On the nature of rigor mortis / by R. Norris.

Contributors

Norris, Richard, 1830-1916.
Royal College of Surgeons of England

Publication/Creation

[London] : [publisher not identified], [1867]

Persistent URL

https://wellcomecollection.org/works/bgxfdvfa

Provider

Royal College of Surgeons

License and attribution

This material has been provided by This material has been provided by The Royal College of Surgeons of England. The original may be consulted at The Royal College of Surgeons of England. where the originals may be consulted. This work has been identified as being free of known restrictions under copyright law, including all related and neighbouring rights and is being made available under the Creative Commons, Public Domain Mark.

You can copy, modify, distribute and perform the work, even for commercial purposes, without asking permission.

wellcome collection

Wellcome Collection
183 Euston Road
London NW1 2BE UK
T +44 (0)20 7611 8722
E library@wellcomecollection.org
https://wellcomecollection.org

(*From the Journal of Anatomy and Physiology.*)

17.

ON THE NATURE OF RIGOR MORTIS, *by* R. NORRIS, M.D.

Lecturer on Anatomy and Physiology at Queen's College, Birmingham.

THE following paper on the nature of rigor mortis was read at the Birmingham Meeting of the British Association, Sept. 1865, and was the subject of a grant. The consideration thus accorded led to a more extended series of investigations, which were laid before the meeting at Nottingham in August last, in the form of a paper entitled "Researches on Muscular Irritability, and the Relations which exist between Muscle, Nerve, and Blood." This latter contribution will, in all probability, appear in the succeeding number of this Journal.

This paper has for its object the refutation of the commonly received opinion of physiologists in regard to the nature of rigor mortis, or cadaveric rigidity, viz. that it is the result of muscular contraction.

The plan I propose to adopt is to support by experimental proof the three following propositions:

PROP. I.

If in any animal there exists, at any given period, a tendency to universal muscular contraction there will necessarily be a redisposition of the limbs in favour of the most powerful series of muscles, be they flexors or extensors.

PROP. II.

Contraction and shortening, as applied to muscles, are synonymous terms. If any muscle, having its attachments perfect, becomes shorter, in however slight a degree, it will, if *unopposed*, involve a relative redisposition of the osseous structures to which it is attached; if in a limb, the position of the limb will be altered.

PROP. III.

Contraction and the presence of irritability being inseparable associations, it follows that if, in some cases, irritability is absent for a long period prior to the supervention of rigor mortis, the latter cannot be regarded as a contractor.

In respect to the first proposition there are many ways by which the entire muscular systems of some animals may be thrown into convulsive contraction, either permanent or intermitting in its character. The frog is an animal well adapted by its anatomical con-

struction to exhibit extremes in muscular contortion, inasmuch as the extensor muscles highly preponderate in the hind extremities—an arrangement adapted to the acts of leaping and swimming. Now if by any means the entire muscular system of this creature is made to tend to contract, we get the hind limbs rigidly extended. If, e.g. we place a frog under the influence of strychnia, it is not simply the extensor muscles which are tending to convulsion during the spasm. The extension of the limbs in this case is simply the result of the preponderance of extensor power in the hind extremities; for if, before exciting the nervous system with strychnia, we divide the extensor tendons, the corresponding flexor muscles will be thrown into convulsive spasm and, as a consequence, the limbs will be powerfully flexed. Idio-muscular contractions of a permanent character have been long known to be producible in frogs by extremes of temperature as high as 130° or as low as 25° Fahr.

I have myself discovered that many vapours, among which chloroform, ether, and bisulphuret of carbon stand out most prominently, possess the property of exciting permanent contractions in the muscles of the frog, of as powerful a character as the most extreme neuro-muscular action of strychnia. As in thermal tetanus, these latter phenomena depend for their existence upon an action directly exercised upon the muscular tissue, as is demonstrated by isolated muscles being as readily influenced when exposed to these vapours.

All examples of general muscular excitation, whether induced indirectly through the nerve (neuro-muscular) or directly by effects upon the muscular tissue (idio-muscular), produce the same arrangements of the limbs in obedience to the strongest set of muscles, which in the hind limbs of the frog are the extensors; but if in the hind limbs the extensor tendons be divided, in any of these cases the limb will be as forcibly flexed as it otherwise would have been extended. In all these cases, therefore, the weaker muscles are powerfully stretched and their elements ruptured; inasmuch as they are compelled to contract contemporaneously with their stronger rivals, so that they are extended by sheer force at a time they are powerfully tending to contract.

