

The lumbosacral dorsal rami of the cat

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INTRODUCTION

Several reflexes involving dorsal rami have been demonstrated in the cat (Pedersen, Blunck & Gardner, 1956; Bogduk & Munro, 1973). However, there is no adequate description in the literature of the anatomy of lumbosacral dorsal rami in this animal. The present study was therefore undertaken to provide such a description, hoping thereby to facilitate the design and interpretation of our own (Bogduk & Munro, 1973) and future research on reflexes involving lumbosacral dorsal rami, including reflexes possibly relevant to the understanding of back pain in man.

These nerves are described in the present study in relation to a revised nomenclature of the muscles in the dorsal lumbar region. Such a revision (Bogduk, 1975) was necessary because of the different nomenclatures and varied interpretations in the literature.

METHODS

Six laboratory cats (*Felis domesticus*) were embalmed with 10% formalin and studied by gross dissection. In addition, confirmatory observations were made on another 16 cats in the course of surgical procedures.

Lateral branches of dorsal rami were first identified during reflexion of the skin and then during the resection of iliocostalis and longissimus lumborum. These branches were subsequently traced back to their origins from the dorsal rami, a dissecting microscope being used. The medial branches of the dorsal rami were then traced through the intertransversarii mediales into multifidus.

Sinuvertebral nerves were also sought. Nerve roots were detached from the spinal cord before removing it from the vertebral canal. The canal was then examined under a dissecting microscope for traces of sinuvertebral nerves, looking for their possible origins from spinal nerves, rami communicantes, and plexuses near the posterior longitudinal ligament.

OBSERVATIONS

Lumbar dorsal rami

The lumbar dorsal rami arise from the spinal nerves as they pass caudal to the accessory processes. The dorsal rami are, in general, exceedingly short, seldom reaching more than 1 mm in length. Each dorsal ramus passes dorsally and pierces the intertransverse ligament, where it divides into its branches. The morphology of the branches of the dorsal rami was found to differ slightly at the L1–5, L6 and L7 levels. The findings at these three levels are therefore described separately.

Dorsal rami L1-5

In a study of 36 dorsal rami at these levels in six specimens, only 8 were found to form two branches as is typically described (Reighard & Jennings, 1934). The remaining 28 dorsal rami were found to form *three* discrete branches (Fig. 4). These branches will be described as the lateral, intermediate and medial branches of the dorsal rami.

Lateral branch (Figs. 1, 3 and 4). This branch arises from the dorsal ramus as it pierces the intertransverse ligament, and emerges from the ligament just lateral to the tip of the accessory process (Fig. 3). It then courses caudally, laterally and dorsally through the iliocostalis lumborum. It supplies branches to this muscle and eventually emerges on its dorsolateral surface to become cutaneous.

Cutaneous branches. After emerging from the iliocostalis the cutaneous nerves pierce the dorsal layer of thoracolumbar fascia. The principal trunks of these nerves run for considerable distances in the subcutaneous tissue superficial to the dorsal layer of the thoracolumbar fascia. They are directed caudally and medially, and even extend across the midline for some distance (Fig. 2).

Intermediate branch (Figs. 1, 3 and 4). This branch arises from the dorsal ramus in the intertransverse ligament and for the proximal part of its course runs close to the lateral branch, both nerves being enclosed in a common sleeve of fascia derived from the intertransverse ligament. The intermediate branch then leaves the lateral branch, and courses dorsally, laterally and caudally into the longissimus lumborum. The nerve ramifies in this muscle and no cutaneous branches of it have been found by dissection.

The intermediate and lateral branches are exclusively distributed to the longissimus lumborum and iliocostalis lumborum respectively. Because of this they are effectively separated in their distribution by the lumbar intermuscular septum.

Medial branch. This branch arises from the dorsal ramus in the intertransverse ligament and initially courses directly caudally, ventral to the accessory process. In this part of its course it is covered by a part of the intertransverse ligament which attaches to the accessory process. This ligamentous expansion separates the medial branch from the intermediate and lateral branches (Fig. 3).

