account the number receiving the adult blood in comparison with a corresponding number not so treated. We must await future events before attempting any general prediction on this important subject; but enough would appear to have been achieved already to warrant a further and wider trial of this safe and readily available means of preventing epidemic poliomyelitis, which continues to be a serious menace on a world-wide scale.

One aspect of the subject of immunity in poliomyelitis remains to be considered. We have long known that monkeys may be rendered actively immune by successive small injections, or one large injection, of poliomyelitis virus made beneath the skin,²² or by successive inoculations made into the skin.²³ Both these methods of securing immunity suffer from the disadvantage that occasionally monkeys develop paralysis instead of immunity. It appears that monkeys, in common with human beings, exhibit varying degrees of susceptibility to the presence of the virus in the body. An effort is being made to improve and perfect this means of active immunization in order to avoid the rare onset of disease. The combined use of immune serum and virus offers greater security. That active immunity can be obtained by the injection of mixtures of the serum and virus has been shown by Rhoads.²⁴ Recently we have carried out experiments on a larger scale, in which virus and serum have been injected separately into the bodies of monkeys. These animals developed active immunity, and, up to the present, without the appearance of symptoms of infection in any case. Moreover, evidence is accumulating that as the original human virus is passed from monkey to monkey it undergoes modification, and while retaining its immunizing properties changes its infective power. Whether or not use may be made of this transformation in securing active immunization of human beings when menaced by epidemic poliomyelitis future study alone can determine.²⁵

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THE TREATMENT OF RECENT INJURIES

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My interest in recent injuries and my claim to some knowledge of their nature and treatment had a beginning on the football field, where I had personal experience of nearly every type of injury. Since then I have made a careful study of all the methods of getting such injuries right, whether by physiotherapeutic, manipulative, or operative means. In such work it has been of great value to have a personal knowledge of the time an injury should take to mend, of each stage in its improvement, and of the pain associated with it. In being healed by the methods I advocate, a patient can be reassured as to his progress—a most essential point—for although he is cured in the shortest possible time, extreme pain is often experienced during the treatment. This pain, however, cannot be compared to the agony that must be experienced should the injury be left untreated until teno-synovitis or periosteal thickening develops.

I am anxious to emphasize that by treating all injuries intensively from the beginning—however small they may be—sequelae will be avoided and the necessity for manipulation prevented. It is with the prevention of adhesions and thickenings that follow injuries that I am chiefly concerned. A blow on any structure, whether muscle, bone, ligament, or cartilage, will cause a bruise by rupture of minute blood vessels and a haematoma will form. If the blow happens to fall on a joint or tendon sheath, traumatic synovitis or teno-synovitis will occur. It is the organization of these haematomas and synovial effusions that is responsible for the formation of adhesions.

I want to emphasize the importance of "working out" the bruise at once by vigorous methods, by which I mean massage with increasing vigour, radiant heat, faradism, diathermy, and active and remedial exercises. This method is extremely painful and, to many, may appear brutal, but it is the only way of preventing adhesions and thickenings, which, if left, are far more difficult to disperse.

INJURY TO MUSCLES

When a muscle is bruised, torn, or partially ruptured, a haematoma forms. Naturally some of this haematoma is absorbed into the blood stream, but the remainder, unless promptly treated, becomes organized, and the resulting fibrous tissue binds together the ends of the damaged structure. In many cases it also causes the muscle to unite with the surrounding structures—muscles, nerves, bones, etc. Sometimes the haematoma does not organize completely. It is suggested that many of the so-called muscle herniae are in reality haematomas with fluid centres.

The correct way to treat these injuries to muscles is:

1. Strapping or elastic support while repair is taking place.
 2. Massage on the first day, with increasing vigour, to bring out the bruise—a very painful procedure, but endured by the patient if the reason is explained.
 3. Diathermy. In injuries where extravasation of blood has taken place diathermy is superior to ionization; on the other hand, where traumatic synovial effusions are present ionization has more effect than diathermy. Both relieve pain and help the absorption of effusion.
 4. Surging faradism, gentle at first.
 5. Active and remedial exercises to strengthen the muscle.
- The haematoma will either work to the surface, where it can be aspirated or expressed from a small incision under local anaesthesia, or it will track along tissue planes. In the latter case, tender spots appear remote from the site of the

injury. If adhesions have already formed when the patient is first seen, the part should be manipulated and this followed by a daily course of physiotherapy and movements.

