Physiology. — *Experimental contributions to the knowledge concerning the segmental innervation of the abdominal muscles in the dog.* (3rd communication). *The M. obliquus internus, the M. transversus abdominis and conclusions.* By Prof. G. VAN RIJNBERK and Miss L. KAISER.

(Communicated at the meeting of September 28, 1929).

Anatomical introduction.

Gross Anatomy. The obliquus internus muscle as well as the M. transversus consists in dog in very thin and broad layers of muscle substance. The obliquus internus is inserted craniad into the last rib and usually also into the cartilage of the last rib but one ; medial into an aponeurosis that continues into the sheat of the rectus abdominis, lateral into the dorsolumbal fascia, and caudad into an aponeurosis inserting into the pubic and iliac bone. The fibres run from dorsocranial towards caudoventral. The M. transversus arises craniad from the inner surface of the false ribs, making some connections with the diafragm, medial from the sheat of the rectus muscle (linea alba), lateral from the transvers processi of the lumbar vertebrae, a fascia intervening, and approaching caudally the pelvis. The fibres take a purely lateromedial course. Neither of the muscles shows any fibrous septa.

Peripheral innervation. The obliquus internus muscle receives its innervation from the medial rami of the lowest thoracic nerves and from the highest lumbar nerves (ileo-hypogastric and ileo-inguinal).

The transversus muscle receives its innervation from the same nerves. The peripheral segmental nerve branches that provide the motor innervation of the rectus muscle are six or seven in number and run parallel to the fibres of the transversus on the outer surface of that muscle.

Experimental part.

M. obliquus internus. The data as set forth in this communication were obtained for the obliquus internus muscle from four dogs (D. 9, 11, 49 and 50) and for the M. transversus also from four dogs (D. 11, 29, 49, 50). Method and technique were the same as described in the preceding communications.

Stimulation of one of the ventral medullar roots that takes part in the innervation of the muscle always results in contraction of a definite and circumscribed part of the muscle. The contraction includes a number of fibres