The medial branch emerges from the intertransverse ligament at about the level of the tip of the accessory process and then runs caudodorsally across the lateral surface of the lamina of the adjacent vertebra (Fig. 4). It reaches the dorsal surface of the vertebra by hooking over the lateral edge of the lamina, near the root of the superior articular process (Fig. 4). The nerve continues caudomedially for a short distance over the lamina, lying in some fine areolar and adipose tissue deep to the multifidus. It then obliquely enters the multifidus along its deep surface. Within the multifidus the medial branch continues caudally, lying between the spinous process and the zygapophyseal joint. It can be traced as far as the next interspinous space, but here becomes too fine to be traced macroscopically any further.

No consistent branches of the medial branch were found within the multifidus. Articular branches could not be identified. The only consistent branch of the medial branch identified was the nerve to the intertransversarii mediales.

Nerve to the intertransversarii mediales (NIM). This nerve is a constant branch of the medial branch at each segmental level (L1-6). It arises from the medial branch

either during its early course through the intertransverse ligament or as it runs along the lateral surface of the lamina (Figs. 3 and 4).

The NIM runs for a short distance with the medial branch of the dorsal ramus across the lateral surface of the lamina, but soon leaves it to enter the deep surface of the intertransversarii mediales. It continues longitudinally through the muscle and can be traced macroscopically as far as the next caudal intertransverse space. It was occasionally noted that the NIM divided into separate trunks which ran in parallel through the muscle (Fig. 4). This suggested that perhaps each of the separate bundles of the intertransversarii mediales (Bogduk, 1975) which arise from a given accessory process receives a separate division of the corresponding NIM, each running longitudinally through its related muscle bundle.

In the eight dorsal rami which did not exhibit triple branching, the absent branch was the intermediate. The medial and lateral branches of these dorsal rami were nevertheless identical with those described above where the intermediate nerve was present. Absence of a third branch did not occur consistently at any particular level, and so it is believed that the absent nerve was probably destroyed during resection of the longissimus.

Dorsal rami L6

In a study of six dorsal rami at the L6 level in five specimens, all were found to give off medial and lateral branches. An intermediate branch could be identified coming from only one dorsal ramus.

Medial branch. The L6 medial branch is identical with the medial branches at more rostral levels. The NIM, however, is very small because of the paucity of intertransversarii mediales fibres at this level.

Lateral branch. This nerve ramifies in the caudal fibres of iliocostalis lumborum. Possibly it gives cutaneous branches like the other lumbar lateral branches, but such branches were not found in the present study.

Intermediate branch. When found, this nerve ramified quickly in the longissimus lumborum.

The failure to find intermediate branches in the majority of dissections may reflect a genuine absence of the third branch at this level, but it is more likely that fine intermediate branches did occur but were destroyed during the resection of the longissimus.

Dorsal ramus L7

Six dorsal rami at this level were dissected in five specimens.

This nerve emerges from the intertransverse ligament just ventral to the lumbosacral zygapophyseal joint. It runs at first dorsally and caudally, hooking over the ala of the sacrum. In this part of its course it lies directly on periosteum deep to the caudal fibres of longissimus and lumbococcygeus (Fig. 5). As it hooks over the ala, the L7 dorsal ramus gives off a branch which corresponds to the intermediate branch of other lumbar dorsal rami. This branch passes caudolaterally, and runs either into or over the surface of the longissimus lumborum (Fig. 5). After giving off this branch the dorsal ramus continues as the medial branch, which hooks medially around the caudal aspect of the root of the lumbosacral zygapophyseal joint, and enters multifidus

