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RECURRING TORSION OF THE SPERMATIC CORD, WITH AN ACCOUNT OF FIVE CASES.

By J. W. DOWDEN, F.R.C.S. EDIN.,
Assistant Surgeon, Edinburgh Royal Infirmary.

TORSION of the spermatic cord occurs with greater frequency than is generally supposed, and the reason why it is not more often recognized is due to the absence of, or scant, information in most of the surgical textbooks.

Perry,¹ writing on torsion, describes two varieties, the first characterized by one sudden and acute attack, the other by more or less frequent recurrence, with or without the eventual onset of an acute degree of torsion. The term "recurring" is a suitable one to apply to this second variety.

The literature in connexion with the first form is now fairly large, and especially good are the monograph by Dr. A. Lapointe,² and a paper by Dr. J. Vanverts of Lille.³ With regard to the second variety—recurring torsion of the cord—there is but little information. Perry¹ and Van der Poel⁴ have described cases, while Gifford Nash⁵ has published an interesting case bearing on this variety. Since publishing an account of 2 acute cases, and a probable recurring one, in September, 1901,⁶ 6 others have been seen by me, 5 of which suffered from recurring torsion, and were operated on; another case, a child aged 5 months, had an attack which passed off spontaneously.

Etiology.

The main predisposing factor is the abnormal manner in which the testicle, suspended by the cord, hangs free in the tunica vaginalis. Both testicle and cord are completely surrounded by visceral tunica vaginalis, so that the testicle resembles small intestine, and the cord the mesentery, termed here the mesorchium. Lauenstein⁷ has compared this arrangement to a fruit hanging by its stalk, and Lapointe² to the heart in the pericardium, and a term descriptive of this would be "floating testicle."

Lauenstein has also laid stress on a broad and flattened cord as another predisposing cause, and this is a common condition to find. In all the five cases of recurring torsion operated on it was present. Not only is the cord flattened, but it shows as well an abnormality in the disposition of the vas deferens and the main vessels. The chief vascular structures pass between the visceral layers of the tunica vaginalis to the globus major, occupying one border of the mesorchium, while in the other the vas deferens ascends from the globus minor. There is no satisfactory term for this arrangement. "Bifidité du Cordon" or "Bifurcation" expresses but imperfectly the actual condition, consequently it appears to me that "intermesorchial separation of the cord" would prove a more suitable descriptive title.

Kocher⁸ describes how this may be brought about in the descent of the testicle. The lower end of the testicle, globus minor and part of the cord, covered by tunica vaginalis, are arrested in their descent, but the upper end and globus major, together with the vessels, continue. Consequently, the testicle tends to assume a horizontal position, and the vessels are drawn away from the vas deferens by the descending globus major. If, however, the descent of the globus major continues, complete vertical inversion of the testicle may occur, so that the globus major lies inferior to the globus minor.

Curling⁹ considered the chief factor to be the defective formation or attachment of the middle strand of the gubernaculum testis, with the result that there is no fixation of the lower portion of the testis to the bottom of the scrotum. As to the side affected, in 10 cases of recurring torsion 5 were right and 5 were left, and in the recorded cases of acute torsion the same holds good, neither side showing any

marked preponderance. The testicle may be situated anywhere in the line of descent. In 10 undoubted cases the testis was descended in 6, almost descended in 2, and in 2 it was situated in the inguinal region. On the other hand, acute torsion affects imperfectly-descended testes more frequently than descended. Puberty may be considered as another predisposing cause, for in both recurring and acute torsion the majority of reported cases developed symptoms about this period. In 10 cases of recurring torsion the attacks commenced at the age of 20, 12, 13, 24, and 3 respectively. In Van der Poel's case⁴ it was 22, and 11 and 13 in 2 of Perry's.¹ Nicoladoni¹⁰ reported a case where the attacks began at 12, Macaigne and Vanverts¹¹ at 15 years. In the last 2 cases operation was performed on account of the severity of a subsequent attack.

Nash and Perry¹ reported cases, aged 19 and 15, where a torsion was diagnosed and untwisted. In Nash's case this was followed by some atrophy, but no subsequent attacks. Perry's patient did not report himself again. Lapointe² in 37 cases of acute torsion which he collected found that 24 occurred between the ages of 13 and 25. It must, however, be borne in mind that many cases of torsion in the infant are undiagnosed or the symptoms attributed to an orchitis, which—with no scientific foundation whatever—it is said undescended testicles are liable to.