In contradistinction to these undeniable cases of muscular contraction we have in Co^2 an agent which favours, or produces, simple rigidity. If frogs be kept for varying periods in Co^2 they will be found to become rigid, but with the peculiarity that no contortion or redisposition of the limbs occurs, the muscles becoming fixed in the position they occupied on the cessation of voluntary movement by the animal. This condition is essentially different to that induced in the former cases.

Now, it has not only been contended that rigor mortis is muscular

contraction, but that it is *the most energetic form* of muscular contraction. On this head Valentin remarks[1] to the following effect. "In the dead bodies of most animals three conditions of the muscular substance succeed each other. There is first a space of time during which the muscles retain a greater or smaller residue of their vital activity, or of their capacity of contracting under proper stimuli. They next experience an *extraordinary contraction* which gives rise to that peculiar phenomenon called the rigor mortis, or the stiffening of death. Finally, as putrefaction advances, the muscular substance softens and dissolves with more or less rapidity. Dr Radcliffe (*Lectures on Epilepsy*) urges that the state of elongation should be regarded as the really active condition of muscular fibre, in which all its vital properties and peculiarities are most strongly marked; whilst the state of contraction is due to its being left to the influence of the attractive forces inherent in its molecules, the *most energetic* operation of which is seen in the *rigor mortis*." If this be so, why is it, I ask, that no redisposition of the limbs takes place in rigor mortis, after the fashion of the model cases of universal muscular contraction which I have laid before you? In these cases there can be no doubt that we have examples of *energetic* muscular contraction.

The following experiment will illustrate the effects of rigor mortis as observed in the frog in contrast to real cases of contraction in the same animal, May 23, 1863. A female frog, which had died in the act of spawning, exhibited in the hind extremities no susceptibility to galvanism; but the muscles were in a relaxed and flaccid state, i.e. could be easily flexed or extended. From their insusceptibility it was apprehended they would soon pass into the state of rigor; and one limb was placed in the extended and the other in the flexed position. These limbs became rigored, but remained in the position in which they were placed. No redisposition of the limbs occurred in favour of the strongest sets of muscles, which should have been the case if rigor mortis is a contraction. I have seen numbers of frogs in a state of rigor mortis; but I never in a single instance observed any spontaneous rearrangement of the limbs as in the examples of true contraction above cited. Again, in respect to warm-blooded animals; in the hind limb of a mouse the following phenomenon was observed. The extensor muscle of the foot became rigid, i.e. could not be stretched or elongated; while the opposing flexor could still be easily extended, that is to say, the foot could be brought into a right line with the leg, but could not, on the other hand, be bent to more than a rectangle. The flexor muscle did not become rigid

[1] Valentin's *Text Book of Physiology*, by Brinton, p. 374.

for an hour after. Now if the state of rigor in the extensor had been the result of contraction, inasmuch as it was unopposed by any corresponding rigidity of the flexors, it must have resulted in an extension of the limb, which was not the case. The state of rigor, as exhibited in this extensor muscle, can only be regarded as an incapacity on the part of the muscle to be stretched or elongated; that is to say, rigor mortis had suspended the *extensibility* of the muscular structure, nothing more. When this occurs in antagonizing muscles it of course produces complete fixation of the osseous structures to which the muscles are attached, which is the phenomenon of cadaveric rigidity. The rigid condition induced in the frog by prolonged immersion in Co^2 appears to be identical with rigor mortis, and to have nothing in common with the examples of contraction induced by extremes of temperature and exposure to ætherial vapours.

Prop. II.

We come now to the experimental verification of our second proposition.

