case of the proximal joints, and requisite stability for weight-bearing in the case of the knee, while the other joints are in such a position that the important functions of the limb are still possible. In this country splints and plaster which completely immobilize the limb are the usual methods employed, but in view of the results obtained by Professor Rollier in his clinics at Leysin, and by others, it is by no means certain that it would not be better, where possible, to restrain the joints by means of sandbags or plaster troughs. These enable the patient to make small voluntary movements, and it is noticeable that voluntary movements never do harm to a joint, for the pain resulting from the threat of too great movement immediately inhibits the movement. The result of these small harmless active movements is that there is extraordinarily little muscular wasting, even although, as is the case at Leysin, no massage or other form of physiotherapy is used.

The second aim is to restore and maintain the tone of the surrounding muscles so that the ultimate stability of the joint is endangered as little as possible, and the patient

is enabled to resume active life at the earliest possible moment. This can only be achieved by exercising the muscles without disturbing the joint, either by allowing small active movements as described above, or by careful massage. Splints, if used, should be so fashioned that they can be removed sufficiently for the masseuse to get at the muscles without disturbing the position of the joint. The massage must be strictly confined to the bellies of the muscles, and care should be taken not to cause any pull on the ligaments which form the capsule of the inflamed joint. For this reason any effort to restore muscles by electrical stimulation is contraindicated, since the resulting muscular contractures inevitably disturb the periarticular structures. In no circumstances should the joint itself be touched by the masseuse, even if the position is bad, for sudden movements will only intensify inflammatory reactions, and changes in posture are better effected by the steady and gradual traction of properly applied extension apparatus.

The reduction of inflammation and swelling can be effected by counter-irritants such as Scott's dressing or blisters or by ionization. The latter process consists in the application of pads of lint soaked in certain saline solutions to which are attached electrodes in the circuit of a galvanic battery. In this way a constant current is passed through the joint, and the burning of the skin which would result from the direct contact of the zinc electrodes is prevented by the pads. The original theory of this method of treatment was that certain drugs were conveyed into the joint in an ionic and therefore extremely active form. There is considerable evidence to support the contention that the metallic and acid radicles are carried into, and possibly through, the skin and distributed by the blood stream, but it is extremely doubtful if the drugs reach the deeper tissues of the joint. The action of ionization would appear to be twofold: in the first place, the skin is stimulated and the effect of counter-irritation is produced; and secondly, the passage of the current through the joint results in a local hyperaemia which ensures the neutralization of toxins and the removal of waste products. Ionization should be applied for twenty minutes on alternate days with a current of from 30 to 70 milliamperes, varying with the tolerance of the patient, till the swelling and redness have reached the limit of subsidence. This method should not be applied over broken skin, and any complaint of too severe pricking or irregularity in the register of the milliamperemeter independent of the supply of current are warnings that burning may occur and indications to reduce the current.

Subacute and Chronic Infective Arthritis.

In this condition the joint is no longer hot and red but may still be swollen and tender. In many cases, as they are brought to the physician, deformities of the joints have already occurred, whether from the spasm of neighbouring muscles or the formation of adhesions, and these deformities require to be corrected. In practically every case marked muscular wasting is present and there is considerable trophic deterioration of the skin, which becomes shiny, blue, and cold. Treatment should be directed to the correction of deformities, removal of swelling, and restoration of muscular tone. In the correction of deformities the question of an anaesthetic is of some importance. For diagnostic purposes this is of great use. Under an anaesthetic all muscular spasm is relaxed, so that the extent of the deformity due to adhesions may be estimated. Corrective plasters may be put on with advantage when the muscles are relaxed, but this should be the only form of treatment practised under anaesthesia. The temptation to break down adhesions is considerable, but should never be yielded to in any circumstances. Admittedly brilliant results are sometimes obtained, but the risks are too great. If the adhesions are extra-articular they can be broken down by active and passive movements, as will presently be described, but if intra-articular, they can only with difficulty be stretched or broken down at all, and the attempt to do so suddenly, without the restraint of the subjective feelings of the patient, leads inevitably to fresh haemorrhage into the joint, with subsequent formation of still more dense adhesions.