Pearce Gould¹² has shown that there is a true venous hypertrophy in the cord at puberty, and both Davies-Colley¹³ and Spencer¹⁴ refer to an increased vascular arrangement in connexion with the testicle at this period.

Exciting Causes.

These are indefinite. The statements made by patients as to the cause of onset were strain, walking, coming on at night in three cases; crossing the right leg over the left caused the onset in a right testicle, and in another case crossing the left leg over the right also caused an attack in the right testicle.

In the acute form of torsion strain—such as lifting a weight, coughing, blowing the cornet, defaecation—are mentioned, as well as attacks coming on at night. There are several theories put forward to explain how the actual twist is brought about. R. W. Johnston¹⁵ suggests the action of the cremaster muscle, and J. Hutchinson, jun.,¹⁶ thinks that sudden contraction of its more oblique fibres may have a share in the mechanism. Davies-Colley¹³ considered the action of the gubernaculum probable. Spencer looks upon the veins as a factor, and when it is considered how at puberty there is a venous hypertrophy in connexion with the testicle, how these veins are arranged at one edge of a broad cord, and how readily they are distended by abdominal strain, some weight ought to be given to the theory. Position has to do with the onset, and the question arises how far it is mechanical or only an interference with the venous return. The actual exciting cause cannot be definitely stated, but it seems probable that there are combinations of conditions which, acting together, induce the onset, otherwise the sufferer from recurring torsion would incessantly be having attacks.

Symptoms.

Patients suffering from this condition apply for advice during a severer attack than usual, or because they have just passed through one, or, annoyed by attacks, they wish to avoid the recurrence of them.

The history is generally typical, attacks coming on from time to time in young adults, attributed to strain, position, or to no definite cause. There is the sudden onset of pain in the testicle, sickening in character, spreading over the hypogastric and up towards the lumbar region. Vomiting usually occurs early, and with it signs of more or less collapse, shown by pallor, and perspiration on the forehead and lips. The testicle is extremely tender on handling, and in the course of a few hours swelling occurs in this region. The thigh on the affected side may be flexed. Prostration is complete till relief, which, as a rule, comes in the course of some hours. With, usually, the sudden cessation of the severe symptoms and the disappearance of the local swelling in the course of a day. Patients have attributed their relief to stroking the testicle and hot fomentations. These attacks, varying much in severity, may come on at intervals of weeks, or more usually months, and for years such recurrences may take place, as in one of Perry's cases, where for fourteen years there had been an attack every two or three months, and in two of mine, where for ten years there had been recurring attacks.

When a patient is seen during an attack the local symptoms are extreme tenderness, especially about the epididymis, and

should some hours have elapsed fluid is generally present in the tunica vaginalis. The testicle may or may not be fully descended; it may be horizontal or with the epididymis anterior. The epididymis is enlarged, and on tracing the cord upwards a hard, very tender area may be felt. This is the site of the torsion. In addition to these local signs there are the general symptoms and history already mentioned, with, after existence for some time, a possible rise in the temperature. In one of my patients it was 100° F. This rise of temperature has been noticed in cases of acute torsion. It was 100.6° F. and 100° F. in two cases operated on by me, and Barker¹⁷ reported a case where it registered 102.2° F.

If advice is sought on account of the annoyance caused by recurring attacks, in addition to the history, local examination may assist the diagnosis. The testicle may lie in its normal position, or be drawn up, or it may be horizontal. An endeavour should be made to produce torsion by grasping the testicle, and, rotating it in its vertical axis, first of all inwards, and, failing this, outwards, the characteristic pain may be so induced. In some of the cases the testicle was smaller than on the other side, and in Van der Poel's case there was a history of slow descent in childhood.

That recurring torsion may occur in infants the following case will illustrate:

D. B., aged 5 months, was seen on November 19th, 1903, with Drs. Burn Murdoch and A. N. S. Carmichael. The history was that at 5 p.m. the child was suddenly seized with pain and became collapsed. It was found that a swelling was present in the right inguinal region, hard "like a slate pencil," exquisitely tender on palpation, no impulse on crying. The testicle was descended and tender. Vomiting occurred shortly after the onset, but there was a history of vomiting practically since birth. When seen at 9 p.m. there was swelling in the right side of the scrotum, but none in the inguinal region. The right testicle was descended and the epididymis enlarged and evidently tender; fluid was present in the tunica vaginalis, and could not be reduced into the abdomen. The severe symptoms had somewhat rapidly ceased shortly before 9 p.m., and flatus had been passed. The diagnosis of probable torsion of the cord with spontaneous relief which had been made was agreed with. The after-history was that the hydrocele had disappeared in a few days, and five months afterwards the child was well, and no recurrence had taken place, nor was there any atrophy of the testicle.

