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

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V. THE BEARINGS OF MARSHALL HALL'S DISCOVERIES ON ORTHOPAEDIC PRACTICE.

WHEN Marshall Hall first announced his discovery of reflex action, at a November meeting of the Zoological Society of London in 1832, he was a man of 42, a consulting physician with a considerable practice in London. He was born of a Saxon Midland stock—with an infusion of that hybrid strain which reached England through Normandy. His father was a cotton spinner and bleacher near Nottingham, the first in England to use chlorine for bleaching cotton. Marshall, at the age of 15, was apprenticed to a chemist or druggist in Newark, but in 1809, four years later, he became a medical student at Edinburgh, where he spent five years, three as a student and two as a resident in the Infirmary. After two years as a physician in Bridgwater and eight in Nottingham, he settled in London in 1826.

In the course of experiments on the circulation in capillaries he made a chance observation which directed his attention to the nature of the functions of the spinal cord. He had cut off the tail of a salamander, and happening to touch its skin observed that there was a quick movement in response. That response Marshall's predecessors had often seen happen, but it immediately excited his attention because it was taught in his time that a muscle could be stimulated to action in three ways only—either by touching or stimulating it directly, or by stimulating the nerve, or by a volitional stimulus from the brain. He knew that the movement he had evoked in the salamander's tail was due to none of these three causes; there must be a fourth way of calling muscles into action, and, as was his wont with exceptional cases, he followed up the clue. He destroyed the part of the spinal cord which lay in the detached tail, and found, on touching the skin, no movement could be elicited by touching the skin. He thus was led to suspect that in the spinal cord there resides a power, or mechanism, for the production of such movements as he had witnessed in the salamander's tail. To test his guess he took a snake and cut its spinal cord across, just behind the head, thus separating the brain, the recognized centre of muscular machinery, from the body. The snake remained perfectly still until he touched it, or a puff of wind struck it, or until the table was struck on which it lay, and then the snake moved and kept moving until he wrapped it in cotton-wool and thus brought it to a standstill by protecting it from all external stimuli; so soon as it was brought to a standstill and its skin was protected all movements ceased. He then cut off the head of a turtle, and found that on touching the nose, which he knew from Bell's teaching to be a respiratory area, the floor of the mouth executed the respiratory movements which occur in one phase of breathing in turtles, but that when he destroyed the medulla oblongata, he could no longer elicit the respiratory act. He concluded that when the nose was stimulated by touch, a message was carried to the medulla by the fifth nerve, and therein a centre excited another message which was reflected along the motor nerves which control the muscles of the mouth and throat. He pictured in his mind an arc of nerves, and recognized that a stimulus was necessary to produce the reflected or reflex muscular act.

He then exposed the spinal cord of the headless turtle; he touched the spinal cord with a needle: the limbs were thrown into movements; messages, he concluded, must have been excited which had passed up and down the cord and been reflected to the muscles of the limbs. He touched the posterior roots of a fore and then of a hind limb: the

limbs were thrown into movements; he exposed and touched nerves exposed in the trunk: movements of the limbs and body followed. He touched the skin of the trunk and of the limbs, and with each prick found that the movements evoked by stimulation of the skin were more vigorous than those which followed stimulation of nerves, the nerve roots, or even the cord itself; evidently the skin was the chief end-station for evoking such movements. He noted, in the headless turtle, that the sphincter of the anus retained its normal tonic power and function, but when he destroyed the hinder part of the spinal cord all tone and contraction disappeared from the sphincter. The power or mechanism which regulated the tonus or function of a sphincter was clearly resident in the spinal cord. On pricking the headless turtle he could evoke movements in the limbs; it was also clear that in the spinal cord there was resident a mechanism which could time and regulate the contraction of muscles. And lastly and for our present purpose he made a most important observation—when he removed the spinal cord from the headless turtle the limbs became limp, all tone and degree of contraction disappeared from the muscles of the limbs. That passive contracture of muscles which can work such dire deformities in diseased joints was, on Marshall Hall's showing, to be traced to a disordered function of the spinal cord. The spinal cord regulated the balance of the limb muscles and determined the posture of joints.

