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

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BY

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**I. THE ORTHOPAEDIC PRINCIPLES OF
JOHN HUNTER.**

Abstract.

In my lectures for the present year I propose to review our stock of that kind of knowledge which is needed by the surgeon in the treatment of disabled men. There never was a time when we stood more in need of a ready knowledge of the right kind of anatomy and physiology than now. There are in our hospitals—our repairing sheds—thousands of human machines which have been damaged or maimed in the service of their country—awaiting or undergoing repair. We cannot restore action to any machine, much less that most complex of all machines, the human body, unless we know the arrangement and working of its parts. Whatever means or practices we adopt and apply for the treatment of these disabled men, there is one condition which must be fulfilled—they must be based on a knowledge of the structure and function of the body.

In this and in some of my subsequent lectures I propose to make excursions into the past, and cull from the lives of men who devoted themselves to the study of the human body such facts and experiences as may be of use to us at the present time. There are many reasons why I should begin with John Hunter: his life's work is the common inheritance of the Anglo-Saxon peoples; he was still in the full flight of his career when the United States and Britain parted ways; his career, as you know, reached an abrupt end as the winter session of 1793 began. It is not the stretch of intervening years, but the crowded series of revolutionary movements which have swept across the fields of surgery and medicine which make him seem distant to us. In his closing years came a knowledge of oxygen, of combustion, of respiration, of oxidation of the tissues, of heat and temperature—knowledge which threw much of Hunter's best work into the realm of pure history. Then later, in 1839, began the revolution of the microscope, which gave anatomists and physiologists their atomic theory. The result of that revolution was to make us think in terms of living cells; Hunter thought in terms of living structures, tissues, and organs. Then, finally, came the great Pasteur-Lister revolution; problems which Hunter had struggled to solve—problems of inflammation, infection, and repair—were finally fixed on a new basis of knowledge, and thus another section of Hunter's life's work lost its currency. The great evolutionary movement left Hunter's work unchanged; he was an evolutionist, but, fortunately for us, he studied the evolution of function rather than form. For medical men it is function rather than structure which matters. Hence it is that when we have deducted those parts of Hunter's labours which have been replaced by the progress of knowledge, there still remains a vast fund of permanent value not only for us now but for generations to come. I propose to pass in review only those parts of his writings which bear on the restoration of action to limbs and joints.

Were I asked to cite the most important contribution Hunter ever made to surgery, I would reply that it was his clear recognition of the fact that restoration is effected by powers inherent in the living tissues of the patient; the surgeon can only help recovery by tending these powers. This attitude towards disease keeps on recurring throughout his works. I shall quote only one instance. It is from a passage where Hunter speaks of the practice, followed by certain surgeons, of preventing wounds from scabbing. "This practice," he writes, "arises from the

conceit of surgeons who think themselves possessed of powers superior to Nature, and therefore have introduced the habit of making sores of all wounds." You will see that Hunter regarded the surgeon as standing in the same relationship to disease and injury as a gardener does to his plants. He may trim and prune, weed and delve, manure and support, and thus help them to thrive, but the power of growth does not lie in his hands; he can only assist that power. That lesson, I dare think, is needed at all times, and in none more than in the present. A soldier waiting wearily for movement to return to his stiffened joint or limp limb is apt to think that the means of recovery lie in the surgeon's hands, and expects a cure to be worked on him by active means. It is small wonder if in these circumstances the surgeon may be tempted to become more than Nature's mere assistant. In many modern operations the surgeon's share in effecting a cure is pre-eminent. A stone is removed from the bladder, an enlarged prostate from the pelvis, a calculus from the kidney, gall stones from the cystic duct, or a fulminating appendix from the abdomen, and thus the conditions necessary for a recovery are at once established. The surgeon's large share in such cures is beyond dispute. Nature cannot reappose the fractured ends of a broken bone, nor can she set the parts displaced in a fracture dislocation of the ankle or the dislocation of a joint. There, again, the surgeon's aid is an essential factor for a good recovery. But in the treatment of chronic ailments and disabilities which follow gunshot wounds it becomes a much more difficult matter to assess Nature's and the surgeon's share in the recovery. It is in these cases that we have to make certain that the means of treatment which we apply are founded on a rational and well-established basis.

