

(5) The arteries gave evidence of marked change in five cases; their coats were thickened, their lumen narrowed, containing thrombi in some situations.

(6) There was absorption of bone in nine cases. In some places the absorption had progressed right across the bone, the place of the latter being filled up by fibroid tissue. In one case "necrosis was complete," in another "only partial," and in both the arteries were affected as above described.

(7) Some cases showed "cysts expanding the bone, associated with fibrosis of the mucous membrane."

I give *verbatim* Dr. Martin's conclusion as appended to his report:  
"Conclusion.—From the result of the examination of the specimens I should conclude that the disease is apparently a primary chronic inflammation of the mucous membrane, which may take several courses: 1. There may simply be the fibroid condition of mucous membrane, *with or without* absorption of bone. 2. There may be a tendency to great development of myxomatous tissue. 3. There may be necrosis of the bone in connection with diseased arteries (2 cases out of 20), Cases 1 and 7. 4. There may be cystic formation, Cases 2, 9, 11."

In forwarding his report,<sup>4</sup> of which the above is a faithful epitome, Dr. Martin favoured me with the following statement: "I enclose final report of specimens of middle turbinate disease. I have stated the matter as fairly as I can from a pathological standpoint. If you intend to publish drawings, it will be well to have a skilled draughtsman to do the specimens of necrosed bone and of absorption of bone." I have only to add that Dr. Martin selected his own draughtsman, Mr. Lewin, who is well known for the fidelity and skillfulness of his work, and that each drawing was submitted to and approved by Dr. Martin.

I think, therefore, that, in reviewing all the ascertained facts, no impartial and competent critic can reasonably resist the convincing nature of the evidence which has been accumulated for the existence of definite and constant pathological changes observed in association with the clinical manifestations of this form of nasal disease.

#### FURTHER EXPERIMENTAL NOTE ON THE CORRELATION OF ACTION OF ANTAGONISTIC MUSCLES.<sup>1</sup>

By C. S. SHERRINGTON, M.A., M.D. F.R.S.

In a previous communication<sup>2</sup> it was shown that physiological contraction, and even mere mechanical tension of the flexor muscles of the knee, exerts considerable physiological influence upon the activity of the antagonistic muscles, the extensors. For instance, the elicitation of the "jerk" from the extensors can be rendered impossible or difficult for a time by appropriate excitation of the flexors, and can, on the other hand, be much facilitated by flaccidity or paralysis of the latter.

In order to judge whether under these circumstances the briskness of the knee-jerk varies directly with the degree of tonus of the extensor muscles, the rapidity of onset of rigor mortis has been selected as a guide to the degree of tonus existing in them before death. The experiments of Brown-Séquard, Kölliker, and Hermann and his pupils, have discovered that section of the nerve of a muscle, even when performed very shortly before the death of the animal, considerably delays the time of onset of rigor mortis in the muscle. After control experiments which simply verified the statements by these observers, experiments were instituted on the influence of section of the motor spinal roots upon the time of onset of rigor mortis. The examination showed that a marked delay of onset of rigor mortis was thus produced. The delay seemed to be as considerable as after section of the entire muscular nerve. The effect of section of the posterior roots was next examined, and found to be a marked retardation of the onset of the rigor; the retardation was greater if the spinal cord remained intact than if the cord were previously severed across in the region of the first lumbar segment. The effect of placing and keeping one of the hind limbs in the pose most favourable for elicitation of the

jerk (knee flexed) and the other limb in the position in which the jerk is restrained (knee extended) was investigated, in every case after previous severance of the spinal cord at the first lumbar segment. It was found that upon the side on which the knee had been kept flexed the onset of rigor was delayed in the extensor muscles, whereas upon the opposite side, in which the knee had been kept extended, rigor was delayed in the flexors. This infers that the tonus of the extensors is heightened by excitation of the antagonistic set, and conversely.

The research was also extended to the examination of the mutual association of action of antagonistic muscles about other joints than the knee. It had been noticed in an earlier series of observations<sup>3</sup> that during excitation of the cortical areas of the hemisphere, when isolated movements of the pollex and hallux are being initiated, the movement of response obtained is often reversed by section of the peripheral nerves supplying the muscles predominating in the movement obtained. Thus, for instance, flexion can, by section of the flexor nerve, be at once converted into extension or *vice versa*. Sometimes, however, movement in the same sense, although diminished in force and extent, persists even after section of the motor nerve to the predominant group of an antagonistic pair, thus indicating that in some cases accompanying contraction of the one group of muscles there is concomitant inhibition of the antagonistic. This evidence of inhibition of one set of the synergetic muscular couple during the co-ordinate movement induced by cortical excitation is in the cases of the digits, hallux, and pollex of comparatively infrequent occurrence, but it is quite usual in the case of ocular movements. By stretching or by exciting with tetanising currents the inferior oblique muscle of the eye, reflex movements in both eyes can be readily evoked, but these are of variable direction. When the external rectus muscle of one eye (for example, of the left eye) having been put out of action, the frontal cortex of the right hemisphere is excited, the eyeballs, if previously directed to the right, revert both of them to the left—that is, the excitation which evokes contraction of the right internal rectus evokes also relaxation of the left internal rectus. Again, when the internal rectus has been put out of action—for example, in the left eye—excitation of the left frontal cortex produces, if the eyes have been previously directed to the left, an immediate movement of both eyeballs to the right, the left eye frequently rotating beyond the median primary position. Here the same excitation of the cortex which induces contraction of the right external rectus muscles induces synchronously a relaxation of the left internal rectus muscle.

These inhibitions of the contraction of one antagonist concurrent with augmentation of the contraction of its opponent are obtainable as well from appropriate areas of the occipital cortex as from areas in the so-called motor region. Also there can be inhibited from the cortex not merely the "tonus" but the active contraction of ocular muscles. During volitional movements similar phenomena occur, but appear to be less obvious than during experimental excitation of the hemisphere with moderate currents. Although inhibition of contraction is apparently so extremely common a factor in the mechanism of the mutual co-ordination of the antagonistic lateral straight muscles of the eyes, they yield occasionally good indication of the existence of synergetic contraction as well as synergetic relaxation. The mutual association of the two oblique muscles of the eye seems to be usually of the nature of concomitant contraction, not of contraction coupled with relaxation. On the other hand, the muscles which close and open the palpebral fissure appear to be altogether independent one of the other in the action. In their case section of the particular peripheral nerve concerned in by the movement is at once followed by total disappearance of the movement, and that without reversal. Although the cerebral cortex exercises inhibition apparently so usually in the field of innervation of the third nerve, the dilatation of the pupil so readily produced by excitation of that portion of the cortex appeared whenever tested to be due to impulses discharged *via* the cervical sympathetic, and not to inhibition of the constriction exercised *via* the third nerve.

<sup>4</sup> December 26th, 1889.

<sup>1</sup> Abstract of a paper communicated to the Royal Society.

<sup>2</sup> Sherrington, *Proceedings of the Royal Society*, February 1st, 1893.

<sup>3</sup> *Journal of Physiology*, vol. xiii, October, 1892.