

Physiology. — *Experimental contribution to the knowledge concerning the segmental innervation of the abdominal muscles in the dog.* (2nd Communication.) *The M. Obliquus Externus.* By Prof. G. VAN RIJNBERK and Miss L. KAISER.

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ANATOMICAL INTRODUCTION.

Gross Anatomy.

In the dog the M. obliquus externus consists in one broad and flat layer of muscular tissue, arising cranial and dorsal from the 5th (6th) — 13th ribs with several heads. At the ventral side it is connected with the fascia of the rectus abdominis muscle by means of a tendinous membrane. Caudad the muscle becomes tendinous and is inserted into the pubic bone.

Its fibres run practically parallel, diverging slightly fan-like from dorso-cranial in caudoventral direction. We never saw fibrous partitions that might be looked on as inscriptions tendineae. The muscle can be considered as homologous to the internal intercostal muscles.

Peripheral innervation.

The obliquus externus muscle is innervated by branches of the lateral rami of the 5th (6th)—13th intercostal nerves, and by branches of the

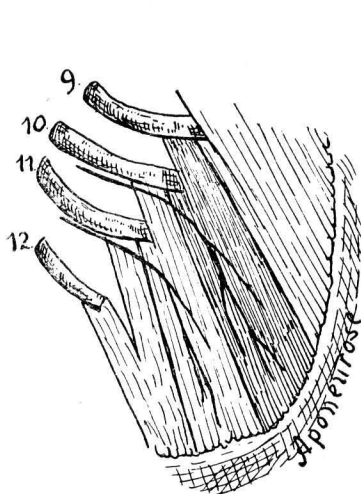


Fig. 1.

(After SEYDEL) Single nerve-muscle-territory (Orang) M. Obliquus from right side of body.

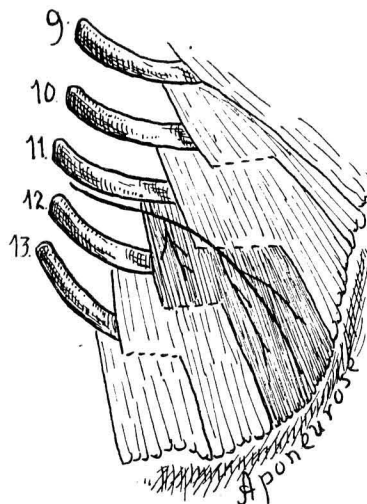


Fig. 2.

(After SEYDEL) Double nerve-muscle-territory (Troglodytes niger) M. obliquus from right side of body.

N. ileohypogastricus and *N. ileoinguinalis*. In some mammals (*Nictycebus*, *Cercopithecus*, *Lemur*, etc) the parts of the muscle innervated by the segmental nerve-branches form consecutive territories. But in other animals (*Cynocephalus*, *Inuus*) the segmental branches innervate two or more parts of the muscle not lying next to each other but have changed their respective positions. (Cf. a. o. SEYDEL¹).)

Many variations between those two extreme conditions may be seen. In the first case the muscle consists in a series of segmental nerve-muscle territories, following each other in cranio-caudal direction. In the second place at least two of such series can be found, the ventral series lying topographically caudad from the dorsal series, but from a segmental view point the ventral series is situated in a more cranial part of the muscle.

EXPERIMENTAL PART.

A. Method.

The research was carried out on 13 dogs.

The method used is chiefly the same as used and described in our communication on the *M. rectus abdominis*.

B. Results.

Stimulation of one of the ventral spinal roots partaking in the motor innervation of the *M. obliquus externus* always results in a contraction of one or two more or less clearly defined sections of the muscle. The contracting part assumes a somewhat darker aspect, it increases in thickness and its consistency becomes firmer. When several roots are stimulated consecutively, it can be felt and seen easily that the contracting part shifts its position. But from the caudal part of the muscle it is not very easy, to obtain a clear conception concerning situation, relation and exact extension of the various rhizomers.

1. Segmental boundaries of the muscle.

Once the cranial border of the muscle was found to be innervated by Th 3 and 4 (dog 26) once by Th 4 (dog 25) three times by Th 5 (dog 27, 42 and 46²)). In dog 42 it could be ascertained that Th 3 and 4 did not partake in the innervation. The caudal border was innervated in eight cases by LII (dog 8, 9, 24 25, 26, 27, 42, 46). In four of those cases LIII did not partake in the innervation of this muscle; in the other cases this point was not investigated.