To understand how Hunter's attitude towards the cure of disease became his second nature you must make his acquaintance during those twelve years he worked in his brother's dissecting room in Covent Garden—from 1748 until 1761, when he set out at the age of 33 to serve as a staff surgeon in the expedition to Belleisle, off the mouth of the Loire. It was his fortune during those twelve years in London to be associated with men who studied the human body to learn its living mechanism. He was still more fortunate in studying with men who preferred to dissect their knowledge directly from the actual part than to obtain it at second hand from the printed page. He learnt then to work, to love work, to become work's most willing slave. During those twelve years there were intervals of clinical work at Chelsea and St. Bartholomew's; he had been surgeon pupil and house-surgeon at St. George's Hospital. But the knowledge which was to give him a foremost place amongst surgeons was gathered within the walls of the dissecting room. Just glance at the researches he carried out then: He worked at the descent of the testicle, and recognized that certain mysterious forces were involved in that operation of Nature. He saw that the condition of the testicle somehow controlled the act; he saw with curious eye what was merely an everyday observation to others—that the roots of shedding teeth were absorbed; that the extraction of a tooth was followed by the removal of its alveolus, and that such changes could not be effected unless the animal body was provided with a mechanism—a marvellous mechanism—for the removal of useless as well as dead parts. If only he could discover how Nature effected such changes, and could copy her methods, then why should he not use such methods to clear away those innocent and malignant growths which so often threatened life itself? The thread of that inquiry runs all through his laborious career: the removal of sequestra, the burrowing of abscesses towards the surface of the body, and the removal of sloughs. He never did discover that opsonic power—that "consciousness of imperfection" which makes useless parts fall a prey to surrounding healthy parts. It was during those twelve years he unravelled the structure of the placenta. He discovered then that nerves must be of different kinds and serve different functions, otherwise there could be no explanation of branches of the first and fifth cranial nerves terminating on the same area of nasal mucous membrane. He examined the earliest stages in the incubation of the chick, noting the origin of the red blood islands, their fusion and invasion of the embryo. It was then he commenced to probe the secrets of life itself, testing the peculiar properties of living matter by the manner it

reacted to cold of varying degrees. He proved that an egg was really a living thing; living matter did not putrefy; life keeps tissues sweet. He had inserted dead matter into abscess cavities to test the alleged digestive action of pus. Above all he had made an acquaintance with the hydra, and realized that even in its simplest form living matter had the power to move, digest, and feel and effect repair.

With a knowledge of those years you will be in a position to understand his attitude towards a party of wounded soldiers he met with on his arrival at Belleisle. Four wounded soldiers came in after being in hiding for a space of four days; one had received two bullets through his thigh, one was shot in the chest, a third was shot through the knee-joint by a bullet which pierced the lower end of the femur, while another was shot through the shoulder, involving the joint. "When they were brought to the hospital their wounds were dressed superficially and they all got well." That is Hunter's account of their surgical treatment. There was also another case, that of a grenadier of the 30th regiment who had been shot in the arm, the bullet passing between the biceps and the humerus. He had been taken prisoner by the French. The arm was fomented and a superficial dressing applied by the French surgeon. About a fortnight afterwards the grenadier escaped and came in with the wounds healed. "There only remained a stiffness in the joint of the elbow, which went off by moving it." Hunter cites those cases to support his contention that in many instances nothing is to be gained by opening and enlarging gunshot wounds. I do not cite Hunter's cases to suggest that the treatment which answered at Belleisle in 1762 is applicable to Flanders in 1917. I cite them because they illustrate Hunter's conviction that Nature is the master surgeon. We also note that he cured stiff joints by movement, and that he preferred voluntary to passive movement.

