With reference to the general health, I attach much importance to milk forming a large element in the food. I strongly advise tepid water enemata, on alternate days if necessary, rather than purgatives, when there is any tendency to chronic constipation. The patient should be in the open air for several hours daily, and should always remain in the best possible positions, whether sitting or lying.

I have not referred to the subject of division or excision of tendons for shortening partially paralysed muscles, as I have not yet seen any cases in which this treatment appeared likely to be of the slightest use.

Prognosis.—If there be ever so small an amount of voluntary power left, some improvement should be obtained by a month's treatment, and a very decided and marked improvement by the end of three months. Afterwards, the friends, having been properly trained, as well as the patient, can carry on the treatment almost as successfully at home for as long as is necessary.

THE RADICAL CURE OF HERNIA BY TORSION OF THE SAC.

Read in the Section of Surgery.

By CHARLES B. BALL, M.Ch., F.R.C.S.I.,

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DURING the last few years, in this Association and elsewhere, the radical cure of hernia by operation has been freely discussed; and I take it that the general opinion of practical surgeons is in favour of operating in properly selected cases, and that some of the many methods by which the neck of the sac is exposed by incision, and directly treated, are much to be preferred to the subcutaneous operation of Wood, Spanton, and many others.

Obviously the most radical of these in conception, and the one which contains the most essential elements of success, is that in which the sac is excised, its neck ligatured high up, and sutures applied to the hernial orifice. Of this operation, there are several modifications, with the object in view of making the closure of the opening more complete, such as scraping the edges before suturing, as recommended by Messrs. Steele of Bristol, and Marcy of Boston; the use of the cautery for the like purpose, as recommended by Dr. Warren of Boston; and when difficulty is experienced in bringing the edges of the ring together, making liberating incisions through the tendon of the external oblique, parallel to the pillars of the ring, as recommended by Reverdin.

This operation has been performed sufficiently frequently for us to draw deductions as to its safety, and as to the resulting cure. It would appear from the published cases, that it is practically as devoid of danger to the life of the patient as any other method, but that the proportion of failures to effect a complete cure is somewhat large.

According to Dr. Guénod, during the space of three years in the surgical clinic of the hospital at Bâle, forty-four operations of this kind had taken place, and of these thirty-four had been found and examined by Dr. Guénod at different periods. Twelve had a return of the hernia, and twenty-two had been completely cured; in other words, over one-third were failures.

The results obtained by the Liverpool surgeons, who have practised this operation on a very large scale, would appear to justify similar conclusions. Mr. Banks having stated that, with an experience of between fifty and sixty cases, he did not believe in the radical cure, but considered the use of a truss necessary afterwards.

It is, therefore, evident that we must look for something more if we hope to be able to cure hernia so absolutely, that the further use of a truss will be unnecessary; and I believe that torsion of the sac will prove to be a right step in this direction. It is probable that this addition to the operation has suggested itself to other surgeons, but hitherto I have failed to find any allusion to it in published cases.

At the adjourned discussion on the Radical Cure of Hernia at the Academy of Medicine in Ireland, held January 22nd last, I suggested twisting of the sac as a procedure likely to effect a more permanent cure; and, owing to the favourable reception accorded to it, I have practised the operation, and it has also since been performed by other Dublin surgeons.

The advantages which may be claimed for this operation are these. First, a more thorough closure of that portion of the sac situated in the inguinal canal is obtained than can possibly be obtained by any simple ligature, no matter how high up it is placed. Secondly, the twisting has the effect of tightening and throwing into ridges the peritoneum for a considerable area surrounding the abdominal opening. This I believe to be a matter of extreme importance; for, as Lawrence pointed

out many years ago, one of the most fertile predisposing causes of hernia is an abnormal laxity and fullness of peritoneum in the neighbourhood of the hernial opening. Thirdly, the danger of septic peritonitis is diminished; for, if by any imperfection in the dressing the wound become septic, it is highly improbable that inflammation would spread up the tube of peritoneum closely twisted into apposition without producing limiting adhesion.

The first case upon which I operated by this method was a male, aged 23, who had a large scrotal hernia on the right side, which gave him a great deal of pain, and could not be properly controlled by a truss. He had a small hernia on the left side, which occasioned but little trouble. He was unable to follow his employment as a labourer in gas-works, and stated that, unless something were done for him, he would have to go to the union. On January 25th last, I exposed the neck by incision, and isolated the sac from the cord. This proceeding was a little tedious, as the component structures of the cord were spread out over the hernia. Separation having been completed, the sac was grasped with a clamp-forceps high up, and given six half-turns, that is, three complete revolutions. A decided resistance was now felt, and it was evident that any further torsion would be attended with risk of rupture. A ligature of carbolised gut was tightly tied round the neck, and a salmon-gut suture passed through the pillars of the ring, and also through the twisted stump, with the view of preventing untwisting. The wound was closed, a drainage-tube inserted, and gauze dressings applied. Recovery was retarded by slight supuration about the wound, and by the formation of a scrotal abscess; but in four weeks the healing was perfect, and there has not been since the slightest tendency to recurrence. The patient is working regularly, a light truss being sufficient to keep up the small hernia on the left side.