Though no attack has followed, so far as can be ascertained, the fact that one has occurred with spontaneous detorsion is evidence that other attacks may take place, and for this reason the case is of interest. In another case, detailed at the end of the paper, recurring attacks began at the age of 3 years, and continued at intervals till the age of 13, when an operation was performed to prevent recurrences.

Diagnosis.

When an attack is present and the testicle lies in the scrotum, the condition for which it is most likely to be mistaken is epididymo-orchitis; for there is pain, swelling, extreme tenderness, and possibly an elevated temperature, while the age of the patient, usually about puberty, renders the possibility more probable. The sudden onset of pain with collapse in a person otherwise well, the early and severe local tenderness, with perhaps the presence of a very sensitive hard swelling in the cord, ought to be sufficient to enable a correct diagnosis to be made. If, however, there is still a doubt, the absence of gonococci in a stained film of urethral mucus, and a negative history as far as mumps is concerned, will still further assist in the elucidation of the condition. The history, of course, is of the greatest assistance; but, even if the attack be the first, the diagnosis ought, in the large majority of cases, to be made correctly, instead of jumping to the conclusion that pain, swelling, tenderness, with an elevation of temperature, are necessarily the signs of inflammation, and inflammation only.

After swelling has occurred, strangulated hernia may be simulated, and more especially is this so when, from the severity of the attack, vomiting and collapse are present. On careful inquiry, however, it will be found that pain was the first symptom, followed in some hours by swelling. In hernia, as a rule, there will be swelling, followed by pain. In torsion there is no fullness of the inguinal canal, the early vomiting tends to cease, and complete obstruction is very rare. Whipple and Nash,¹⁸ however, reported a case of acute torsion where the vomiting became stercoraceous in character. Even in a first attack these points of difference ought to render the diagnosis fairly easy, while if there is a previous history of recurring attacks the diagnosis is clear.

In undescended testes the onset of torsion is most likely to be confused with strangulated hernia, but there is the empty scrotum, the sudden pain, followed gradually by swelling,

and generally incomplete obstruction. It is in children, however, that the chief difficulty arises, but the case when seen may have suffered for such a time that the rise of temperature and improvement in the general condition, with absence of obstruction, renders the diagnosis easier. There may, of course, be a hernia as well, and consequently when there is doubt the diagnosis should be settled by an exploratory incision.

The diagnosis of epididymo-orchitis in an undescended testicle must be made on the lines already given, but a word of warning may again be sounded concerning the onset of inflammation in the undescended testis of infants and young children. It is a popular belief that inflammation often followed by atrophy is liable to attack such misplaced testes, and though this statement is constantly repeated, no proof whatsoever has been forthcoming beyond the clinical symptoms, which are those of torsion. Even in such a recent and excellent paper as that of Odiorne and Simmons¹⁹ (1904) it is stated that "the undescended testicle is more commonly the seat of inflammatory conditions than one which is normally placed," and shortly after a case (No. 31) is described, which is typical of recurring torsion. No doubt a testicle situated in the inguinal region is more liable to injury, but no amount of injury will cause by itself a true microbic process.

Lapointe² has at the end of his monograph detailed 6 cases under the heading of "Infarctus hemorrhagiques sans torsion," and earlier in his work he states that, though rare, such conditions may occur. A doubt, however, is thrown on a case of Volkmann's. Reading over the quoted cases, it appears probable that they are primarily due to torsion which had undergone spontaneous detorsion after permanent damage to the testicle had taken place. In one case—that of Englisch²⁰—the testicle was found fixed to the posterior wall, which renders it likely that some other cause than torsion was responsible for the condition.