Marshall Hall was elected a Fellow of the Royal Society in 1832, and on June 20th, 1833, he read to it his paper "On the reflex function of the medulla oblongata and medulla spinalis," in which he demonstrated the existence in these parts of "a principle of action not hitherto distinguished with sufficient precision." We have to remember that in 1833 knowledge of the finer structure of the central nervous system was crude and imperfect; yet he pictured an arc system, and grasped the full bearing of his discovery on the realm of medicine and biology. He had an instinct for signpost facts and critical experiments. He saw that the reflex function of the cord and medulla could be exalted—by opium in the frog and strychnine in the mammal; that the manifestations of tetanus and hydrophobia received a rational explanation for the first time. Asthma and epilepsy he also wished to bring within the scope of his reflex law. The excito-motor or reflex function of the spinal cord he found to be more easily excited in the young than in the old; if a teat touched the lips or a finger pressed the palm of a newly born child, it was grasped by lips or fingers. The anencephalic human fetus he regarded as a purely reflex mechanism. He observed how all the entrances and passages at the front end of the body, all the muscles and operations connected with the entrance of food and breath, were presided over and manipulated by his systems of reflex arcs. The action of the canals and muscles at the hinder end of the body were regulated by a similar system; defaecation, micturition, parturition were reflexly controlled acts. He found he could elicit such acts by stimulating the mucous linings of these canals; tenesmus, stranguary, renal and biliary colic, the localized contractions of the belly wall, and the manifestation of sympathetic pains which accompanied diseases or disorders of the intestinal tract were all brought by him within the scope of his new law. He found that reflexes could be set up by stimulation of the dura mater, pleura, and peritoneum; the muscular disturbances which may attend the eruption of teeth or the presence of worms in the rectum could be explained on his newly discovered system of reflex arcs. His conclusions, which most concern us now, relate to the muscles of the limbs; they, too, were controlled by the action of stimuli speeding along his postulated system of reflex arcs. Stimuli which arose in the moving limb were carried to the spinal cord by "incident" or excitatory nerves, and were there "reflected" along the outgoing or motor nerves to the muscles. Each contact of the foot with the ground he supposed to call forth a new series of movements. At first he believed that the "tone" of muscles was also a true reflex manifestation, but later he regarded the tone of muscles as a function of the cord, manifested independently of the arrival of peripheral stimuli.

Marshall Hall as a physician desired to be Nature's servant—a sincere and outspoken servant if not a very humble one. "I am persuaded," he said, "that a knowledge of the healthy body action is the only foundation for

practical medicine and the only remedy for quackery." "A mere practical man is a quack" was one of his aphorisms, yet there never was a man so misconstrued as Marshall Hall was by his contemporaries. The blame is not to be saddled altogether on them, for he had an unconscious art of rousing antagonism, jealousy, and mistrust. We can hardly wonder that John Hilton preferred to think of nerve trunks than of spinal centres as the functional elements which presided over the muscular system of the body. Neither he nor the line of surgeons which followed him perceived that Marshall Hall had given a new basis for the diagnosis of all disordered actions of muscles, and a sure principle in which a rational means of treatment could be based for the recovery of deformed and disabled limbs. Nay, I would go further. The full bearings of Marshall Hall's discoveries, and particularly the significance of the further investigations made by those who have so brilliantly explored the field which he had opened, have not yet been fully utilized by modern orthopaedic surgeons. Marshall Hall made it impossible for us to think any longer in the terms of single muscles, bones, and joints. All of them in the living state are combined into a functional whole by the spinal cord and its system of reflex arcs.

Memoranda:

MEDICAL, SURGICAL, OBSTETRICAL.

STERILIZATION OF THE THROAT AFTER DIPHTHERIA AND IN CARRIER CASES.

THE detention of diphtheria carriers and of convalescents who continue to harbour the bacillus is irksome to those isolated, and must in the aggregate involve a considerable expenditure of money both in civil and military practice. In the BRITISH MEDICAL JOURNAL of March 11th, 1916 (p. 374), Dr. W. S. Thacker reported on the effect of painting the tonsils and nasopharynx with strong solutions of silver nitrate, his work being restricted, I gather, to carriers. He used a 50 per cent. solution, and two applications procured sterility in every case. A 90 per cent. solution was employed for the staff, and one painting then sufficed, the throat being cocaineized beforehand. Used in these strengths the solution has been known to cause severe spasm of the glottis, when it has happened to reach the rima.

