there has been no discharge whatever between the grafts, although I had regarded them as very unsuitable cases before the application of flavine.

2. The grafts should not be covered with any dressing and should be properly protected. At the suggestion of Dr. Culverwell I have used inverted boxes of various sizes and shapes cut to fit the contour of a limb if necessary. A jeweller's or instrument maker's cardboard box is the most suitable. The edges should be slightly padded, and the box should be amply large, so that there is no risk of the padding touching the wound.

3. The technique I have used is as follows: The surface from which the skin is to be taken is prepared in the usual way. The wound is covered with a simple gauze dressing, and when this is removed care is taken to disturb the surface as little as possible. Two razors are employed, so that one can be dipped into boiling water while the other is being used; thus the freshly cut surface heals without any suppuration. The grafts are cut about the size of a postage stamp, and with practice can be cut to almost any shape. The skin and razor are kept thoroughly wet with normal saline, so that the grafts can be more easily cut and removed from the razor. The graft is conveyed to the wound on the razor, and slipped off it with the help of a blunt probe. The grafts are generally placed about one-eighth of an inch apart, but can be closer together in a very clean wound. The box, sterilized beforehand, is adjusted to the part and fastened down by long strips of rubber plaster; the ends of these are thoroughly bandaged, the bandage being brought up to the box as close as possible on all sides, but not over it. As a further safeguard against any chance of slipping the bandage is always used in the form of a spica whenever possible. It is then pinned to the box with a liberal supply of safety-pins. The box remains quite firm for three or four days, when it can be removed. The grafts are then found to be firmly fixed, and any dressing, such as fomentations or red lotion, can be applied.

Lectures

ON

THE ANATOMICAL AND PHYSIOLOGICAL PRINCIPLES UNDERLYING THE TREATMENT OF INJURIES TO MUSCLES, BONES, AND JOINTS.

GIVEN AT THE ROYAL COLLEGE OF SURGEONS OF ENGLAND, NOVEMBER–DECEMBER, 1917.

BY

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IV. THE INTRODUCTION OF TENOTOMY.

THE events which led to the introduction of tenotomy as a measure of surgical routine had nothing to do with Hunter's experiments; they occurred nearly thirty years after he was dead.

The man who can best serve as a guide as we follow the march of events, is William John Little, the son of parents living in comfortable circumstances in the East End of London. Little was born in 1810, and was therefore a contemporary of Hilton. In his infancy he suffered from a fever which left the extensor muscles of his leg (so he informs us) paralysed. As he grew up his left foot became inverted, the heel raised, and a typical talipes equino-varus developed. At the age of 16 he was apprenticed to a neighbouring apothecary, but two years later, in 1828, his indenture being cancelled, he began the study of medicine at the London Hospital. He entered his studies with the fixed intention of discovering what could be done for the relief of such a condition as he suffered from. He found that club-foot was regarded as lying outside the legitimate scope of surgery, and, in the opinion of his teachers, was properly confided, as his own case had been, to the care of bonesetters and sprain rubbers, who treated the condition with manipulations or instruments, often with a fair degree of success. A man whose chief object in devoting himself to medicine had been the alleviation of a personal infirmity—one with which his senior contemporaries Lord Byron and Sir Walter Scott were afflicted—was not likely to remain content with the comfortless promise of his time. All through his time of study at the London Hospital he sought every opportunity of making himself acquainted with the actual condition of parts in deformed feet; he had a facile command of the French tongue, and during his studenthood followed medical progress in the literature of Paris as well as in that of London. He became particularly interested in the work of Delpech of Paris, who had proposed and carried out in 1816 section of the tendo Achillis for the cure of club-foot. When he had passed through the curriculum of his own hospital he went to study in the *post-mortem* room at Guy's Hospital, under Thomas Hodgkin, and to study comparative anatomy under Dr. Robert Grant at University College. It was in that year (1834) that he settled to a city practice in Billiter Street, and was appointed lecturer on comparative anatomy and physiology at his own hospital—the London. In 1834, being then 24 years of age, he became a Member of this College, but in that year was his failure to obtain a vacant assistant surgeoncy at his hospital. He therefore resolved, as is not unusual under such circumstances, to become a Licentiate of the College of Physicians, and devote himself to medicine. For that purpose it was necessary for him to spend two years at a university. He chose Berlin, drawn thither by the great fame of Johannes Müller. In 1834 we see this lame and somewhat sensitive Englishman set out for Berlin armed with a letter of introduction to Müller from Grant of University College and supported by the status accorded to him because of his office of lecturer in comparative anatomy. When Little entered Müller's laboratory he found there Schwann, Henle, Remak, and the other young men who, a few years later, were to reveal the cellular constitution of living matter. Little had every opportunity given him in Müller's laboratory of continuing his dissections of deformed feet. The condition revealed by his dissections supported the conclusions he had drawn from his investigations in England—namely, that surgeons were in error in believing club-foot to result from an inherent defect in the growth of the bones of the foot; the cause of the deformity lay in the soft parts—particularly in a disordered action of the muscles. With that conclusion Müller agreed. He also concurred with Little in regarding the condition as one which should be amenable to surgical treatment.