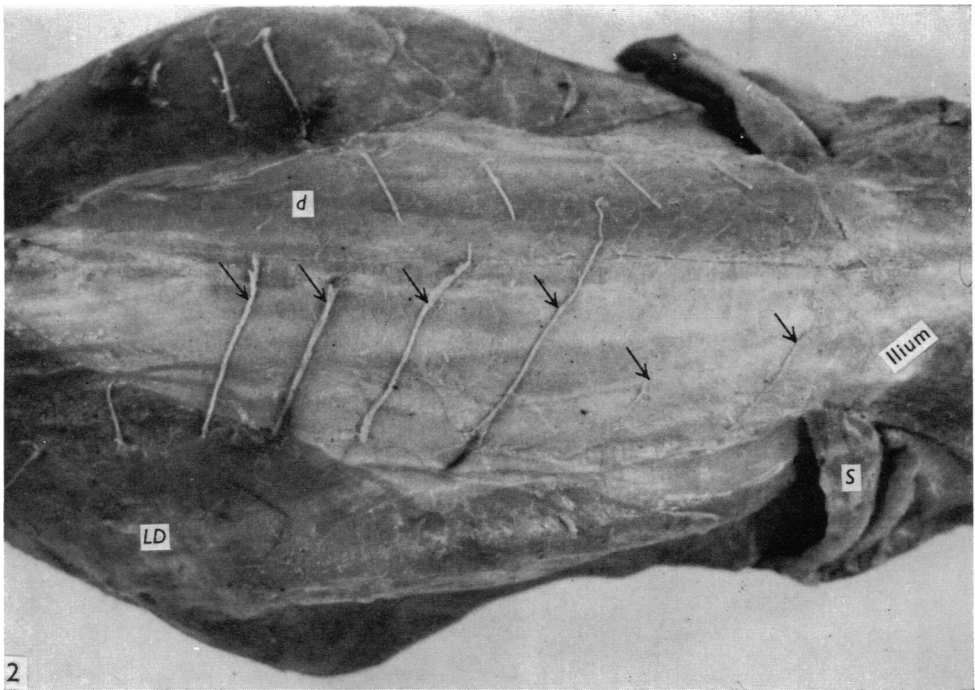
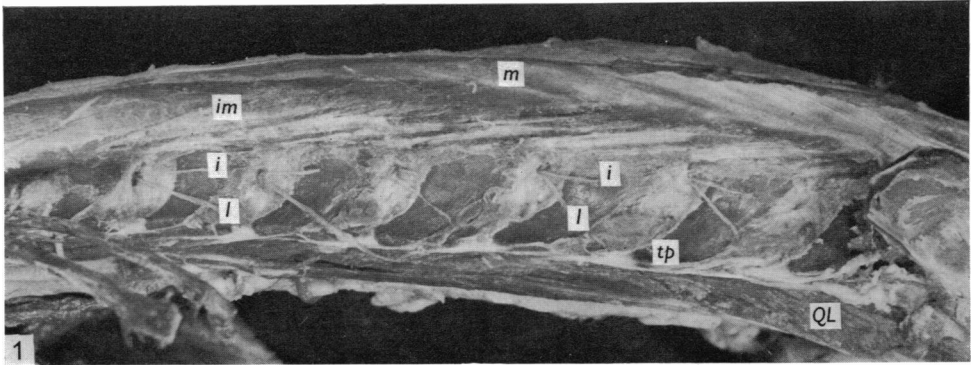


Fig. 1. Lateral view of the dorsal lumbar region. In this and the next three figures the cranial end of the specimen is to the left. The longissimus and iliocostalis lumborum have been resected to reveal the dorsal aspects of the transverse processes (*tp*) and the lateral aspects of the multifidus (*m*) and intertransversarii mediales (*im*). The lateral (*l*) and intermediate (*i*) branches of the dorsal rami are shown. (*QL*) marks the quadratus lumborum.

Fig. 2. Dorsal view of the lumbar region. The dorsal layer of thoracolumbar fascia (*d*) is intact. Cutaneous branches of the lumbar dorsal rami are arrowed. *S*, sartorius; *LD*, latissimus dorsi.