Let us consider injuries to muscles in certain situations.

Muscles in Relation to Ribs

In a typical case the patient has an injury over the ribs, and a fracture is suspected. There is local tenderness, intense pain on coughing, deep breathing, or laughing; but, on pressing the sternum and vertebral column together, there is no pain referred to the tender spot and the radiogram is negative. The diagnosis is an injury of one of the muscles attached to the rib—abdominal obliques, intercostals, abdominal recti, diaphragm, pectorals, or serrati. The pain is caused by the presence of a haematoma at the site of the injury which, each time the muscle works, contracts down on this blood clot. Most of these cases are strapped, and in two to four weeks' time the acute pain gradually wears off. Later, when the strapping is removed, the patient finds that there is pain or a dragging feeling on certain movements, owing to the organization of haematoma with the formation of adhesions. It is suggested that such an injury should be treated as already indicated. Support is best obtained by means of a broad piece of elastic in the form of a belt, which can be tightened or loosened as required. This prevents the pain and inconvenience of removing strapping. If this line of treatment is adopted the disability will have passed off in a week, and there will be no painful adhesions or scarring to give rise to symptoms later. A shifting of the area of tenderness, together with evidence of crepitus—denoting organizing blood clot in the region of tenderness—is indicative of tracking of the haematoma along tissue planes. The direction is usually towards the renal or lumbo-sacral region, and would account for the pain and stiffness here which often follows injury to ribs. Bone-setters and osteopaths make much of this point, telling their patients that they have vertebrae out of place or subluxations in these regions. They manage to convince the patient by producing cracks from the breaking down of adhesions, with subsequent relief of symptoms.

A personal experience may illustrate the value of the treatment advocated.

Playing football five years ago, I sustained an injury to the right abdominal oblique muscle at its attachment to the ribs. I strapped it, and it was five weeks before I could play again and a further month before the pain and stiffness had entirely disappeared from the site of injury. Two years ago exactly the same injury occurred to me on the left side, and, being particularly anxious to play in a match in five days' time, I massaged the site of the injury as hard as I could stand it, and on the following four days (including the day of the match) I gave myself diathermy and surging faradism. I played strapped, but never felt the pain again, either in that match or in subsequent ones.

Erector Spinae

It has been advocated that injuries to the erector spinae should be manipulated at once, but if vigorous treatment is started immediately these cases recover in three to five days. There is, therefore, no need to manipulate them, as adhesions have not been allowed to form, and full spinal movements are maintained by active movements.

Thigh and Buttock Muscles

If the gluteus maximus is injured great care must be taken to prevent a clicking hip or bursitis from haematoma tracking down the thick sheath of this muscle to the great trochanter. Also, in injury of the hamstrings at their origin, the bruise must be worked out at once, otherwise it settles on the ischial tuberosity or at the bursa in relation to it.

Calf Muscles

These are usually strapped, the patient walks about comfortably, and after a month feels no ill effects. On the other hand, some of these cases experience swelling and pain in the region of the ankle-joint due to gravitation of haematoma, with the formation of adhesions and thickenings, and sometimes a bursitis of the Achilles tendon bursa. Rupture of the gastrocnemii sometimes occurs bilaterally in elderly men as a result of the general degenerative process associated with old age. These cases should be treated with complete rest, and gentle massage until firm union of the ruptured muscles has taken place.

Besides the complications already mentioned—that is, the muscle continually giving way, adhesions, thickenings, and bursitis—the following sequelae may also occur to injured muscles.