The scrotal abscess which retarded recovery in this case, and which has been frequently noticed by other surgeons after excision, is no doubt due to the difficulty of efficiently draining the large cavity from which the sac was removed; and in future I shall always bring a drainage-tube out through the most dependent portion of the scrotum, and completely close the wound over the neck. In order to obviate the disturbance of parts necessary in the complete removal of the sac, the recommendation of Buchanan to divide the sac in two may be adopted, but I believe this is only suitable in cases of the congenital form of hernia. In this variety, as the lower portion of the sac is the tunica vaginalis, its attachments to the testicle would render extirpation impossible; but this close relation would also insure the vitality of the portion of sac left; so that, were I called on to operate in a case of the congenital form, I would divide the sac, suture the lower portion to form the tunica vaginalis, and twist up the upper portion.

In acquired hernia, the case is different, for here the entire vascular supply comes from above; and if any portion of the sac be left after ligature or division, sloughing is apt to occur.

In effecting separation between the sac and the cord, it is essential to remember that the three normal coverings of the cord are common to it and the hernia, so that it is necessary to ensure the thorough division of these on a director before attempting to isolate the sac, and to twist nothing but the thickened peritoneum and subperitoneal tissue.

In inguinal hernia in the female, in femoral or other forms of rupture, when the cord is not present to complicate matters, it is evident that the operation of twisting the sac can be carried out with much greater facility.

In quite a different category from the operation for radical cure of reducible hernia, must be placed the addition of an attempt to ensure permanent obliteration, to the ordinary operation for strangulated hernia. In the latter, the surgeon is unable to select his cases, and is frequently called upon to operate under circumstances in which nothing short of the most dire necessity would justify any surgical interference. In these cases, twisting of the sac adds nothing to the risk, and may effect a permanent cure; indeed, it would seem probable that this addition renders the ordinary operation safer, by preventing hemorrhage into the abdominal cavity, and, as above noted, by lessening the risk of septic peritonitis. It is obvious that, for statistical purposes, the cases should be kept absolutely distinct.

I have adopted torsion of the sac in one case of strangulated femoral hernia. The patient was a female, aged 54. The hernia had been strangulated for three days when I saw her, and she was suffering from chronic Bright's disease. Upon opening the sac, which was much thickened, the intestine was found to be adherent to the interior; this was carefully separated, and the hernia reduced. Five half turns were now given to the sac; and a catgut ligature applied. As there did not appear to be any tendency to untwist, no suture was used. About

three hours after the operation, I was sent for, as there was a good deal of bleeding. On taking down the dressings, a large blood-clot was found distending the wound, and passing under the surrounding skin. Having cleared out the clots, a small vessel was found and secured, after which there was no further trouble. Had the opening into the peritoneal cavity not been efficiently closed, no doubt internal bleeding would have gone on, to a possibly fatal extent. Subsequently, the patient had very violent diarrhoea, and gradually sank. She died on the tenth day after operation. At the *post mortem* examination, it was found that a small portion of the intestine (about the size of a threepenny-piece) which had occupied the hernia had sloughed; the abdominal opening was closed by a plug of lymph, and from it spirally radiating folds of peritoneum could be traced for a considerable distance, adherent in many places by recent lymph to the attached peritoneal surface; showing, when the specimen was recent, very beautifully the result of torsion.

My experience of this operation is as yet but small; I trust, however, that the present communication may be the means of inducing other surgeons to give this method a fair trial, so that soon we may have sufficient statistics from which to draw conclusions; and I am convinced that a large number of permanent and complete cures will eventually be credited to the operation by torsion of the sac.

ON THE NATURE OF RIFLE-BULLET WOUNDS, AND THE PRINCIPLES OF THEIR EARLY TREATMENT.

Read in the Section of Surgery.

By GILBERT KIRKER, M.D.,
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WHILE attending to the Turkish wounded in the services of Lord Relyea and the Stafford House Committee, I was struck by the facility with which some severe bullet-wounds—notably one of the thigh, with fracture of the bone—were healed. This directed my attention to the nature of rifle-bullet wounds, on which subject I made some observations in Turkey, and a number of experiments after returning home. A few of the results of my work, having been experimentally examined by Professor Longmore, were referred to by him at the meeting of the International Medical Congress in London, while a fuller record of them is published in a paper in the *Transactions* of that meeting.

In the present paper, I propose to refer briefly to the more important points, in what I stated was the nature of rifle-bullet wounds; to show how what I have seen of wounds produced in the South African and Egyptian wars has sustained my statements; and to point out what principles of early treatment can be founded on a knowledge of the nature of these wounds.

It will assist in a more thorough understanding of the first subject, to look at the attributes of the projectile by which the wounds are produced; and, as the most typical rifle-bullet, I shall take the cylindro-conoidal.

The transverse or wounding area of this bullet is relatively small, its impinging end is somewhat pointed, and, when in motion, it rotates screw-like. These attributes enable it to travel with a minimum expenditure of force, and, consequently, it retains for a long time a high velocity.