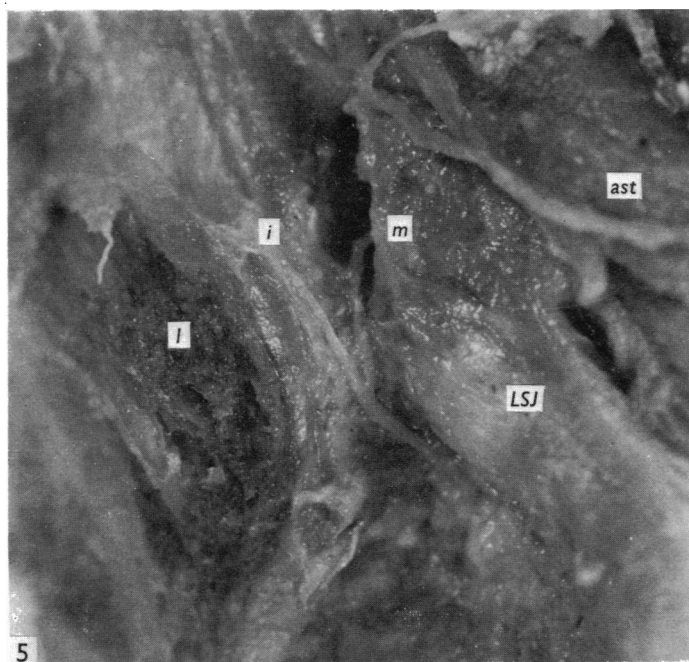
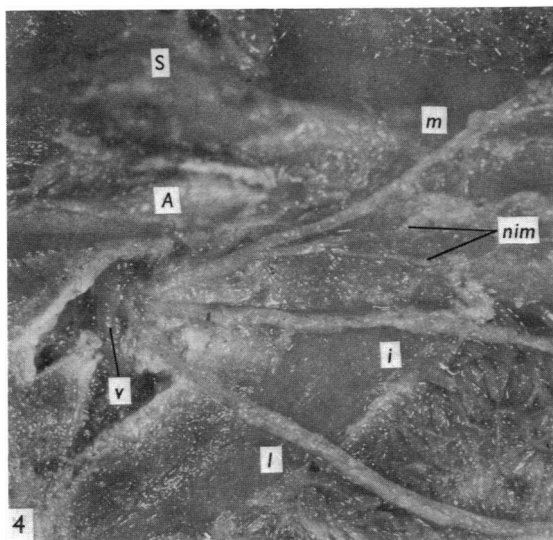
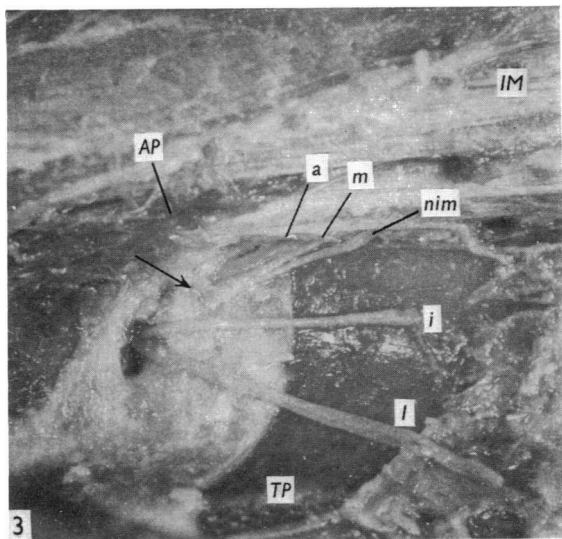