1. *Neuritis*.—This may be caused either by the pressure of the haematoma or the subsequent adhesions on nerves in the vicinity. Cases have been seen in which the muscle has shown partial and, sometimes, complete R.D. either from the pressure of the haematoma or from the toxic effects of the blood clot. Naturally, even though they may show complete R.D., the nerves should not be exposed by operation for at least three months, because other treatment will often cure the condition.

2. *Rheumatism* in the muscle and surrounding structures or neuralgic pains in the overlying nerves. In such cases the patient may complain of almost unbearable pain with no physical signs to account for it, thus inviting a diagnosis of functional disease. Besides, analgesics, radiant heat, infra-red rays, and ionization often remove these pains instantaneously.

SUBPERIOSTEAL HAEMATOMAS

Included under this heading are bruises of bone and cartilage. Both these conditions produce excruciatingly tender spots over the injured area. Treatment must be started at once—consisting of massage and diathermy. Even one treatment often relieves the intense pain and tenderness in these cases. If the haematoma works forward it can be aspirated under strict aseptic conditions. The surrounding muscles and ligaments must be massaged and moved to prevent the haematoma settling in them and forming adhesions. Many of these cases are rested and left, with the result that the haematoma or products of bruising organize to form exceedingly tender areas, which give rise to pain on the slightest movement or pressure.

The following cases illustrate the importance of immediate treatment.

A football player sustained a severe kick on the tarsal scaphoid, causing bruising of this bone and surrounding muscles. The radiogram was negative. As a result of vigorous treatment, the player was fit in a week and able to play in a cup tie in ten days' time, although he had been unable to walk for the first three days. This represented seven hours' work. Another footballer, who had met with a similar injury, was strapped, and on examination six weeks later was found to be suffering from stiffness in the mid-tarsal joints and bruising over the cuboid. The foot was manipulated and treatment had to be carried on for ten days—representing twenty hours' work—before the condition was right.

Another type of case, showing bruising of bone with teno-synovitis which had been left untreated for over a week, is of interest. This combination is seen on the dorsum of hand and foot, and I would rather deal with anything than such an injury, if it has been left so long untreated.

The bone is tender to pressure, and on moving the tendon there is pain, which is agonizing on kicking a football or hitting a ball with a cricket bat. Slight thickening of both the tendon and the bone may be noted, but this is not typical. Treatment is started at once—massage, diathermy,

or ionization, and movements. Presently the painful area will become more and more tender until agonizing pain is produced there. Effleurage is useless; deep friction is essential with increasing vigour. In the meantime the patient writhes in agony, swears, and squirms, and it is most difficult to persuade him to carry on with the treatment. To operate on these cases is useless, as it is impossible to scrape the bone and tendon sufficiently to do any good. Rest does not put matters right, and the only thing is vigorous treatment. As the bruise works out swelling appears; it seems as if the fibrin of blood clot must collect fluid from the tissues and swell. Later this swelling begins to break up and form little fibrous bodies. If these fibrous bodies are trapped under the finger intense agony is experienced. Under treatment the swelling will gradually disappear and the hand or foot will become well again.

INJURY TO A JOINT

Sprains are often rested, and, when subsequently moved, cause great pain from thickenings and stiffness.

They must be treated at once on the first day with massage, ionization, radiant heat, and unloaded active movements. Intense pain will be experienced, but there will be improvement as the bruising works out. An exception to this occurs in the elbow-joint, on account of the occurrence of myositis ossificans. These cases must be rested for at least three weeks, movements being then allowed gradually. If sprains of the finger-joints are treated as indicated, in about four days there is no evidence of the sprain, and the treatment prevents the unsightly joints so often seen.

Sprained Ankle

The generally accepted treatment for these injuries is to strap the ankle and force the patient to walk about on it, a procedure which will not prevent swelling, and usually results in a sleepless night and untold pain.

The first thing is to assess the degree of sprain from the clinical signs, and secondly, to inquire as to the amount of strain put on the ankle after the accident. This is important, as structures already sprained are further strained by weight-bearing. The common type is the adduction sprain, which falls into three types:

1. Slight degree. This type can be strapped and used. After three days strapping is removed and massage and exercises started, continuing until no tender spot or swelling remains.
2. Severe degree, without fracture of external malleolus.
3. Severe degree, with fracture of external malleolus. Small chips off the malleoli can be disregarded as fractures, whereas the concomitant injury to the lateral ligaments must be considered as important and treated accordingly.