Rare conditions that might simulate the complaint are embolism of the spermatic artery and appendicitis in an inguinal hernia. Stanton and Shaw²¹ have described a herniated appendix adherent to the testicle in the tunica vaginalis; and Golding,²² of Brooklyn, has recently recorded a case of inflamed appendix in an inguinal hernia that simulated strangulated hernia. Ruptured varicocele, bruise of irreducible omental hernia, lymphadenitis of the horizontal chain of glands, are less likely to be mistaken for torsion. When a case is seen in the interval there is nothing which simulates closely these attacks.

Pathology.

In 7 out of 8 cases of recurring torsion where the direction of the twist was noticed the rotation took place from without inwards. Lauenstein has referred to this in acute forms of the affection; and quotes Kustner's similar experience in connexion with torsion of the ovarian pedicle. Lapointe, however, from the literature of 24 cases, states that no rule can be formulated. The degree of torsion must in recurring cases vary from a slight amount to such an extent that the patient seeks advice on account of the severity of the symptoms, and then a variation has been found from half a turn to two turns, meaning by a half-turn the rotation through a half-circle 180 degrees. The site of the twist is in that free portion of the cord which, covered by tunica vaginalis, suspends the epididymis and testicle. Sometimes the arrangements are unusual, as in an acute case reported by Texer,²³ where the torsion took place between an abnormally-situated epididymis, which, with the vas deferens, lay outside the tunica vaginalis, and the testicle suspended in the serous sac by a mesorchium which contained the vessels only. In order to understand the various lesions that result from torsion it is necessary to refer to the pathological changes found in acute cases.

Incision into the tunica vaginalis reveals more or less bloodstained fluid, occasionally clot. The cord and epididymis are greatly swollen and bluish or purplish in colour, while the spiral intersections produced by the twist are obvious. The appearance resulting from this has been compared by Barker to a bloated leech, and by several other observers to a portion of strangulated intestine. The testicle itself varies in dimensions and appearance. It has been described as double its size by Manson.²⁴ Whipple and Nash, as well as Legueu,²⁵ have found it apparently normal. Two children operated on by me on the fifth day after onset showed no enlargement of the testicle, but a marked reddish-black discoloration. It is difficult to understand how

such a dense structure as the tunica albuginea becomes distended to any great extent. The condition of the cord at the site of torsion has been noted by Nicoladoni, Lexer, Souligoux²; the veins were found to be flattened and obliterated, while the spermatic artery was pervious. This is what might be expected, except in very severe degrees of torsion, when the artery might be occluded, or in the late stages of the affection, when stasis and clotting might have taken place in it. The result of this obliteration of the veins is that the distal parts become engorged with blood, and naturally the more distensible structures show this most markedly, hence the striking appearance presented by the epididymis and any portion of the adjacent cord below the twist. Section of the affected parts shows intense engorgement, appearing red, black, or purple. Microscopic examination has shown great blood infiltration and degenerative changes in the affected structures. The result of this lesion is the destruction of the testicle, not a necrosis in the ordinary sense of the word, because there is no organismal infection but an aseptic death of the gland, which in process of time undergoes fibrification and consequent atrophy if left in the scrotum. Adhesions between the tunica vaginalis and the testis may occur as shown in Niemann's²⁶ case, operated on thirty-two days after the onset.

With the evidence so obtained, it is possible to understand what may take place in recurring cases. Repeated congestions, some severe, would possibly tend to produce by degrees a certain amount of fibrosis of the testicle and epididymis, with a consequent degree of atrophy. At the same time, any sharper attack than usual may cause lymph to be deposited in the tunica vaginalis, and so the formation of adhesions which will anchor the testicle.

A severe attack of torsion may be followed by atrophy, as in the case reported by Gifford Nash, where detorsion was carried out an hour and a quarter after the onset of the attack, but did not prevent a certain amount of atrophy which was reported later.

Prognosis.

The only prognosis that can be given in recurring torsion is that the attacks will continue and probably result in a varying degree of atrophy, unless an operation to fix the testicle is performed. At any time such an acute degree of torsion may occur that a termination in atrophy takes place; even if the patient has been shown how to carry out the needful action for untwisting his cord this is a possibility. A testicle in the young adult, situated in the inguinal region, is probably functionless (Griffiths)²⁷. So the effect of torsion on it as a secreting gland need not be considered when compared with a descended testicle; the pain and annoyance from repeated attacks will, however, continue. In those below puberty there must also be taken into consideration the fact that if the testicle is left in its undescended position it will not develop satisfactorily. So far as is known, torsion of the cord has never proved fatal.