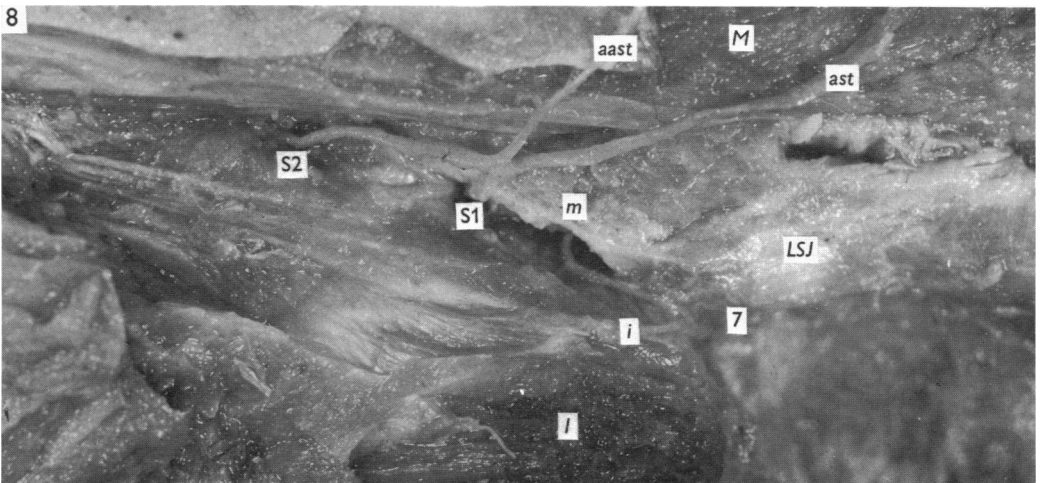
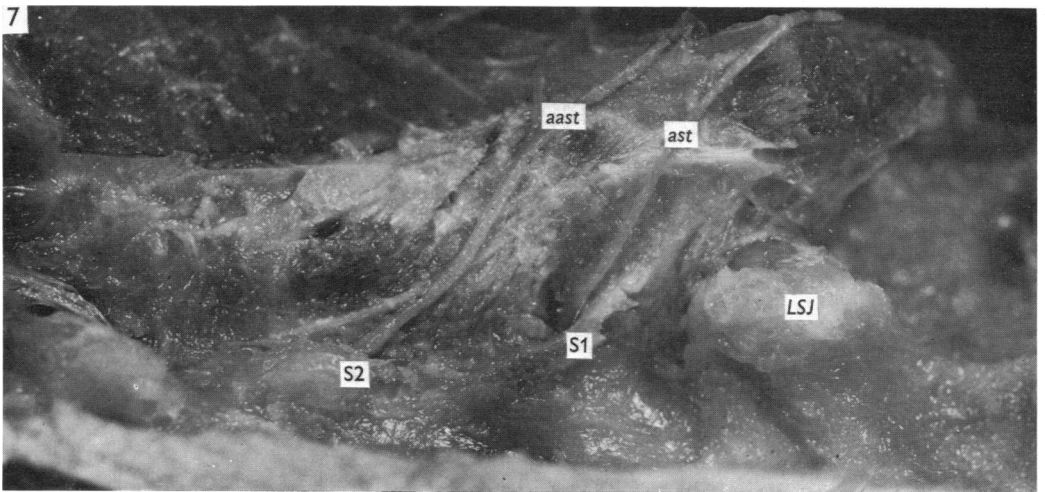
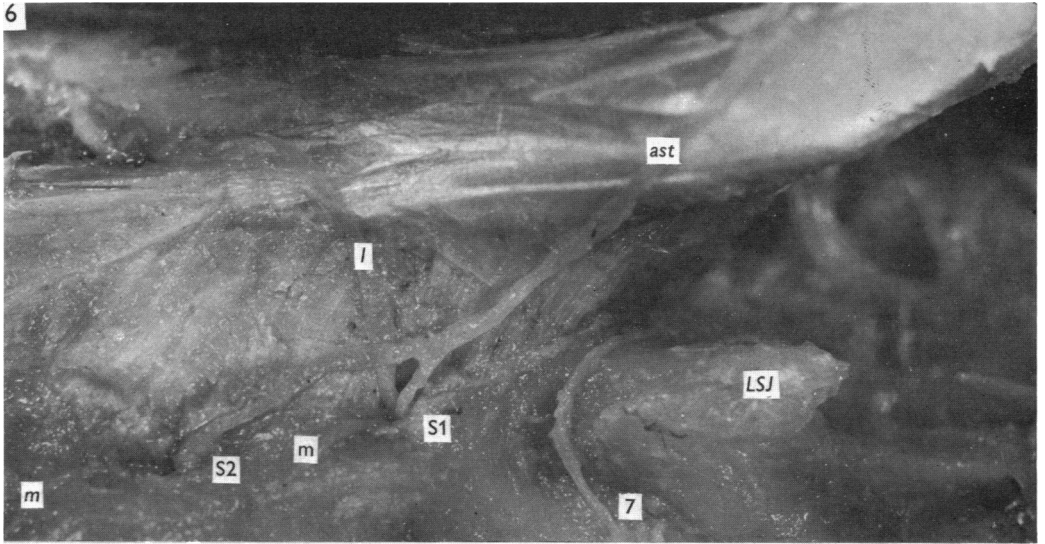