There are two types of muscle tone—postural, which is always present and holds the position of the foot; and phasic, which carries out movements. In a badly sprained ankle the postural tone is depressed, and consequently, if the body weight is put on the foot, the muscles are unable to perform their work of supporting the arch, while the ligaments, already strained, are further damaged. No amount of strapping support will be sufficient—it only makes for further strain and adhesions round the ankle.

These severe strains must be rested, while massage, heat, and diathermy are given to help absorb the effusions and haemorrhage. While this is being carried out active movements are performed with the patient lying on a couch or bed. These unloaded active movements are entirely different from active movements with weight-bearing, and produce no strain.

Thus, a badly sprained ankle is treated by:

1. X ray to rule out fracture.
2. A firm bandage applied over lint soaked in some soothing lotion, such as lead and opium, liquor hamamelis, or mag-

nesium sulphate compress. This allows some swelling to occur, but prevents it becoming excessive. One should remember to give an analgesic—even up to morphine—for the first night at least.

3. Massage at once, together with heat and diathermy applied with unloaded active movements. If treated in this way even badly sprained ankles are well in from seven to fourteen days, with no such sequelae as thickenings—especially over the external lateral ligament and both sides of Achilles tendon—with swelling in these places after exercise, flat feet from muscle strain, and stiff, rigid feet from organization of effusion and haemorrhage. After a badly sprained ankle the patient must wear proper shoes and boots—not sand-shoes or flat rubber shoes.

Sprained Wrist

Every doctor is familiar with the results of falls on the outstretched hand with the thenar or radial side taking the brunt of the force. Any of the following things may happen—Colles fracture, dislocation of the semilunar, fracture of the scaphoid, or sprain of the wrist-joint. In contrast with this, injuries caused by falls, or pressure, on the ulnar side of the hand are not generally appreciated. They may cause any of the following: bruising of the triangular cartilage of the wrist-joint, sprain of the inferior radio-ulnar joint, and fracture of the styloid process of the ulna. In cases with bruising and sprains they must be treated vigorously from the beginning as indicated above in the case of other joints.

Dislocated Shoulder

The correct way to treat a dislocated shoulder after reduction is:

1. X-ray to rule out associated fracture such as greater tuberosity of the humerus.
2. Test for involvement of circumflex nerve. It should be remembered that the deltoid may show partial R.D. without sensory loss. If there is any circumflex nerve paralysis the arm should be put on an aeroplane abduction splint.
3. Radiant heat.
4. Diathermy or ionization from the first.
5. Treat in a sling, but encourage the patient to remove the arm twice each day and put the shoulder through movements as far as possible.
6. After a few days, surging faradism to the surrounding muscles. By this method the patient is able to take vigorous exercise in five weeks with support. Strapping, so as to limit abduction, with a pad of cotton-wool in the axilla, is best, and has the advantage of giving the patient confidence and protecting the part slightly, while it controls the movements and prevents extremes of abduction.

Acromio-clavicular Joint

It is essential to realize that an injury causing one obvious derangement may at the same time be responsible for several less apparent ones. For example, a fall on the shoulder with dislocation of the acromio-clavicular joint may give rise to bruising of the end of the bones, adhesions around the shoulder-joint and subdeltoid bursitis, injury to the trapezius, or brachial plexus neuritis from tearing of the origin of the scalenes. If the dislocation or subluxation does not remain reduced after four weeks' immobilization, it may often be neglected, but this is not true of other disabilities, as they give rise to pain and limitation of movement, and are often the real cause of symptoms in such a case.

SUMMARY

1. All injuries without fracture must be treated intensively and vigorously from the beginning, except those of the elbow-joint for fear of myositis ossificans.
2. The essential factor is to work out the products of injury—that is, the bruise—immediately.
3. Methods for accomplishing this are described.