A vigorous frog was immersed in Co^2. In about an hour it was removed and found to be dead. The muscles still retained their susceptibility to mild galvanism. The entire body was exceedingly flaccid; i. e. the relaxation of the muscles was perfect. As a means of comparison I separated the hind extremities from the body and divided them from each other, of course retaining the bony structures to which the muscles of the thigh were attached. I now galvanized the muscles of one limb in every part till the irritability was entirely exhausted; and no further contraction, however slight, could be produced. The other limb remained perfectly irritable. The muscles which had had their irritability destroyed remained in a perfectly relaxed state; in this respect there was no difference between the two limbs. The irritability of the galvanized limb was destroyed at 6.15 P.M. I now divided the extensor tendon of the foot of this limb and placed it in the extended position to await the accession of rigor. The extensor tendon of the irritable limb was also divided. At 8.25 P.M. there was no return of the slightest irritability in the galvanized limb, but there seemed to be slight evidence of commencing rigor; for if both limbs were held up perpendicularly, so that they might be flexed by the simple act of gravity, the knee-joint of the non-irritable limb did become flexed to the same extent as that of the other limb. The extensors on the thigh were therefore becoming flexed. On repeating this observation at 10 P.M., the

knee-joint did not bend at all. It is important in this connection to observe that two hours intervened between the destruction of the irritability and the first evidences of rigor mortis. Both limbs were now set aside till morning; the one in which the irritability was destroyed was placed, as before, perfectly straight, the other in the flexed position. At 8 A.M. next morning the limb in which the tendo Achillis was divided was found straight out as when left. The other limb had become rigored in the flexed position in which it was placed.

A second frog was kept in an atmosphere of Co^2 for $5\frac{1}{2}$ hours; after which it was found, by the application of powerful magneto-electricity, that all irritability was destroyed. In spite of the absence of irritability, the whole muscular system was unusually flaccid and relaxed. I cut the flexor tendons of the one foot of this frog and left the foot in the flexed position to test the effect of rigor upon the extensor. At 4 o'clock the next day, after an interval of 20 hours, the muscles were in a state of rigor; but no alteration or redisposition of the limbs had taken place; the foot in which the flexors were cut was not extended in the slightest degree.

In applying this mode of research to warm-blooded animals an obstacle is presented. The opposing muscles of the extremities, by virtue of their elasticity, are so arranged as to exercise a balancing strain upon each other, and so maintain a state of mutual extension. In consequence of this arrangement section of their tendons at once results in a redisposition of the limb. On dividing the flexors the foot becomes extended to nearly a right line with the leg, or, on section of the extensor tendon, is flexed to a rectangle; and, as in muscles, there is both a primary and secondary retraction due entirely to elasticity. It would be impossible to ascertain what belonged to elasticity and what to rigor.

Under these circumstances one method which has suggested itself is that of inducing rigor mortis prematurely in certain sets of muscles by a rapid destruction of the irritability by galvanism. In this manner rigor mortis may be induced in certain sets of muscles long anteriorly to its natural accession in others, in fact, while the irritability and extensibility of their antagonists remains perfect. Under such conditions, if rigor be a contraction, the limb should become flexed or extended as the case may be; whereas I have repeatedly proved by experiment that no modification of position occurs.

PROP. III.

This proposition asserts that, contraction being impossible in the absence of irritability, the occurrence of an interval between the

cessation of irritability and the supervention of rigor mortis proves that the latter cannot be a result of contraction. The evidence of a prolonged interval between the annihilation of irritability and the accession of rigor is contained in the preceding experiments, in which complete relaxation of the muscles obtained for several hours subsequently to the destruction of the vital property of irritability.

In reviewing the whole of my experiments, of which I have been able to give only a few illustrative ones, I am led to the conclusion that rigor mortis is not an affection of the vital property of irritability in muscles, and therefore cannot be regarded as vital contraction; on the contrary, that it is some peculiar alteration in muscular tissue which leads to immobility of its constituent elements, and which, so long as it is present, suspends or interferes with the properties of elasticity and extensibility in muscle; but that the phenomenon of rigor mortis is owing to the temporary suspension of the *latter quality alone*, for it is easy to understand that if antagonizing muscles are rendered incapable of elongation the limb must become fixed.

The circumstances which lead to this non-extensibility or rigidity in muscle cannot, I think, receive a better exposition than that of Brücke and Kühne, viz. that it results from the coagulation of a material contained in the interfibrillar juices of the muscles. If this be correct, the restoration of the elasticity and extensibility of the muscles, and consequently of mobility of the limbs, at the commencement of putrefactive changes, may receive an easy explanation by the hypothesis that these changes first commence in this recently coagulated fluid and restore it to a liquid condition, and thus liberate the muscular elements from their state of bondage.