Fig. 3. A close-up lateral view of the L1-L2 intertransverse space, showing medial (*m*), lateral (*l*), and intermediate (*i*) branches of the L1 dorsal ramus. (*nim*) refers to the nerve to the intertransversarii mediales (*IM*). Note the expansion from the intertransverse ligament separating the medial from other branches (arrowed). *AP*, accessory process; *TP*, transverse process; *a*, artery accompanying medial branch.

Fig. 4. A close-up lateral view of the L2 dorsal ramus, showing triple branching. *l*, lateral branch; *i*, intermediate branch; *m*, medial branch; *nim*, nerve to intertransversarii mediales; *A*, accessory process of L2 vertebra; *S*, superior articular process of L3 vertebra; *v*, L2 ventral ramus. The dorsal ramus is too short to be clearly labelled. It lies at the point of convergence of the three branches, and the ventral ramus.

Fig. 5. The lumbosacral region viewed from caudally, ventrally and medially, to show the right L7 dorsal ramus hooking over the ala of the sacrum. *LSJ*, lumbosacral joint (zygapophysial); *l*, ilium (resected); *i*, intermediate branch; *m*, medial branch; *ast*, ascending sacral trunk.



(Fig. 5). There is no NIM at the L7 level, since there are no fibres of that muscle arising from the 7th lumbar vertebra.

In no cases was a lateral branch found at this level.

Sacral dorsal rami

Dorsal rami S1 and S2

These dorsal rami lie deep within the sacral canal. They form three discrete branches which emerge from each of the first two dorsal sacral foramina. One of these branches – the medial – hooks medially around the articular process at each level and ramifies in multifidus (Fig. 6). Another, the lateral, passes laterocaudally to supply the lateral tail muscles (Fig. 6). The third, middle, branches of the S1 and S2 dorsal rami are involved in the formation of the ascending sacral trunk and the accessory ascending sacral trunk.

Ascending sacral trunk (AST)

The AST is formed on the deep half of the lateral surface of the lumbococcygeus over the sacrum. It is usually derived from the middle branch of S1 and a communicating branch from the middle branch of S2 (Fig. 8). There may be no S2 contribution (Fig. 7). The AST courses rostradorsally across the lateral surface of the lumbococcygeus until it gains the dorsolateral border of the muscle, generally at about the level of the L6–7 interspinous space (Fig. 9). In this initial part of its course the nerve lies immediately deep to, and is clearly visible through, the transparent fascia of the lumbococcygeus. Having gained the dorsolateral border of the muscle it continues rostrally along this border as far as the middle third of the lumbar region. It then passes slightly medially into the lumbococcygeus and continues its rostral course within the muscle. The AST can be traced by gross dissection as far rostrally as the level of the L4 spine. Along its course the AST regularly gives off small twigs to the lumbococcygeus. Indeed, lumbococcygeus is the only muscle innervated by the AST. This has been confirmed by dissection and, physiologically, by stimulating the nerve.

Fig. 6. Dorsal view of the left side of the sacrum. The lumbococcygeus has been removed to show the origin of the ascending sacral trunk (*ast*) from the S1 and S2 dorsal sacral foramina. Also shown are the medial (*m*) and lateral (*l*) branches of the S1 and S2 dorsal rami and the L7 medial branch (7). *LSJ*, lumbosacral joint.