Where adhesions occur, therefore, it is better to exercise

patience and trust to active and passive movements. Where the condition of the joint is still subacute and thus liable to flare up into active inflammation it is best to trust to active movements by restoring the muscles by massage and encouraging the patient to stretch his joints himself. If he is prepared to work really hard in this way the desired result will be obtained, with the safeguard that the reflex inhibition of movement will prevent him doing any harm. In any case, increased heat, redness, or swelling in the joint is indicative of too much movement and the necessity for rest.

Before any effort is made to correct deformity, whether by active or passive movements, it is well to relax the muscles concerned by radiant heat or diathermy. The former exposes the part to a dry atmosphere which can be raised to a considerable temperature without burning—300° to 400° F. The latter is a process whereby the heat and blood supply of the joint are increased by the passage of an interrupted current by a method similar to that used in ionization. It is often found after these treatments that with the relaxation of the muscles there is a considerable reduction in the pain of the joint, and the patient may get up and think some miraculous cure has been achieved. Within a very few minutes, however, the spasm and the pain usually return. The reason for this is that the muscular spasm is Nature's method of splinting so as to prevent contact of painful and inflamed surfaces, and although this special contact may be avoided for some moments in certain postures, sooner or later a position is adopted which does involve the painful contact, and spasm returns. For this reason, when it is desired to correct deformities by movements after muscular relaxation and these deformities are pronounced, it may be necessary to preserve the correction obtained by plaster or other splints. These may be removed after a day or two and the joint further relaxed and the splint reapplied. While a joint is so inflamed as to induce repeated muscular spasm whenever a particular contact occurs, much mobilization should not be expected or attempted, and the aim of treatment should be to attain the optimum orthopaedic position. Joints may, however, remain stiff, either from adhesions or muscular spasm, after all active inflammation has subsided; in the case of adhesions these may be gradually stretched as described above. Where muscular spasm persists this is due to the persistent suggestion induced by the previously painful and inflamed joint. In such cases efforts should be made to induce the patient to relax the muscle and persuade him that the spasm is unlikely to recur. The old posture of the limb, however, may be maintained for some days until use has restored the normal postural tone of the muscle.

Reduction of the swelling in the joint may be furthered by increasing the vascular supply by radiant heat or diathermy, or by ionization used in the way described above. In all such treatments, however, great care must be taken not to burn the skin, which is usually unhealthy. Too prolonged or too intense applications are dangerous, and it is better not to give the treatment more often than once on alternate days and gradually to work the current up to the requisite strength. If the pads used for diathermy and ionization are not evenly soaked in the saline solution, sparking and short-circuiting are apt to occur and much increase the risk of burning. As is well known, electric burns take a very long time to heal and may interfere with treatment of the joint just when steady persistence is of the utmost importance.

The restoration of tone in the muscles is effected by massage, as is done in the acute joint, but when active inflammation has subsided this may be more vigorous and may be supplemented by electrical stimulation of the muscles, whether by interrupted galvanism, faradism, or the Bristowe coil. These will all tend to restore both tone in the muscles and better circulation in the skin, with a more rapid return to normal.

Climacteric Arthritis.

The arthritis commonly met with in women at the menopause is closely allied to the chronic villous arthritis in which the swelling of the joint is chiefly due to an overgrowth of synovial membrane. This arthritis is often associated with infective foci, but the general metabolic change

in the body is more obvious and important than these. In the common type mostly affecting the knees of middle-aged women there are signs of definite thyroid deficiency, and thyroid extract should always be tried. The joint is swollen and puffy, the surrounding bursae being concerned in the synovial overgrowth as well as the joint surfaces themselves. As a result the joint is often shapeless and unstable from the stretching of the capsule. Coarse grating on movement, due to the dried synovial fringes riding over each other, is common. The joint is stiff, painful, and moderately tender, but not as a rule red or hot; the surrounding muscles are wasted, but not more than would be expected from the disuse of the limb, in contradistinction to the marked atrophy of acute infective arthritis. The wasting is somewhat masked by the general myxoedematous condition of the skin and subcutaneous tissues.