Before leaving England Little had read of a young surgeon at Hanover, Stromeyer by name, who had modified Delpech's operation, and was cutting the tendo Achillis for the rectification of club-foot. Müller agreed with Little that such an operation had a rational basis. Hence we find Little, in the summer of his second year of study in Berlin, and the twenty-sixth year of his age, visiting Stromeyer in Hanover.

Stromeyer was only six years Little's senior. He was born in Hanover in 1804, the son of a surgeon there who had strong leanings towards the art as practised in England. After spending almost a year in England, young Stromeyer commenced practice in his native town in 1828. From the outset of his practice Stromeyer applied himself to the treatment of physical disabilities and deformities. He fitted out a small private hospital, but found the establishment of the kind of practice he desired an uphill task. In 1831 his opportunity came. The son of a local schoolmaster, a boy of 14, was the subject of club-foot—intractable, painful, the despair of his relatives and medical attendants. Stromeyer gave the lad a bed in his hospital, and settled down to give his case eighteen months of unremitting attention and care. As a last resort, he cut the tendo Achillis by a new—a subcutaneous—method; he found that the foot could then be flexed (dorsiflexed) and that the cut ends of the tendon separated for three-quarters of an inch. The gap evidently frightened him somewhat; at least he again extended (plantar flexed) the foot until the ends were in apposition, before he fixed it in a splint. At the end of six days he found on bending the foot that the cut ends of the tendon did not separate, but moved together. He gradually dorsiflexed the foot, thus, as he supposed, stretching the scar in the tendon, so that in eight weeks the heel was brought down to its proper level and all trace of the equinus deformity removed. Stromeyer ascribed his success, not to the eighteen months of unremitting attention he had given to the case, but to the operation he had thus introduced into surgery. Tenotomy, he declared reduced the

time necessary for the cure of club-foot from months to weeks. It brought hope and healing to a neglected class of beings. One great truth he clearly recognized—one which has still to be insisted on—that the theory of congenitalism which had been so consistently applied to a certain class of deformities was a curse to surgical progress; it was used to cover ignorance, and when applied to club-foot prevented surgeons from inquiring into the nature, origin, and ultimate cure of the condition. Nature, he said, could not cure club-foot; it could only make the condition worse. Heat and rubbing, he found, were useless in mending spastic or contracted muscles. He regarded deformities as primarily due to disordered muscular action. To cut the tendon of a spastic or contracted muscle was, therefore, a rational means of treatment. He was impressed by the discoveries of Charles Bell, and in 1836, when Little came under his care, he published a paper on lateral curvatures of the spine, ascribing them to a disordered action of the muscles of respiration. Section of a tendon, he believed, not only relieved the tension of a muscle, but also, as Hunter had concluded, altered its functional behaviour. He observed that a spastically contracted muscle, when its tendon was cut, passed into a condition of rest. Tenotomy he regarded as a means of giving rest to an inflamed joint. He saw how tenotomy could be profitably applied to many regions of the body; he introduced it as a cure for strabismus. Tenotomy was not only a cure for deformities—it gave the surgeon an opportunity of directly affecting the disordered action of a muscle.

Such was the condition of matters when Little entered the modest orthopaedic hospital at Hanover in the July of 1836. There he had his deformity rectified; numerous opportunities were given of perfecting himself in the technique of the new operation; he returned to Berlin convinced that a new era had dawned for the deformed. He showed himself to Müller and to Müller's colleague, Dieffenbach, the surgeon; they were amazed at the success of the Stromeyerian methods. Dieffenbach put them in practice almost immediately; in the course of a little over a year he had operated on 140 cases of club-feet, preferring to rectify the deformity rapidly at the time of operation to the slow post-operative reposition practised by Stromeyer.