Treatment.

This depends on whether a patient is seen during an attack or in the interval. When torsion is present an endeavour should be made to untwist the cord-detorsion. The testicle should be grasped between the thumb, first and second fingers, and slowly rotated on its vertical axis, first of all from within outwards, as in recurring torsion, it seems the most likely to succeed. No great force ought to be used, and the rotation should be continued until relief is felt, or the pain and resistance become so severe that it is obvious the wrong direction has been taken. Should this be so the opposite rotation ought to be carried out. There is necessarily some pain connected with this manipulation, but not very intense, and if successful there is immediate relief from the severe symptoms. Detorsion may prove a failure, and then an operation must be performed as soon as possible to remedy the condition and fix the testicle, and if it be undescended an endeavour made at the same time to bring it down into the scrotum.

The fixation of the testicle is all that requires any description here, and the method given will probably prove the best and simplest.

An oblique incision is made which crosses the cord just below the external abdominal ring, and through this opening the tunica vaginalis is exposed and separated from the coverings either before or after opening. There is usually a drachm or more of clear yellow fluid in the sac. The parietal layer of the tunica vaginalis is clipped away and

the visceral layer over the testicle and cord scraped. The testicle is now fixed to the coverings by one or more catgut stitches passed through the tunica albuginea, being careful to anchor it well down and avoid torsion when so doing. The ease with which the testicle and its coverings can be evaginated through this incision renders the operation simple, but it requires more care to stitch the testicle to a suitable portion of the coverings and to avoid a certain amount of torsion than if the incision were made in the scrotum.

Professor Annandale had a successful case by simply drawing the testicle out through a small incision in the tunica vaginalis, turning the vaginalis inside out, and suturing the opening, so allowing the testicle to form adhesions.

The after-results in the 5 cases operated on were, as far as can be followed, successful, and in one case it is three years since the operation. I have to thank Professor Annandale for allowing me to publish one case, and Mr. Cathcart for not only two cases, but for his kind consideration in asking me to operate on one of them. The following are the notes of 5 cases:

CASE I.

Mr. M., aged 30, was seen, with Dr. J. McGibbon, in December, 1901. He is a married man with two children, and until ten years ago was strong and healthy, when, while severely exerting himself, he was seized with sudden, intense pain in the left testicle. This pain was sickening in character, and shot up the line of the spermatic cord towards the left kidney, and also over the lower part of the abdomen. It was followed in the course of a quarter of an hour by vomiting, and he had to get to bed as soon as possible. The testicle was unaltered in position and size, but swelling in the scrotum gradually occurred. Fomentations were applied on account of the pain, and during their application sudden and immediate relief was obtained, though palpation still caused a certain amount of tenderness. The swelling rapidly disappeared, and in twenty-four hours he was perfectly well. For the last ten years he has had on an average two attacks a year similar in the main characteristics to the first attack, and always preceded by some strain, even coughing. Mr. M. volunteered the statement that he thought his testicle twisted to the right. There is no history of delayed descent or other abnormality. The attack in which he was seen by me was similar to the above description, and on examination the left side of the scrotum was found to be fuller than the right, and marked tenderness was present in the region of the epididymis, which was swollen and tender. The testicle was not raised, and lay in apparently a normal position. Some fluid was present in a large tunica vaginalis. The temperature was 100.6° F. The diagnosis of torsion of the spermatic cord, which had already been made by Dr. McGibbon, was agreed with, and an endeavour to untwist the cord was carried out. The testicle was twisted from right to left, and though momentarily painful this was successful in giving complete and immediate relief. A little more than half a turn was needed. An operation to fix the testicle was recommended, and carried out ten days later.

Operation.—An oblique incision was made over the external abdominal ring, and the tunica vaginalis, which extended to this point, was exposed. When opened about 1 oz. of clear yellow fluid escaped, and the testicle, fully descended, was seen lying free in the sac of the tunica vaginalis, with the long axis horizontal. The cord was broad and flat, and consisted of two groupings—at the one border the vas deferens passed to the globus minor, and at the other were the veins, somewhat varicose. The whole cord and testicle were covered from the external abdominal ring by visceral tunica vaginalis, so that they lay free in the large tunica vaginalis—in fact, a condition of floating testicle. The veins, being somewhat varicose, were removed for the distance of 1 in., and the catgut ligatures were tied together, so shortening the cord. The parietal tunica vaginalis was clipped away, and the visceral layer over the testicle was scraped with the knife. Two catgut sutures were inserted through the tunica albuginea and the raw surface of the scrotum. The after-history was uneventful, and three years have now elapsed without any recurrence of his previous trouble.