The condition being one of deficient circulation in the joints, the chief aim of treatment is to promote the blood supply to the part. Radiant heat, diathermy, and ionization are useful here, especially the last two. Massage is necessary to restore muscular tone, and in these joints a certain amount of friction to the joint assists in the supply of blood to the part. Movements, both active and passive, are used to restore mobility, and these can be practised relatively freely as there is less risk of setting up an acute inflammatory attack. Most of the patients with this type of arthritis are too heavy, and since the incidence of the disease is usually in the knees and ankles this is an important factor in the case. There can be no doubt that once the synovial membrane has taken on the habit of proliferation, the continued close approximation of joint surfaces when a heavy person walks tends to increase this synovial overgrowth. Measures directed to reduce weight are therefore important; they comprise the administration of thyroid extract, dietary measures, and general massage, in addition to local treatment. At the same time, in the more severe cases it may be desirable to take the weight of the body off the affected joint for a time. As it is essential for the general health and reduction of weight that the patient should get about, the only method available is by fitting some form of walking calliper modified according to the joint affected; the general principle is to transmit the body weight from the pelvis by means of steel bars to the heel of the boot below the ankle-joint.

Periarticular Fibrositis.

This is a special variety of a generalized fibrositis affecting the fibrous capsule of the joints. The characteristic lesion of fibrositis is the replacement of inflamed fibrous tissue by scar tissue, which is liable to contract. This contracture leads to thickenings which, if still the seat of inflammation, are tender and form nodules, and to shortening of the ligaments, which, if allowed to persist, pull on the ends of the opposing bones and results in deformities.

In periarticular fibrositis there is no definite swelling of the joint, and the wasting of the surrounding muscles is that of disuse rather than of trophic disturbances. Tenderness may be considerable, but is generally localized to affected areas in the ligaments and not to synovial surfaces. There may be much pain on movement and restriction of mobility. In the ball-and-socket joints—the hip and shoulder—rotary movements (which are specially restricted in a true arthritis) are relatively less restricted than flexion and extension, abduction and adduction.

The aims of treatment are reduction of active inflammation, restoration of mobility, and removal of scar tissue. The first object may be attained by radiant heat, diathermy, or ionization, and, on the whole, experience shows that local radiant heat gives the best results. When the pain and tenderness are lessened treatment should be directed as soon as possible to the two last objects, as once the contracture of the scar tissue has induced much stiffness and deformity the restoration of full function is difficult. Massage should be employed, as in other forms of arthritis, to restore muscular tone and efficiency, so that the patient may use his own efforts to recover movement of the joint. In addition, the localized thickenings in the ligaments must be sought for by careful palpation, taking care not to mistake small inflamed bursae for these; when found they must

be subjected to deep kneading, with the object of softening and stretching the scar tissue and, if possible, getting rid of it altogether. The patient must be warned that this process will be painful, but at the same time encouraged to expect the benefit which results from successful treatment. Massage must be supplemented by active and passive movements, persistent but never sudden, the degree of stretching the adhesions at any one time being guided by the patient's feeling of pain. As has been said above, it is better to progress slowly than risk any actual tearing of these fibrous bands, which may give rise to bleeding and subsequent formation of fresh adhesions. By these methods deformities may be reduced, and scar tissue dispersed at the same time.

Periarticular bursitis is common in the neighbourhood of all joints, and is characterized by tense swollen bursae which may be hot and red. These are tender to palpation and painful when the joint is moved in such a way as to stretch or press on the inflamed synovial walls. The condition is apparently due to the infection settling in a bursa irritated by a constant strain on the surrounding tendons and ligaments. This is well illustrated by the clinical picture of subacromial bursitis as described by Buckley. With the arm at rest by the side there is a point of extreme tenderness if the bursa is palpated under the tip of the acromion. As the arm is abducted there is severe pain while the wall is stretched by the action of the supraspinatus whose tendon crosses the floor of the bursa. With abduction beyond a right angle, however, both pain and tenderness disappear as the bursa passes in below the protecting acromial process. As these conditions are due to strain or trauma in conjunction with infection, the joint must be protected from the strain or trauma, whether the swing of a golf-club, the use of a tennis-racket, or other such movement, until the inflammation has subsided. For hastening this end, ionization is the method of choice; it combines counter-irritation with the direct increased blood supply to the part from the passage of the current. Once the inflammation in the bursa has subsided there is no difficulty in restoring mobility and full function.

Osteo-arthritis.