Little read his thesis for the doctorate of Berlin University on the nature and treatment of club-foot, and early in 1837 returned to London and at once settled down to treat cases of club-foot. His enthusiasm compelled the attention of his British colleagues; some were interested, others were sceptical, many were actively opposed to the new measures. Although of a retiring, modest nature he proved to be the right man to lead a crusade. In 1838, with the help of relatives and friends, he succeeded in establishing the Orthopaedic Institution—afterwards the Royal Orthopaedic Hospital—the first of our public charities for the relief of the maimed and deformed poor. Into the labours of that institution he threw his full strength. In 1839 he published a treatise on *The Nature of Club-foot and Analogous Distortions*—dedicating the work to Sir Astley Cooper. He gave courses of lectures to students on orthopaedic treatment of deformities; he published the course he gave in 1843–44 under the title of *The Nature and Treatment of the Deformities of the Human Frame.*

There can be no doubt that Little was the pioneer of orthopaedic surgery in England. He regarded subcutaneous tenotomy as a great discovery—a surgical revolution. If in this he was too sanguine he at least focussed attention on the treatment of deformities, and particularly on muscles and tendons. We have evidence that his influence and labour made themselves felt in London and Edinburgh. In 1839 James Paget, then a young man of 25, waiting at St. Bartholomew's Hospital for an appointment on the staff, was moved to investigate the repair and blood supply of tendons. He found that tendons were provided with a double supply, (1) from the arteries of the muscle, (2) from the arteries of their sheath. If a tendon were cut, both these supplies took part in furnishing the "callus" of repair with nourishment. In Edinburgh Syme began to practise the operation of tenotomy. He cut tendons in deformed feet and almost immediately turned patients out of hospital to let Nature complete the cure; we know now that in such cases she performs her part very ill.

On Little's return to England he became a Licentiate of the College of Physicians, and in 1840 was appointed assistant physician to the London Hospital, but the College could not look upon his surgical endeavours with a favourable eye, and he was a man of 67 before his College made him a Fellow. He also had his gains. It was his interest in orthopaedic surgery which drew him to the study of the disordered action of muscles and led to his recognition and description of spastic paralysis (Little's disease). His belief in the efficacy of tenotomy ultimately waned; he came to think that a stretched muscle recovered better than one which had been tenotomized. We find him in 1876, when he gave an address in Edinburgh, towards the end of his professional life, using expressions which show us that his early enthusiasm for tenotomy had become tempered by an experience of forty years. He then realized that tenotomy might be a curse as well as a benefit. Tenotomy applied as the sole measure for the treatment of deformities might have disastrous results. He came to the final conclusion—the same conclusion H. O. Thomas reached—that it was the continuous care of the surgeon, the nursing and coaxing of the parts day by day, with an infinite expenditure of patience, which gave restoration of shape and function to deformed parts. In 1884 William John Little withdrew from active practice to live at West Malling, Kent, where he died in 1894. Stromeyer's career had come to an end long before; he died in 1878, at the age of 74.

To see the principles which guided the practice of the men who followed in the orthopaedic movement started in England by Little, we shall follow the career of William Adams. When Little returned from Berlin in 1837, Adams, a lad of 17, had just been apprenticed to his father, a surgeon in Finsbury Square, in the city of London. He joined St. Thomas's Hospital as a student, working under Hodgkin and Green, and after four years became a Member of this College in 1842. By that time the orthopaedic movement started by Little was well afoot. At Hodgkin's suggestion Adams became curator of the museum at St. Thomas's Hospital and worked there at pathology, waiting for an appointment on the staff, trying at the same time to build up a practice in the city. In 1851, being then 31 years of age and seeing no hope of an appointment to his own hospital, he sought and obtained a place on the staff of the orthopaedic hospital founded by Little. We can see by the way he then set to work that he knew how scientific surgery should be built up. There was still a doubt as to the exact manner in which repair was effected after a tendon is cut. He carried out a series of experiments on sixteen rabbits, cutting the tendo Achillis and studying each stage in the process of repair. His description of the nucleated blastema need not detain us, nor need we linger over his insistence on the part played by the sheath or peritendineum in supplying the material needed to make good the gap in a cut tendon. If time permitted, it would repay us to review the results of his dissections of deformed feet in which the operation of tenotomy had been carried out at varying periods before death occurred from some accidental cause. In one case of tenotomy of the tendo Achillis, he demonstrated that 2½ in. of new tendinous material had become inserted in the course of repair. In another foot, where the tibialis posticus had been cut within its synovial sheath behind the malleolus, he observed that repair had failed, and at the point of section the tendon had become adherent to the bone. Adams availed himself of every opportunity to look beneath the surface and obtain an accurate knowledge of the condition of the deep parts—bones, joints, ligaments, and muscles—which had to be dealt with in the rectification of deformities. He investigated particularly the condition revealed by the dissection of club-foot, and in 1864 was awarded the Jacksonian prize of this College for his dissections and investigations. When, however, we seek for a deeper knowledge of the cause and prevention of deformities and of the action of nerves and muscles, we shall search Adams's publications in vain. With Stromeyer and Little, he believed that deformities should be slowly reduced after the necessary tenotomies had been performed, and that rectification had to be effected by the application of rigid machines.