CASE II.

W. T., aged 16, was seen in the out-patient department of the Edinburgh Royal Infirmary in January, 1902. For four years he had had attacks of pain affecting the left testicle every two or three months. The attacks were predisposed to by walking, but at times came on at night. The onset of the attack was always sudden, the pain, sickening in character, shot up towards the left kidney, and caused prostration. In about a quarter of an hour vomiting took place, and later there was some swelling of the testicular region, followed by gradual cessation of the pain, and then disappearance of the swelling. Such an attack usually incapacitated him from work for a couple of days, and there was constipation. The present attack has lasted four hours and came on suddenly. There is pallor and faintness. The testicle is somewhat drawn up, exceedingly tender, and in the region of the epididymis there is a hard rounded swelling about the size of a hazel nut. A half turn was sufficient, from right to left—from within outwards—to bring about immediate relief and an appreciable descent of the testicle. Operation was recommended, and Mr. C. W. Cathcart, whose receiving day it was, admitted the patient, and most kindly asked me to operate.

Operation.—A few days later an oblique incision was made over the external abdominal ring and the tunica vaginalis exposed. It was found to be large, and extended from the external ring downwards. On opening it, about 2 drachms of clear yellowish fluid escaped. The testicle and cord hung free in this cavity from the external abdominal ring, and were covered by visceral tunica vaginalis. There was a broad arrangement of the cord, with separation of the vas deferens from the vessels, and the testicle itself hung almost horizontal. The parietal tunica vaginalis was removed, and a strip of the visceral investment was separated with difficulty from the free aspect of the testicle. Catgut sutures were inserted, uniting the fresh surface of the testicle and the scrotal wall.

The after-history was uneventful, and two years later the patient reported that he was in the best of health.

CASE III.

A. W., aged 16, was seen in the out-patient department of the Edinburgh Royal Infirmary in February, 1902. For three years he had been suffering from sudden attacks of severe pain in the left testicle. Strain apparently brought on the attack, which varied in severity and duration. The pain was always sudden in onset, and got very severe in character. It was accompanied by vomiting, in a little time swelling appeared on the affected side, and at a variable time sudden relief would be obtained. As the attacks incapacitated him from work he applied for treatment. On examination there did not appear to be anything abnormal about the testicle, nor could the characteristic pain be induced by endeavours to twist the cord. Operation was recommended, and Professor Annandale, whose receiving day it was, operated later.

Operation.—The testicle, considerably atrophied and soft, was found lying free and horizontal in a large tunica vaginalis, which contained two to three drachms of clear fluid. The cremaster muscle was hypertrophied. The testicle and cord were covered by visceral tunica vaginalis, and the cord was broad, with separation of the vas deferens from the vessels. The tunica vaginalis was evaginated and stitched in this position, the testicle and cord lying in apposition to the fresh internal aspect of the scrotum, to which it was fixed by catgut sutures. As far as could be followed there was no recurrence of the previous symptoms.

CASE IV.

W. G., aged 24, seen at the Royal Infirmary, Edinburgh, in September, 1902, when in charge of Mr. Cathcart's wards. A year ago he had a bicycle accident and injured his left testicle, which remained painful for three weeks. Three weeks previous to admission there was a sudden onset of pain in the left testicle, sickening in character, and this remained for four to five hours, swelling gradually taking place and the pain subsiding. There was no vomiting. Altogether there had been three attacks of a similar nature. On examination there was a slight varicocele, the testicle lay somewhat horizontal and could not be twisted so as to produce a recurrence of the symptoms. Operation was advised and carried out later. The testicle lay free and almost horizontal in a large tunica vaginalis, and with the epididymis and part of the cord was covered completely by visceral tunica vaginalis. There was free fluid present in the tunica, and the cord contained a slight varicocele and was broad in its arrangement. The varicocele was excised and the cut ends united, the tunica vaginalis clipped away, and the testicle anchored by catgut sutures to the raw scrotal surface. Except for some slight superficial suppuration the case did well, but no after-history could be obtained.

CASE V.