In two cases (dog 1 and 11) LII did not appear to partake in the innervation, LI innervating therefore the most caudal part of the muscle.

¹) O. SEYDEL, Ueber die Zwischensehnen und den metameren Aufbau des *M. obliquus thoraco-abdominalis (abdominis) externus* der Säugethiere, 1892.

²) Consecutive numbers were used for dogs from the rectus- and from the obliquus research.

A series of 11—13 roots therefore provides the innervation of the obliquus externus muscle in the dogs that were investigated by us.

Generally the roots Th. 3, 4, 5, 6, 7, 8, 9, 10 provide the innervation of muscle sections that are situated in a row one next to the other. In two cases (dog 24 and 27) Th 11 also innervated a single strip of muscle, but in six cases (dog 25, 26, 29, 42, 44, 46) a double one.

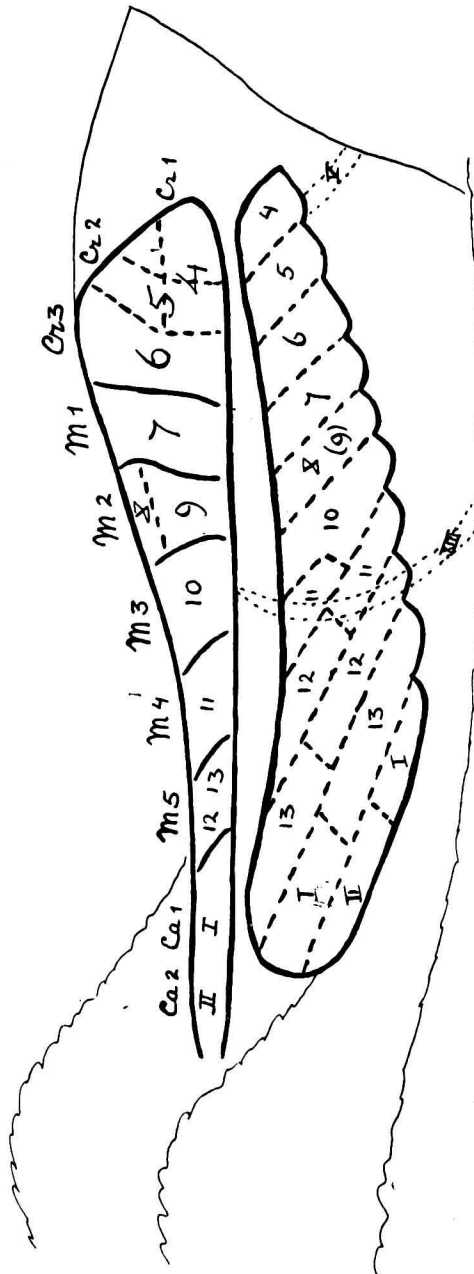


Fig. 4.

Relations between innervation of rectus and obliquus muscle in dog 25. *Top*: M. rectus. *Bottom*: M. obliquus. V, XIII: ribs.

The next roots : Th 12, 13 innervated in all cases two strips of muscle that had shifted their position in cranial-caudal direction over the width of a rhizomere, and were no longer lying side by side. The same is true in case of LI, with the exception of one case (dog 29), in which the section innervated by this root was single. The territories innervated by those roots therefore must be divided in a ventral and dorsal rhizomeric section. LII usually innervates a single section, apparently homologous with the ventral rhizomeric section of the roots immediately preceding.

In one case (dog 24) LII also had two separate rhizomeric sections. In the same dog Th 11 innervated on the contrary a single rhizomere. The ventral rhizomeric sections are situated topographically caudad to the corresponding dorsal rhizomeric sections. From a segmental point of view they occupy a more cranial territory than the dorsal rhizomers.

A tabel shows the relations as found by us.

TABLE.