In 1871 Adams introduced a subcutaneous operation for the relief of ankylosis of the hip-joint. We see in that operation the application of the subcutaneous method to osteotomy. He there applied to the hip-joint a method which had sprung out of the practice introduced by

Stromeyer. Subcutaneous osteotomy, however, had been practised in Germany long before the date at which Adams applied this method to the hip-joint.

THE LAW OF LIGAMENT.

When we examine the principles and practice of Stromeyer, Little, and Adams, all of them pioneers in orthopaedic surgery, we are struck by the importance they attach to ligaments in the production and treatment of deformity; ligaments seemed to them almost as important as muscles. Even now the essential function of ligaments is misunderstood, and so long as this is the case we cannot hope to effect an object which is quite as important as the rectification of deformities — namely, their prevention. Hunter's teaching as regards the respective functions of muscles and ligaments in the mechanism of the human body is very definite. Muscle is the only tissue of the body which can be applied for the continued support of parts without undergoing elongation. A ligament cannot perform that function because it is composed of living passive tissue which must stretch when it is submitted to continued tension. Nature never uses ligaments either for the purpose of passive support or of active maintenance of parts in position; she uses them only for the purpose of limiting movements when the muscles which guard and surround a joint are forced beyond the compass of their normal reach.

This law can be best illustrated at the shoulder-joint. In paralysis of the shoulder muscles, or when a patient is deeply anaesthetized, the head of the humerus drops away from the glenoid cavity under the weight of the arm; the shoulder-joint can then be moved far beyond its normal limits; the ligaments become then the sole agents which limit movements, and are subject to direct stress. If in the dissecting room we strip the muscles from the shoulder and leave the humerus attached merely by its ligaments, we can see then that in all normal movements they never become taut until the usual limits are exceeded. The real ligaments of the shoulder-joint, as of every other joint in the body, are the active defensive contractile muscles.

Now man's upright position has made him more dependent on the ligamentous function of muscles than any other animal. His shoulders, when he stands up or sits up, have to be steadily supported by muscles—every one of the twenty-four vertebrae of his backbone has to be kept continuously balanced one upon the other; the contents of his abdomen have to be constantly braced by the contraction of the muscles of the abdominal wall and thus prevented from falling down. Ligaments are useless for such purposes; Nature never employs them for such ends. We see the same principle applied in the maintenance of the joints of the lower extremities. We cannot stand without the muscular braces of our hip, knee, and ankle joints coming into continuous action. It is easy to demonstrate that the maintenance of the plantar arch owes nothing to ligaments; that can be demonstrated in the living foot and leg, and also in the dissected parts.

It is quite clear that ligaments are passive parts; their elongation is not a cause but a consequence of the deformity. In short, in all static deformities of the human body the cause has to be sought for, not in ligamentous changes, but in the disordered action of the muscles, and we shall never succeed in preventing or mending static deformities until the truth of this law of the function of ligaments is clearly realized.

Memoranda:
MEDICAL, SURGICAL, OBSTETRICAL.

PROFLAVINE IN SEPTIC WOUNDS.

THE following short notes of five cases of septic gunshot wounds of limbs treated with proflavine at the Kineton Auxiliary Hospital may prove of interest to others engaged in military surgery:

CASE I.