Fig. 7. Dorsal view of the left half of the sacrum. The lumbococcygeus has been removed to show the origins of an ascending sacral trunk (*ast*) and an accessory ascending sacral trunk (*aast*), from the S1 and S2 dorsal sacral foramina. *LSJ*, lumbosacral joint.

Fig. 8. Dorsal view of sacral region (right hand side). The lumbococcygeus has been removed to show the origins of an ascending sacral trunk (*ast*) and an accessory ascending sacral trunk (*aast*). Note the communication between the nerves. Also shown is the L7 dorsal ramus (7). *i*, intermediate branch; *m*, medial branch; *LSJ*, lumbosacral joint; *I*, ilium (resected); *M*, multifidus.

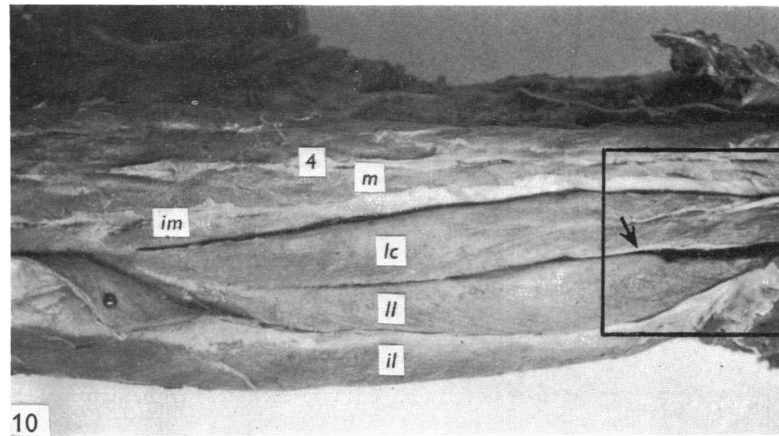
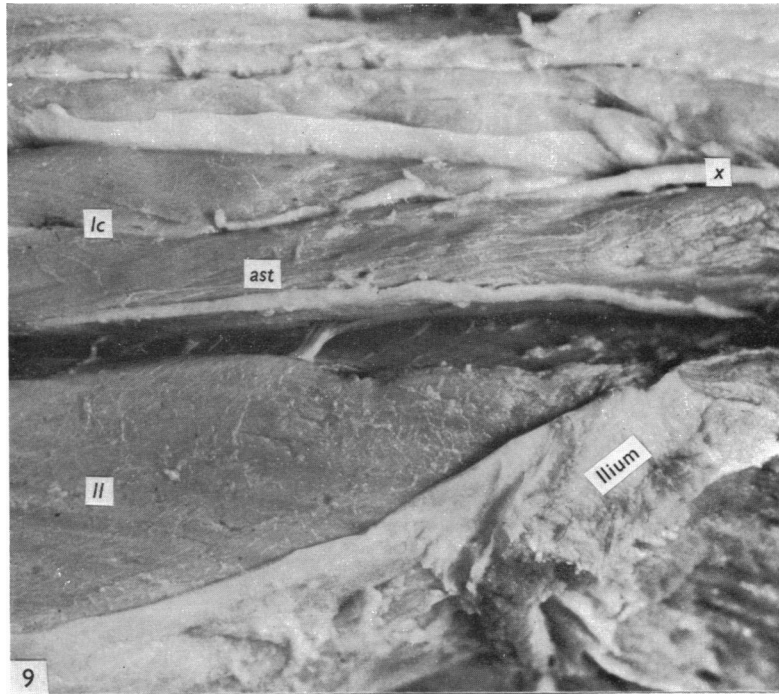


Fig. 9. Dorsolateral view of the left ascending sacral trunk (*ast*) running into the lumbar region along the dorsolateral border of the lumboerector (*lc*). For orientation the region illustrated in Fig. 9 is shown as an inset in Fig. 10. *il*, longissimus lumborum; *x*, tendon of lumboerector.