R. C., aged 13, was seen in the out-patient department of the Edinburgh Royal Infirmary in July, 1903. There was a history of recurring attacks of pain in the right testicle from the age of 3. These attacks usually began in the early morning, waking him from sleep. The pain was sudden in onset, sickening in character, and quickly followed by vomiting. He could not bear any handling of the part, the pain was so severe. In two to three hours from the onset swelling began, and disappeared in twenty-four hours after relief had been obtained. The severity of the attacks varied in duration and degree but always passed off suddenly. He noticed that crossing the left leg over the right tended to induce an attack. The right testicle was smaller than the left; it lay horizontal, and was markedly raised compared to the other. The characteristic pain could be induced by rotation of the testicle outwards. He had been treated with a truss for supposed hernia but no sign of one could be found. Operation was advised.

Operation.—Mr. Cathcart, into whose wards he was admitted, operated, and found the testicle considerably atrophied and soft. It was lying horizontal in a large tunica vaginalis, which contained clear fluid. The testicle and cord were covered completely by visceral tunica vaginalis, and the veins and vessels of the cord were enlarged. The cremaster muscle was hypertrophied. The tunica vaginalis was clipped away and the testicle sewn to the scrotum. Recovery was uneventful.

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AN INVESTIGATION ON THE REGENERATION OF NERVES,

WITH A VIEW TO THE SURGICAL TREATMENT OF CERTAIN PARALYSES.

By BASIL KILVINGTON, M.S., M.D.MELB.,
Demonstrator of Anatomy, Melbourne University.

[PART I.]

THE various nerve fibres which run in a nerve trunk may in the present stage of our knowledge be classified under the following groups:

1. Motor nerves proceeding direct from the central nervous system to skeletal muscles.
2. Preganglionic fibres arising in the central nervous system and ending in nerve cells placed peripherally (sympathetic ganglion cells, mesenteric ganglion cells, and those of the heart, salivary glands, etc.).
3. Post-ganglionic fibres arising in these peripheral ganglia and ending in smooth muscle and glandular tissue.
4. Afferent fibres arising in the peripheral sensory apparatus, and proceeding to the central nervous system, and having their cells stationed in ganglion close to but not included in the central nervous system; with these must be classified for the present the vaso-dilator nerves.

In investigating the results of nerve crossing, we have to bear in mind the fact that the particular nerves used may contain any or all of these groups. Sensory phenomena are extremely difficult to determine in animals; and in such nerves as those of the limbs the preganglionic fibres are absent. Thus the motor fibres attract our chief attention as they give results which are the most striking and easy to interpret.

The startling results obtained from nerve crossing have opened a very fascinating field in surgery. The earliest experiment in this direction was apparently performed by Fleurens¹ in 1824. This observer divided the two chief nerves from the brachial plexus in a cock; one nerve supplies the muscle of the superior and the other those of the inferior surface of the wing. They were both divided, and the proximal end of one joined to the distal end of the other and vice versa. After a time co-ordinated movement was observed in the limb. Since then many other observers have used different nerves for crossing. These nerves may have a similar or different function. Schwann² made some experiments on the sciatic nerve in the frog, to see if sensory fibres could establish a functional connexion with motor fibres. His results were against any such union. These have been confirmed by many other observers, including Bidder and Gluge and Thiersch³, who crossed the hypoglossal and lingual nerves. It seems that any such functional union is very unlikely. In all this class of experiment there is a considerable risk of all the nerves uniting in a common catatrix, which of course vitiates any result obtained. To avoid this, Rawa⁴ used only one crossing, and excised a considerable length of the other nerves. Such a procedure, of course, results in permanent loss of power in one set of muscles antagonistic to those innervated by the crossed nerve. Such a condition is unsatisfactory and not very easy to interpret, owing to the contracture developing in the innervated muscles. Rawa crossed the peroneal and posterior tibial nerves, and describes a contraction occurring in the muscles normally supplied by the posterior tibial, when the peroneal which has been crossed is stimulated and vice versa. This observer also crossed the vagus and hypoglossal, widely excising one set, and in the animals which survived the function of the vagus or hypoglossal was apparently carried on by the crossed nerve. After six months' interval in the animal the central end of whose vagus was sutured to the distal end of the hypoglossal, rhythmical movements were present in the corresponding half of the tongue. These had a definite relation to the movements of respiration. The conclusions drawn from this were that the central end deter-