At the beginning of August, 1917, we began to use silver nitrate on patients in the Plaistow Hospital positive to the culture test after an acute attack of diphtheria, when otherwise nearly fit to go home. As most of our patients are children, we decided to try the effect of weaker solutions. The first painting was done with a 1 in 8 (12.5 per cent.) solution. Where this did not secure sterility a second painting was done with a 1 in 4 (25 per cent. solution). In four cases this proved insufficient and further painting was needed. These were all children with enlarged tonsils and adenoids. Three of them struggled, so that the solution could not be effectively used. In these cases the throat was thereafter painted under ethyl chloride as a general anaesthetic.

Throat cultures were taken on the third and fifth days after the application. The first culture was positive in three cases only. These were children with large irregular tonsils and masses of adenoids. In fact, it was only in cases of this type that there was any trouble in obtaining sterility, a consequence, no doubt, of difficulty in reaching every depression and irregularity. The cases treated yielded on culture the three types of Klebs-Loeffler bacilli, alone or mixed. Our results do not show that any one of these types is more persistent than the others.

Procedure.

The child was rolled in a blanket so that it could not get its arms free, and laid across the bed with its head in the operator's lap. This position prevented any excess of the solution running down the throat. A strip of cotton-wool wound round long sinus forceps was used for the application with 30 to 40 minims of the solution. The tongue was depressed and the tonsils and posterior pharyngeal wall swabbed somewhat firmly with the silver nitrate. It was found advisable to keep the patient without food for two to three hours beforehand. The only

case in which laryngeal spasm occurred was a girl who had had a meal shortly before the throat was painted. Of the first forty cases treated twenty-eight were sterilized by one application, eight cases by two paintings, and the remaining four cases needed further treatment as described above.

Conclusions.—Of cases with positive cultures after an acute attack of diphtheria 70 per cent. were rendered sterile by one application of a 12.5 solution of silver nitrate. A further 20 per cent. were sterilized by a second painting with a 25 per cent. solution. The remaining 10 per cent. were more resistant but could nevertheless be sterilized with silver nitrate in solutions not stronger than 25 per cent. with a little patience.

On the whole Dr. Thacker's method of sterilization marks a greatly needed advance on the preventive side, and it is to be hoped that its adoption in other contagious diseases than diphtheria will prove useful. In practice its efficacy plainly depends on the thoroughness with which the silver nitrate solution is applied over the entire surface of the mucous membrane.

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VINCENT'S ANGINA.

HAVING recently taken swabs from numerous cases of Vincent's angina, and having read various short articles on the prevalence of the condition both amongst our overseas troops and amongst the home service units, we are surprised to find no mention of the condition of the gums in this infection. In several cases the throat has cleared up in eight to ten days, while the organisms have easily been demonstrable in pus around the teeth; and, vice versa, in more than one case the patient has come up for a sore throat (? Vincent's angina), and we have found the organism in peridental pus in great quantity whenever a swab from the tonsil has been indeterminate.

There seems to be no doubt that it is of the highest importance to look for pyorrhoea or other dental trouble in every case of sore throat, as a diagnosis may often be made in cases where nothing is obtained in direct tonsillar smears.

Moreover, no patient who has been under treatment for Vincent's angina should be discharged until it is shown that swabs from around the teeth are negative. We have swabbed several cases of pyorrhoea and several normal throats, and although fusiform bacilli and spirillar forms are occasionally seen, we are satisfied that Vincent's angina can be readily diagnosed from direct smears of the gums and throat, and that no other condition ordinarily met with presents the same microscopic picture.

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WOUND INFECTION.

EVEN at the risk of the accusation of repetition I consider it my duty, in present circumstances, to draw further attention to the excellent results which may be obtained in desperate compound comminuted fractures and other grave septic wounds by the prompt administration of ether, application of a tourniquet, deliberate exposure, and obliteration of pockets and sinuses by large incisions, complete removal of foreign bodies (including denuded infected fragments of bone), thorough tunnel gravity drainage, efficient haemostasis, frequent irrigation with hot peroxide lotion (60 to 120 c.c.m. to litre), followed immediately by hot carbolic lotion (15 c.c.m. to litre), hot mercury perchloride (1 in 2,000) fomentations (wrung dry before application), and absolute rest on a suitable splint until the wound is healed, with extension when necessary. To this should be added, whenever possible, permanent outdoor treatment, which is infinitely preferable to any indoor "primrose sunlight" illusion, and a liberal allowance of wine, stout, or beer with meals.

As far as my personal experience is concerned I have yet to find the equal of the above combination of surgical principles with what, in my opinion, are the best of all