UNUNITED FRACTURES AND FALSE JOINTS.

I propose now to pass on to 1791, the last year but one of Hunter's life, to see him apply his ripest experience to the treatment of orthopaedic cases. In March of that year there came into his wards at St. George's Hospital a man suffering from simple fracture of the right femur, situated three inches below the great trochanter. Splints were applied and the man was rested in bed, but three months later it was found that no union had taken place. On inquiring into the matter Hunter then discovered that his patient had an ununited fracture of the right humerus of old standing. "It being evident from the circumstance of the arm that there was a natural backwardness in the constitution to form bony union," Hunter directed the man "to walk upon crutches and to press as much on the broken thigh as the state of the parts would admit, with a view to rouse the parts to action, forcing them by a species of necessity to strengthen the limb." To the uninitiated, Hunter's language and reasoning seem obscure, but to those who know the meaning he attached to "action" and to "necessity," the principles on which he based his treatment are plain. He recognized that the power of repair was inherent in living tissue; it was an essential property of living matter; it was roused into being by injury—his "stimulus of necessity." If he had coined a learned name from Greek or Latin, as has been done in the cases of other obscure properties of living matter—such as "chemiotaxis," "heliotropism"—he would have impressed his followers, but in reality made them no wiser. He set the man on crutches to call forth anew, by means of injury, the reaction of repair in the tissues between the fractured ends of the bones; the treatment was successful. "In the course of a fortnight there was an evident firmness in the bone, and in less than two months the patient could walk with the assistance of a stick."

I am able to show you the ununited fracture of the humerus of the case which was under Hunter's care in St. George's Hospital in 1791. Hunter was interested in the man, and allowed him to remain in hospital to pick up strength. During that period "he was seized with a complaint of his bowels—which carried him off." The femur was found to be firmly united by bony union, but the humerus "admitted of motion in every direction at the fractured part. . . . The arm was carefully dissected to examine

the state of the fractured parts, between which there was no callus, but a large bag filled with a glairy fluid, resembling synovia." A false joint had been formed, and inside that joint lay thirty to forty loose bodies similar to those which occur in joints. Their presence at once diverted Hunter's mind from the "failure of union" to a subject which had often occupied his attention in former times—the origin of loose cartilaginous bodies in joints. You cannot read and understand Hunter's works unless you know that in his opinion the film of "coagulable lymph" which united the opposite sides of an incised wound was a living bond. That film or plug of coagulable lymph (fibrin) was, he believed, endowed with a most marvellous property. If it lay between the ends of a broken bone, it then took on "from a species of sympathy" the texture and qualities of bone; if between the cut ends of a tendon, then it assumed a tendinous texture; if against the cut end of a nerve or a vessel, then it became nervous or vascular in texture as the case might be. If, then, blood were effused into a joint and coagulated on the surface of the articular cartilage, what was more natural than to suppose that it would, as it became organized, assume the nature of cartilage and form the bases of the loose bodies which occur within, and disturb the action of joints; the occurrence of loose bodies within the false joint of the humerus he regarded as a vindication of his theory. Hunter's theory accounted for many appearances, but fifty years later the microscope showed that naked-eye appearances are sometimes deceptive. But no future discovery can ever destroy the utility of a working hypothesis.

MUSCLES.

We see Hunter at his very best when he comes to speak of cases in which damaged muscles are involved. From his first day in the dissecting room to the fatal visit to St. George's Hospital in 1793, those mysterious and marvellous power-machines of the animal body held as in a vice his curiosity and his ingenuity. If it is true, and I think it is true, that a knowledge of muscles is the beginning and the end of all orthopaedic treatment, then Hunter merits our attention more than any surgeon. Let us see him brought face to face with a case where muscles are involved. He had called on a lady who suffered from the after-effects of a broken patella. She was totally unable to use the limb and was wheeled about in a chair. "Having spent a whole night in considering the probable cause of her loss of power, it appeared to me that the space between the two attachments of the rectus (between the origin and insertion of the muscle) being much shortened, the utmost degree of its contraction would scarcely be able to straighten itself, much less move the patella and leg also. . . . I advised her to sit as before (with her leg dangling free of the floor), but, instead of having the leg moved (passive movement) to exercise the quadriceps, to move it herself. This she could not in the least effect at first. I considered, however, . . . if the influence of the mind were freely exerted on the muscle, it would gain this power of contraction." So it proved; the lady gradually obtained the control and use of her limbs.