If we were to consider what would be the effects of such a projectile traversing an animal organism, we should expect that its track, in direct proportion to the small amount of obstruction which can be offered by the tissues, would show little evidence of destructive action. This conclusion, I submit, is in harmony with what generally takes place; but, remembering the instances in which there is great destruction of tissue in rifle-bullet wounds, it may seem to disagree with experience. These latter instances, however, I believe, are exceptional, and due to some uncommon accident affecting their production, by which the great force which the projectile has conserved to the distance at which wounds are generally inflicted is brought into action and transformed into tissue-destruction, and also sometimes to improper early treatment. That the possession of great momentum which is not brought into play by a projectile in the production of a wound augments the destruction of tissue seems to me impossible. In the paper to which I have referred in connection with this point, there occurs the following passage. "Because the cylindro-conoidal bullet, as a rule, wounds at a greater velocity than the round, it is, therefore, by most authorities, said that, *ceteris paribus*, it produces a greater amount of tissue-injury. I not only hold, however, that this opinion is incorrect, but that reason will build on the same

fact just the opposite conclusion. The disturbance or injury to a body penetrated by a projectile is in proportion to the loss of momentum the projectile suffers; the resistance of the one is overcome by a proportionate expenditure of force by the other. The great characteristic of a rifle-projectile is that, owing to its shape and mode of rotation, it penetrates substances with the minimum expenditure of force, and thus conserves its momentum, and also the varying factor of its momentum velocity. That the greater wounding velocity of the cylindro-conoidal bullet is due to the characteristic facility with which it penetrates, and not to greater initial velocity, is proved by the fact that the modern rifle expels its projectile with less initial velocity than some of the old smooth-bore fire-arms. Therefore, since the cylindro-conoidal bullet retains a greater wounding velocity than the round, it penetrates with less expenditure of force, and in a given wound produces less tissue-injury."

As a rule, a rifle-bullet carries none of the soldier's clothes or accoutrements before it into the wound.

The entrance and exit openings of rifle-bullet wounds are small, and represent only the rupture of the skin. To this rule, there are exceptions in the case of entrance-openings, where the bullet has impinged on skin lying immediately over a bone; and, in the case of exit-openings, when the bullet has been altered in shape, or has carried pieces of bone with it. It is always possible, I believe, immediately after the production of the injury, to distinguish between the entrance and exit openings. The former is small, round, and its edges, which may be blackened, are inverted; while the latter is more irregular in shape, its edges are everted, and some of the subcutaneous tissue protrudes from its centre. Changes, however, soon take place, which make it impossible to distinguish one from the other, and I have generally observed the wound of exit to heal before the wound of entrance.

In the subcutaneous soft parts, the character of a rifle-bullet track seems to depend very much on the arrangement of the constituent tissue-fibres; in aponeuroses, or in the subcutaneous cellular tissue, the fibres are reticulated, the track is round, and has a tendency to remain open; but where, as in muscle, the tissue-fibres have a certain parallelism, the bullet seems to slip between, and leave a slit-like track, whose sides tend to come together. In most cases, therefore, I believe that, other things being equal, an injury of bone in a rifle-bullet wound will heal better where there is a good covering of muscle, than where it lies immediately below the skin and subcutaneous cellular tissue.

The injuries to bones which rifle-bullets produce, owing to the nature of the bone struck, and the manner in which the bullet strikes, are, of course, extremely various, but they have all certain common characteristics. In them, there is little comminution of the bone, but extensive fissuring; for, fractures being produced by the bullets clearing for themselves a passage through the bone, the more they do so by splitting, the less breaking down they have to do.

I have been able, I believe, to actually demonstrate what is here stated. While experimenting, some time ago, with reference to the relative amounts of splintering at the entrance and exit apertures of penetrating fractures of the skull, I noticed that, when the force was applied to the inner surface of the bone, fissures were more apt to be produced than when it was applied to the opposite side. Subsequently, I made this accidental result the subject of examination. I fired a small rifle-bullet through a number of calvaria, aiming sometimes at the inner side, and sometimes at the outer. These experiments not only showed that fissures were oftener produced under the former circumstances than the latter—being the rule in the one, in the other the exception; but again, by accident, I observed that the hole with fissures, which the bullet made in passing from the inside, was less in size than the hole without fissures, which it made in passing in the opposite direction.

Owing to rifle-bullets fracturing bones in this manner, the fragments produced are not deprived of their connections with soft tissue. They retain their own attachments to periosteum and muscle, and, immediately after the injury, they are all connected to each other and the parent bone by the periosteum stretching across the fissures. I look upon the knowledge of this fact as one of the most important acquisitions which military surgery has lately gained; for I expect, when surgeons are able to give to gunshot fractures a fitting treatment in the light of this knowledge, the most dangerous of the not immediately fatal wounds of warfare will lose much of their gravity.

When a rifle-bullet strikes cancellous bone, such as the upper or lower end of the femur, the fragile structure yields and breaks before it, is partly carried forward, and partly crushed against the walls of the track. A moiety of what is crushed laterally is destroyed, while the remainder is saved by the elasticity of the tissue. The latter por-