Fig. 10. The dorsal lumbar region (left hand side). The dorsal layer of thoracolumbar fascia and the erector spinae aponeurosis have been resected to reveal the dorsal lumbar muscles. The area outlined is shown in close-up in Fig. 9. *4*, the L4 spinous process; *m*, multifidus; *lc*, lumboerector; *il*, longissimus lumborum; *il*, iliocostalis lumborum; *im*, intertransversarii mediales; arrowed, ascending sacral trunk.

Accessory ascending sacral trunk (AAST)

The AAST is generally derived from the middle branch of the S2 dorsal ramus. Its formation and incidence, however, are variable. It may be absent (one of the six specimens), in which case the middle branch of S2 passes entirely to the AST (Fig. 6). When present, it is formed either by the entire middle branch of S2 (two out of six specimens, Fig. 7), or by the middle branch after it has given off the communicating branch to the AST (three out of six specimens: Fig. 8)).

Like the AST the AAST courses rostradorsally across the lateral surface of the lumbococcygeus, immediately deep to its fascia. It courses parallel to the AST, but at a more caudal level. However, it does not reach the dorsolateral border of the muscle, but quickly passes into the muscle mass. It has been traced by gross dissection as far rostrally as the level of the L7 spine. The AAST like the AST is distributed to the lumbococcygeus only.

In a study of ten specimens, no branches of lumbar dorsal rami were found to pass into lumbococcygeus. Therefore, the sole nerve supply of lumbococcygeus is from the S1 and S2 dorsal rami via the AST and AAST.

Dorsal ramus S3

No neural elements located in the dorsal lumbar region were ever found to arise from the S3 dorsal ramus. This nerve was assumed not to be involved in the supply of the lumbar region, and hence was not investigated.

Sinuvertebral nerves

No traces of sinuvertebral nerves were found at any of the 16 levels investigated in 3 cats. It would seem that the sinuvertebral nerves of the cat, if they exist, are of microscopic size, as in the monkey (Stillwell, 1956).

DISCUSSION AND CONCLUSIONS

There are few previous descriptions of the lumbosacral dorsal rami of the cat, Reighard & Jennings (1934) state that 'The dorsal rami are similar to those of the thoracic region, sending one branch dorsal to the muscles of the vertebral column. another dorsolateral to reach the integument at about the lateral border of the longissimus dorsi'.

The present study has introduced several significant additions and corrections.

(i) The L1-6 dorsal rami form *three* discrete branches, lateral, intermediate and medial. The intermediate and lateral branches supply longissimus lumborum and iliocostalis lumborum respectively.

(ii) The L7 dorsal ramus forms only two branches, medial and intermediate, the latter supplying longissimus lumborum.

(iii) An ascending sacral trunk (AST) and an accessory ascending sacral trunk (AAST) have been described, apparently for the first time. The AST was traced as far rostrally as the level of the L4 spinous process. The existence of sacral nerves in the lumbar region is interesting. The lumbococcygeus evidently represents a substantial mass of sacral myotome material which has invaded the dorsal lumbar

region. This has obvious implications for the assessment of reflexes from dorsal lumbar muscles.

(iv) The existence of a constant branch of the medial branch of each of the L1–6 dorsal rami supplying the intertransversarii mediales (NIM) has not been noted previously.

SUMMARY

The lumbosacral dorsal rami of the cat were studied by gross dissection.

The L1–6 dorsal rami form three discrete branches – lateral, intermediate and medial. The lateral branches supply the iliocostalis lumborum and become cutaneous over the back. The intermediate branches ramify in the longissimus lumborum, and are separated from the lateral branches by the lumbar intermuscular septum. The medial branches supply the multifidus and have a constant branch – the nerve to intertransversarii mediales. The L7 dorsal ramus forms only medial and intermediate branches.

The S1 and S2 dorsal rami form three branches, the middle of which form the ascending sacral trunk and accessory ascending sacral trunk. The ascending sacral trunk is derived from S1 and S2, the accessory ascending sacral trunk from S2. Both nerves are the exclusive nerve supply of lumbococcygeus.

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