In this case Hunter's treatment was based on his knowledge of muscular action. He had noticed that a muscle works within definite limits. It can contract under the domination of the will until the shortest limit allowed by the flexion of the joint is reached; it can elongate to the furthest limit permitted by the extension of the joint. Hunter observed, however, that under certain circumstances—if a tendon be cut or a bone broken—the muscle could and did contract beyond the shortest limit of voluntary contraction. A muscle has a power of contraction beyond that which can be given by the will. In the case of the broken patella he conceived that the extensor quadriceps was in the stage of extreme contraction, and therefore lay outside the influence of the will, but he knew that the will could by effort dominate a muscle in all positions; he knew that a voluntary muscle was the most educable of all structures. It was on these principles he based his treatment. How many muscles are there to-day which need the simple reasoning of Hunter's mind to help them! By exercising his will a patient may do more to help the recovery of a muscular function than can be accomplished by the most complicated of gymnastic machines.

TENDONS.

When Hunter was appointed surgeon to St. George's Hospital in 1768, and thus obtained the first real opportunity of applying his peculiar store of biological knowledge, he was already 40 years of age. In the previous year there happened two notable events in his life: he was elected to the Royal Society and had his tendo Achillis ruptured. It is the latter event which interests us here. He had been suffering from cramp in the calf of his leg (he was subject to muscular spasms and cramp), and he had been dancing; he was not married then. He noted that the rupture was unattended by pain; it was only when repair set in that the tendon became sensitive. He noted further that he had lost all voluntary control of muscles yoked to the tendon, by no effort of will could he make the muscles of his calf contract. But he also recognized that in sleep the muscle obtained a power of involuntary contraction. He clearly did not understand why the muscles should pass out of action during consciousness, and assume a power to act during sleep. He knew nothing of the structure and functions of the spinal cord, nor the significance of that kind of action we call reflex—that knowledge came with Marshall Hall. He based his treatment on those two simple observations. He encircled the calf of the leg with a bandage to prevent "involuntary movements," and applied an apparatus during the night "to steady the muscles." After the first day or two following the accident the patient was allowed to walk about, with the heel of the boot somewhat raised on the injured side, and was instructed to step off the inner side of the heel, as is the manner with those who suffer from flat-foot.

At the time Hunter suffered from this accident he had already acquired two acres of land at Earl's Court, where he established what would be described nowadays as an experimental station. Healing of tendons became a matter of interest to him. Ottery states that he cut the tendons of dogs by a subcutaneous method—the earliest record we have of such operations. We know from Everard Home that one of the deer then kept at Earl's Court had a tendo Achillis cut for a double purpose—to keep it from jumping the enclosing fence at Earl's Court, and at the same time to provide information as to the mode of healing. I can show you fine specimens of tendon repair which Hunter obtained by experimental means. He found that a gap between the separated ends was no bar to union; coagulated lymph could eventually provide a strong bridge across a wide gap. After his own death it was found that the cicatricial bond in his tendo Achillis had become calcified.

THE MINIMAL MUSCLE LOAD AND THE WILL.