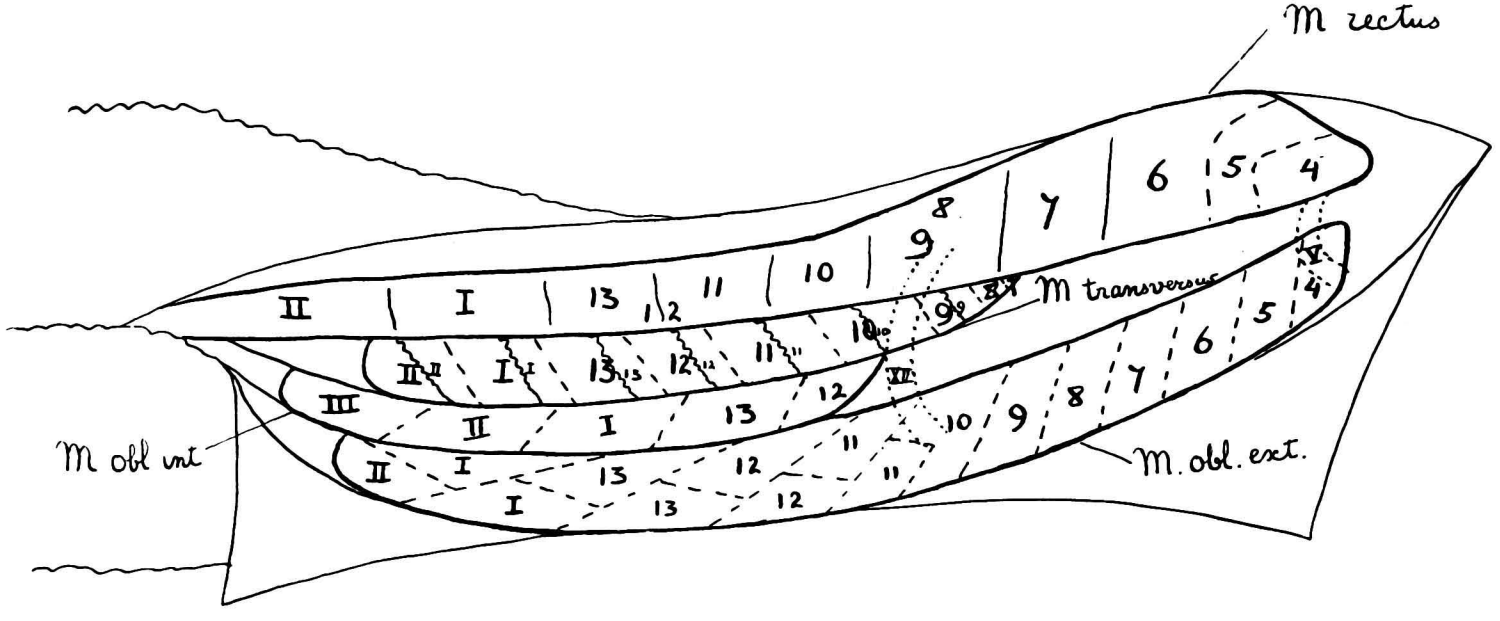

Fig. 1.
Diagram showing the rhizomeres of the four abdominal muscles in dog. The M. obliquus externus is reflected.
4—13 thoracic nerves, I, II, III lumbar nerves. V, XII, ribs.

situated side by side that form a coherent strip of muscle. The contraction may be noted by sight (shortening and change of colour, the fibres turn a darker red) and by feeling (they become firmer). When several roots are stimulated consecutively, the contracted strip can be seen to change its position.

The most cranial root partaking in the innervation of the M. obliquus internus is Th 12 (Dog 9 and 50). In one dog (49) the most cranial root was Th 11. But this dog had only twelve ribs. In three cases we found the most caudal root to partake in the innervation L III (Dog 9, 11, 50). In dog 49 with twelve ribs we found also the most caudal root to be L III. The M. obliquus internus therefore is innervated by five consecutive spinal segments, Th 12—L III. The anatomical publications do not record L III as partaking in the innervation of the obliquus internus muscle. Even with careful observation there was no reason to assume the occurrence of overlapping in cranio-caudal direction.

M. transversus abdominis. Here also stimulation of roots partaking in the innervation of this muscle resulted in contraction in well-defined territories, situated side by side in cranio-caudal direction.

The most cranial root partaking in the innervation is Th 8 (Dog 11, 50). In dog 49 (that had only twelve ribs) and in dog 29, Th 7 innervated a very small part of the muscle, situated quite cranially. The most caudal root was always L II ; in dog 49 L III.

The transversus muscle therefore consists of eight rhizomeres. Those are strictly separated, without any overlapping. Each rhizomere contains a strip of muscle in the middle of which runs the segmental homologous peripheral nerve branch of the rectus and transversus muscle, except in the most cranial strip that does not contain a nerve branch for the rectus muscle. Those segmental nerve branches therefore are situated in regard to the rhizomeres of the transversus muscle intrasegmental, and not intersegmental.

Summary.

1. The M. obliquus internus in dog is innervated by an uninterrupted series of five ventral spinal roots : Th 12—L III.

The M. transversus is innervated by an uninterrupted series of 8 (9?) ventral spinal roots : Th (7) 8—L II.

2. Neither of the muscles shows any segmentation by fibrous septa. The rhizomeres that build up the muscles appear as simple muscle strips laying side by side and forming an uninterrupted series in cranio-caudal direction.

3. Neither muscle shows any trace of mutual overlapping.

4. The peripheral segmental nerve branches that innervate the M. rectus and M. transversus are situated intrasegmental, not intersegmental, i.e. they are situated in the metameric homologous rhizomere of the transversus muscle.

Conclusion.

Examining the results of our investigation it will be clear that the innervation of the four muscles of the abdominal wall has preserved the original segmental caracteristic. The muscle territories that receive their innervation from the various spinal ventral roots (rhizomeres) are situated one after the other in cranio-caudal direction. Those conditions are clearest and most definite in the M. transversus and M. obliquus internus abdominis, in which the rhizomeres appear without any overlapping, mixing or shifting as a series of well-defined muscle territories (Fig. 1).

In the M. obliquus externus there exists the curious condition, that some rhizomeres are divided into two parts : a medial and a lateral division, the two parts having shifted their positions in regard to each other, resulting in a separation of the territories of one rhizomere.

Finally, the M. rectus abdominis shows the most important complications. This muscle does not consist of an uninterrupted series of consecutive and well-defined radical territories : one of the ventral roots of the series (Th 8) often does not or only slightly partake in the innervation of this muscle, and mixing and overlapping of rhizomeric material in various segmental levels will occur. This fact is the more remarkable since the M. rectus abdominis is the only muscle of the abdominal wall that is divided in apparently segmental territories by fibrous septa.

The serial division of the muscle that is caused in this way however is only metameric with a certain restriction.