Pte. P. Gunshot wound of right shoulder on July 12th; large wound on back of shoulder, through deltoid muscle. Exposed bone felt with probe. X rays showed fractured scapula below glenoid cavity running into the joint. Piece of metal present in upper third of arm. The wound was operated on at the casualty clearing station and Carrel treatment used. On admission here on July 25th the wound was very septic and discharging. There was slight rise of temperature at night. Sinus leading to bare bone of scapula plugged with gauze saturated with proflavine (1 in 1,000 in normal saline); dressing covered with protective tissue. Dressed daily for a week. There was a marked decrease in amount of discharge. The wound became healthy and granulating; temperature normal, and the patient doing well.

CASE II.

Pte. O., aged 22. Gunshot wounds of both legs on April 11th. Perforated left tibia; large lacerated wound of left leg, tibia exposed, piece cut away. May 25th, wound very septic; profuse discharge. Wound redrained under A.C.E. and several sequestra removed. Cavity packed with bipp paste. Temperature varying between 101° and 98°. On admission here on June 9th wound still very septic. Eusol irrigations and dressings used, and wound improved to a certain extent, becoming cleaner. Proflavine was tried, irrigations of the solution (1 in 2,000 in normal saline) through drainage tubes, and gauze packings through sinus on inner side of tibia; the wounds were then covered with gauze saturated in the solution (1 in 1,000), and covered with protective. Dressed daily for ten days, then small vesicular rash appeared on surrounding skin. Saline dressings only were then applied. Previous oedematous condition of leg greatly improved, sensation and movements of the limb returning on August 10th; sequestra separating. Temperature slightly raised at night, but patient's whole condition improved.

CASE III.

Pte. F., aged 28. Gunshot wound of left leg on April 27th; large wound of inner side of left calf. Aponeurosis of deep muscles exposed. Wound excised in France. On admittance to Farnborough V.A.D. Hospital, temperature 103° at night; oedematous swelling on inner side of left ankle. This was excised and a quantity of pus removed, and gauze saturated with carbolic 1 in 20 passed through from upper to lower wound. These wounds were also syringed daily with carbolic solution.

On July 15th patient was transferred to Kineton Hospital, and an incision was made above ankle sinus leading to an abscess in front of tendo Achillis. Cavity irrigated with proflavine (1 in 2,000 in saline solution), and then packed with gauze saturated in solution 1 in 1,000. After a week's treatment, cavity quite clean and ready to heal. Wound now healed, and man sent to Medical Board.

CASE IV.

Cpl. C. Multiple wounds of scalp, right arm, right thigh, leg and buttock; wounds dirty and bone exposed. Transferred from France June 2nd, 1917; admitted Kineton Hospital (stretcher case) June 7th, 1917; wounds still very dirty and several pieces of shell imbedded in wounds of leg. Tibia exposed middle third of shaft. Eusol dressings applied for four days. Flavine gauze applied to leg wound. After two days' treatment the wound started to heal at the edges and was so clean that no swabbing was required. Flavine gauze with protective used for ten days, after which the wound completely healed with saline gauze on fourteenth day.

CASE V.

Pte. C. Gunshot wound of right thigh on September 15th, 1916; compound fracture of femur, middle third. Admitted Southampton Hospital September 28th, 1916. Was transferred to convalescent camp May 16th, 1917. Healed and went on furlough end of May, 1917. Reported sick on June 6th, 1917, admitted Birmingham University Hospital. Abscess opened and bone scraped on June 8th. Transferred to Kineton Hospital (stretcher case) on June 16th with large open wound 5 in. in length (unstitched) exposing shaft of femur. Discharge copious. Bone very painful to press from 1 in. above knee to neck of femur. Packed with eusol gauze and fomented every four hours. Temperature high from June 28th to July 7th. Flavine packing and gauze with protective applied July 7th. About a week later the sinus commenced to heal, and on August 22nd packing was discontinued.

FRED. V. ELKINGTON, L.R.C.P., L.R.C.S.,
Surgeon to Kineton Auxiliary Hospital.

PROLONGED CATHETERIZATION.

A PATIENT, aged 76, has just died after having catheterized himself regularly for fifty-seven years.

At the age of 19 he was a very keen oarsman at Cambridge, and after great exertion in rowing had an attack of what was probably transverse myelitis. His legs were completely paralysed, and he was utterly unable to pass water. The legs gradually recovered so that he could walk with two sticks. The bladder never recovered, and for fifty-seven years he passed a catheter regularly twice a day. He had repeated attacks of orchitis and cystitis. He told me that the urethra had grown so hard that no lubricant was wanted, and that he never used any disinfectant.

Yattendon, Berks. F. A. BRODRIBB, M.R.C.S., L.R.C.P.