We come now to another side of Hunter's teaching regarding the nature and action of muscles, which has an important application to present-day conditions. We may call this part of his teaching, in order to distinguish it, the principle of the "minimal load." Let me explain by use of an example what is meant by that expression. Let us take the case of a labourer who has just recovered from typhoid fever. We want to test his strength. We ask him to lift and carry a sack containing 2 cwt. of coal. We should be very foolish if, when we find he cannot move it, we concluded that he has no strength. Yet that is how the strength of weakened and disabled muscles are being tested now in many instances. Let us take the case of the deltoid muscle. If we start it into action as the arm hangs by the side it has to move its maximum load at the very start; it has then to lift the weight of the arm when its purchase is at a minimum. The deltoid may, when so tested, appear absolutely paralysed, yet if the disabled man lies on his back with his arm half abducted and its weight supported on a board, and we then apply the principle of the "minimal load," it may be found that the muscle, far from being paralysed, has a very considerable power of action.

It is characteristic of Hunter that he never did halt or bend to point out the immediate practical application of his observations and "principles." He gives us, as it were, the stick or the knife, but expects that we ourselves will do the whittling. That is why Hunter is a prince to the thinking surgeon and only a babbler to the merely practical one. He tells you the position of a joint which gives

a muscle its greatest power; he points out that the weight of a limb is a heavy burden; he recognizes that muscles may be weakened from many causes; he insists on the mastery which the will can obtain over them, but nowhere does he formulate these observations into a system to be applied to the treatment of disabled muscles. Indeed, I must own that without the aid of my friend Dr. W. Colin Mackenzie I should never have realized the practical bearing of many of Hunter's facts. Dr. Mackenzie makes no claim to be the discoverer of the "minimal load" treatment of disabled muscles, but I am certain that no one has realized its practical importance more than he, and no one has realized and applied the right methods to the restoration of disabled muscles with an equal skill. When you have discovered that a muscle loaded to a minimal degree can exhibit a spark of movement, then you have to bring the will to bear upon that spark. As it increases you will be able gradually to increase the load and thus nurse what is often regarded as a useless structure back to a fair or full degree of vigour. Dr. Mackenzie's methods, as revealed by his published results, bespeak infinite patience on the part of both surgeon and patient, and these are qualities which are hard to obtain in either surgeon or patient. In this we here come back to the bed-rock of Hunterian teaching: the only certain means of treatment are those which employ the natural recuperative powers of the body.

One other aspect of Hunter's teaching has a bearing on the treatment of muscular defects. He was not the first to realize that it is impossible for a muscle or a set of muscles to contract without their antagonists being called into action at the same time. He learnt that doctrine as a student from Winslow's still excellent textbook of anatomy; but he did realize more than any one who went before him that the relaxation of the extensor or antagonist muscle was just as important, as real, and as vital an act as the contraction of the flexor or prime-moving muscle. He never could determine whether the relaxation of the antagonist was due to a voluntary or an involuntary stimulus. That doubt, we shall see, has been resolved in recent times. The surgeon must always think in terms not of single, but of antagonist muscle groups.

Remarks

ON

THE TREATMENT OF NEURASTHENIA
AND PSYCHASTHENIA FOLLOWING
SHELL SHOCK.

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A VERY large number of cases of persistent neurasthenia, psychasthenia, and allied conditions, following shell shock are now under treatment in England. Similar affections are also caused by the shock or continued anxiety of Zeppelin raids and the continued anxiety from other risks of injury. The symptoms may commence suddenly after one severe shock, or gradually after repeated shocks. In many of the severer cases the patient is unable to carry out his duties, military or civil, for a long period, and we have the expense of his continued pension. It is important both for the patient and the country that he should recover as early as possible. The treatment is, however, often very unsatisfactory, and to many medical men very uninteresting. It should be psychological as well as medical. Very slight cases may improve rapidly after a short rest, but in many of the severer cases the symptoms are very persistent. The patients are sent into hospital; they often rest most of the day, take little exercise, and are not occupied definitely in any way. They have time for thinking and brooding all day over their experiences and symptoms, and for thinking of the time when they will be expected to return to the front, or will be exposed to the same risks. Very many of the severer cases do not improve much, and after weeks or months leave the hospital with the symptoms well marked.

The following is a line of treatment which, from a study of these severer cases, I consider useful and would