In this condition rarefaction and absorption of the bone occurs with compensatory formation of osteophytes and overgrowths. The joint surfaces become eroded, and with the destruction of the synovial linings the sensitive cartilaginous surfaces come into contact with each other, causing intense pain and inducing protective muscular spasms. These spasms may result in considerable deformities, and the formation of osteophytes may take place in such a way that restoration of the opposing bones to their normal alignment is impossible. Cases which have progressed to this stage cannot be helped to any great extent by physiotherapy, and indeed any treatment short of active surgical intervention to immobilize the painful joint gives little promise. Moreover, since the condition is most frequently met with in old debilitated persons, little able to stand a major operation, even this method is not often applicable. Every effort should therefore be made to arrest the condition in the early stages, or prevent deformity of joints. Since strain and pressure favour the formation of osteophytes, as soon as the joint can be got into the best orthopaedic position by extension apparatus, weight-bearing splints must be applied to prevent the direct apposition of joint surfaces and convey the stress of the body weight past the affected joint. In order to achieve the object of relieving muscular spasm and restoring good position and at all times to relieve pain, radiant heat is of the greatest service. Massage to muscles is of use in maintaining tone, but care must be exercised that the hypertonia existing in those muscles already in spasm is not increased by injudicious treatment.

I do not suggest for a moment that other methods of treatment of the various forms of arthritis referred to in this paper are not of the greatest use, and in some cases almost essential; but it is useful to indicate that much may be done for these troublesome and all too common afflictions by methods that are within the scope of the available therapeutic armamentarium of most practitioners and within reach of the pockets of most patients.

END-RESULTS OF ARTIFICIAL PNEUMOTHORAX.*

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THE following results are based upon a series of 78 patients whose treatment was commenced fifteen to three years ago. Of those who recovered, only 4 were started later than December, 1921, and only one later than June, 1922. All the patients were in the third stage of pulmonary tuberculosis and were sputum-positive. They were patients who had failed or who were failing to respond to the ordinary sanatorium régime.

Table Summarizing Results.

	Operation Practicable.	Operation not Practicable.
Able to work	29+4=42.3 per cent.	2
Dead	34+5=50.0 ..	9 (64.3%)
Dead from other cause	1	—
Ill with tuberculosis... ..	3	—
Lost sight of	2	3
Total	69+9	14

The 9 patients put separately were some who were largely under my care during the period mentioned, but artificial pneumothorax was not started originally at the Mundesley Sanatorium. During the same period there were 17 patients in whom only a partial pneumothorax could be produced; 8 of these are dead, 4 are well and working, 1 is ill, and 4 I have lost sight of.

Of the patients who died, one lived twelve years, another seven and a half years, both enjoying good health for the greater part of these periods. Others lived six, five, five, and four years respectively; others, again, lived only a few weeks or months. The average duration of life of the 47 patients who died (including the cases of partial pneumothorax) was two and one-third years; and the duration is the same if only the 34 of the first group are taken into account. By comparing this duration to the duration of life of sputum-positive cases of all types treated by other means than artificial pneumothorax (as illustrated, for example, in Dr. James Watt's article in *Tubercle*, August, 1924), it can be seen that life was prolonged appreciably by means of this treatment, even in the cases who eventually died of tuberculosis. From a study of the above statistics it can be said that in any case of moderately advanced pulmonary tuberculosis which is fairly unilateral, the prognosis is best if compression treatment be undertaken and prove feasible.

The comparison in the table also makes clear that artificial pneumothorax is successful when the results are compared with similar cases for whom this treatment has not been possible on account of generally adherent pleura. It will be seen from the table that the death rate with these patients is much heavier. Yet the conditions which lead to the choice of a trial of compression were the same in both cases. No one can say beforehand which patients have general adhesions.

I always advise maintaining the pneumothorax for at least three years. Often four, four and a half, or five years are found advisable. But this is not a hardship, for, even on the day of the refill, the patient's workaday life need not be seriously interfered with. The average duration of the period of refills in those of my patients (34) who have recovered is four years and four months; and the average duration of life since commencing treatment is six years and ten months.

The question of how far the recovery goes, how far the working capacity is restored, is of interest. To what extent does the lung re-expand after the treatment has been stopped? Since the patients dealt with in this series are

* Summary of a paper read before the Assurance Medical Society, November 5th, 1925.