Dog	Single muscle territory	Double muscle territory
24	Th 6, 7, 8, 9, 10, 11	Th 12, 13 L I, II
25	Th 4, 5, 6, 7, 8, 9, 10 L II	Th 11, 12, 13 L I
26	Th 3, 4, 5, 6, 7, 8, 9, 10 L II	Th 11, 12, 13 L I
27	Th 5, 6, 7, 8, 9, 10, 11 L II	Th 12, 13 L I
29	Th 6, 7, 8, 9 L I	
42	Th 5, 6, 7, 9, 10 L II	Th 8, 11, 12, 13 L I
44	Th 7, 8, 9,	Th 10, 11, 12
46	Th 5, 6, 7, 8, 9, 10 L II	Th 11, 12, 13 L I

3. Some special questions.

a. In the investigation of this muscle attention is drawn to the roots Th 8 and 9. In the rectus muscle Th 9 always innervates the same muscle part, M 2, and Th 8 almost never innervates an independent part of the muscle, and sometimes does not partake in the innervation at all, but in the obliquus muscle Th 8 always innervates an independent part of the muscle, and stimulation of Th 9 sometimes may yield but a very slight result. Furthermore, Th 8 and 9 may distribute their branches through the same territory of the obliquus.

b. Attention is drawn to that section of the obliquus muscle where single and double rhizomeres are situated side by side. The relations as found by us may be easiest understood with the help of a few diagrams (See Fig. 3).

c. A comparison of the innervation of rectus and obliquus shows, that

the segmental scope of both muscles is about the same. Specially the caudal border of both muscles is constant and the same (LII). The number of roots partaking in the innervation also in both muscles is the same. Meanwhile, Th 8 and Th 12 do not send branches to an independent

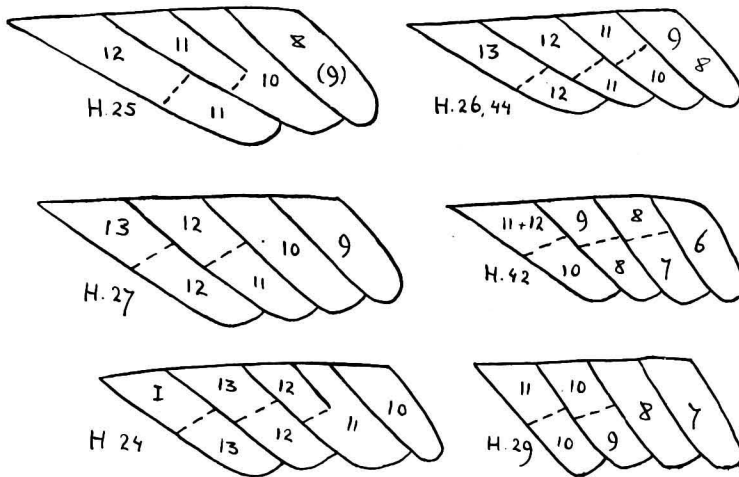


Fig. 3.

Diagrams to explain the changing of single nerve-muscle-territories into double. The figures represent a part of a left oblique muscle from a dog lying on its back.

part in the rectus muscle, and on the other hand, all roots partaking in the innervation of the oblique muscle spread in separate territories.

d. The problem of overlapping could not be cleared further by studying the oblique muscle, since the boundaries of contracting parts are difficult to determine; but overlapping appears to be an exception: once (dog 42) we found Th 11 and 12 innervating a common muscle territory, the same being the case with the rectus muscle of this dog. Sometimes we noticed (as stated under 3a) that Th 9 supplied nerve fibres to a territory, partly belonging to Th 8.

SUMMARY.

1. The M. oblique externus in the dog is innervated by an uninterrupted series of 11—13 ventral (motor) spinal roots: Th (3, 4) 5—LII.

2. No segmentation by fibrous segments is visible in this muscle. The territories of the cranial roots Th (3, 4) 5—7 always consist in single muscular sections, situated in a consecutive row in cranial-caudal direction. From Th 12, 13 and LI on the other hand fibres are sent into two muscular sections, a dorsal and a ventral one, which sections are absolutely separated. The dorsal division of the muscular section innervated by those roots is

situated caudad as to the ventral division. The territory of LII apparently consists in a medial (ventral, cranial) part of the rhizomere only. The rhizomeres of Th 8, 10, 11 may be single or double.

3. Th 8 always partakes in the innervation of the *M. obliquus externus*, Th. 9 only to a slight degree.

4. Overlap does hardly exist in the *M. obliquus externus*. In one case, however, Th 11 and 12 were found to supply a common territory, and in a few cases Th 9 sent fibres into a part of the territory of Th 8.
