

THE RADICULAR ORIGIN OF THE NERVES OF THE LUMBOSACRAL
PLEXUS OF THE BOS TAURUS

by

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INTRODUCTION

The study of the radicular origin of the nerves of the lumbosacral plexus was made because of a need for a more detailed description of the nerves of the pelvic region in the bovine species. The fetuses are well developed at birth in this species and their passage through the pelvic cavity exerts pressure on and frequently injures some of the nerves of this plexus. The damage to the obturator nerve had long been recognized but the vulnerability of the other nerves of the lumbosacral plexus to damage by the passage of the fetus had not been assessed. Many clinical cases have been diagnosed as posterior paralysis because the anatomical information of the area has been too limited to make a more specific diagnosis. A deterrent to an investigation of this area has been the fact that the cow and the horse have a similar vertebral formula and it was assumed that the anatomy of the lumbosacral nerves were essentially similar in the two species.

MATERIALS AND METHODS

The specimens used in this study were procured from the necropsy laboratory of the pathology department, Kansas State University. The specimens were from cattle of various ages and breeds and were selected at random from those cases which died of conditions not involving the caudal part of the animal. All of the animals were considered anatomically normal since their case histories failed to reveal any abnormalities and no evidence of embryological malformation was detected during the necropsy examination.

To facilitate this study the necropsy procedures were modified in

these cases by making incisions through the abdominal wall at the linea alba and the costal arch to allow evisceration. The vertebral column was severed at the lumbocostal junction. The specimens were preserved with a solution containing 35 per cent isopropyl alcohol and two per cent phenol and the arteries were injected with latex. In both procedures the abdominal aorta was used as the site of the injections.

The following dissection procedures were performed to prepare the specimens for examination. The floor of the pelvis was removed by sawing through the pelvis in the sagittal plane at each obturator foramen. This allowed abduction of the pelvic limbs and gave a greater exposure of the pelvic cavity. The parietal peritoneum was dissected free from the abdominal and pelvic cavities. The peritoneum and the pelvic viscera were reflected caudally to expose the nerves of the lumbosacral plexus. The caudal portion of the psoas minor muscle was removed to expose the radicular origins of the inguinal, lateral cutaneous femoral, femoral and obturator nerves. The biceps femoris and gluteus medius muscles were cut at their insertions and reflected proximad to their origins to expose the course and innervation of the cranial and caudal gluteal and the sciatic nerves.

The nerves of the lumbosacral plexus and their major branches were dissected free from the surrounding tissues. The epineurium was incised and the nerve fibers were separated, by using teasing needles and the blunt edge of the scalpel, to determine their radicular origin. The relative size of each root of each nerve and its major branches was determined by visual examination and palpation and recorded as the percentage of the total nerve under consideration. Special dissections were made and photographs taken to record the origins and courses of the nerves. The

lumbosacral plexuses of ten specimens were examined on both right and left sides and ten specimens were examined only on one side, alternating right and left limbs with each succeeding animal.

REVIEW OF LITERATURE

There was little literature published on the nerves of the lumbosacral plexus of the Bos taurus. Emerson (1941) and St. Clair (1942) investigated the nerve supply to the mammary gland. Larson (1953) reported on the course and innervation of the pudendal nerve but gave no account of its radicular origin. Experimental studies of the innervation of the abdominal wall were conducted by Arnold and Kitchell (1957) but their studies included only the third lumbar root of the lumbosacral plexus. Martin (1938), Ellenberger and Baum (1943), Sisson and Grossman (1953), and Nickel et al. (1954) indicated in their comparative anatomy textbooks that the lumbosacral plexus was similar to that of the horse. McLeod (1958) gave an account of the lumbosacral plexus of the bovine species but based the terminology on that of the horse. The lumbosacral plexus was illustrated in the dissection guide by Peterson (1958). Habel (1955) discussed the root origins of the sciatic nerve based on the clinical evidence from man. A detailed account of the lumbosacral plexus of the dog was described by Miller (1952). May (1955) discussed the lumbosacral plexus of the sheep in his booklet on the anatomy of the sheep.

Williams (1947) and Roberts (1956) reported on contusions and injury to the pelvic nerves from the passage of the fetus and the paralysis caused by such damage was discussed by Frank (1953). Clinical case reports on posterior paralysis were reported by Saunders and Roberts (1950), Sakasegawa (1951), Fraser (1952) and Ramakrishnan and Aranthapadmanabhan (1953).

Worthman (1957) demonstrated the specific nerve paralysis of the dog.

OBSERVATIONS

The lumbosacral plexus was found to be composed of those nerves which supplied innervation to the pelvic viscera and the pelvic limb. The primary nerves of the plexus were the femoral, obturator, sciatic, cranial gluteal, caudal gluteal and pudendal nerves (Plate I).¹ Those of secondary importance were the inguinal, the lateral cutaneous femoral, the pelvic and the hemorrhoidal nerves. The latter nerves were placed in a secondary category either because of their relatively small size or because only a few of their fibers contributed to the innervation of the pelvic viscera and pelvic limb. The last four lumbar nerves and all of the sacral nerves were found to contribute to the lumbosacral plexus.

The pelvic splanchnic nerve and the hypogastric plexus were not included in the lumbosacral plexus. They did contribute to the sympathetic innervation of the pelvic viscera and the pelvic limb but the origin of their fibers from the central nervous system was mainly cranial to the third lumbar spinal nerve. The latter nerve was the most cranial root of the lumbosacral plexus.

The roots of the nerves of the lumbosacral plexus received a ramus communicans from the sympathetic nerve trunk. The rami to the fifth and sixth lumbar spinal nerves and the first and second sacral spinal nerves were the largest. The latter spinal nerves were the largest of the nerves of the lumbosacral region.

¹ All plates in Appendix.

The Inguinal Nerve

The radicular origin of the inguinal nerve was from the deep branches of the ventral branches of the third and fourth lumbar nerves (Table 2).¹ A root from the second lumbar nerve was found in 16 limbs. After emerging from their respective intervertebral foramina the roots passed caudolaterad and slightly ventrad between the psoas major and minor muscles (Plate II). The two roots continued on the ventral surface of the psoas major muscle beneath the parietal peritoneum in a plexiform manner. The two main branches from this plexus usually formed a loop around the circumflex iliac vessels and continued as the inguinal nerve. Two or three smaller branches were given off the plexus and were distributed to the inguinal portion of the internal abdominal oblique muscle as satellites of some of the branches of the circumflex iliac vessels. Branches were detached to the external cremaster muscle in the male.

The inguinal nerve continued as a common trunk on the ventral surface of the iliopsoas muscle in company with the proximal portion of the femoral vessels. It turned around the caudal border of the internal abdominal oblique muscle and entered the inguinal canal by passing between the latter muscle and the inguinal ligament. The common trunk of the inguinal nerve divided in the inguinal canal to form the cranial and caudal inguinal nerves which continued through the inguinal canal and were distributed to the mammary gland in the cow and to the scrotum in the bull. In both sexes they supplied some fibers to the skin of the medial proximal femoral region.

¹ All tables in Appendix.

The Lateral Cutaneous Femoral Nerve

The lateral cutaneous femoral nerve had its radicular origin from the superficial branches of the ventral branches of the third and fourth lumbar nerves (Table 2). The roots emerged from their respective intervertebral foramina and passed caudolaterad between the psoas major and minor muscles (Plate II). They emerged from the sublumbar region in the groove formed by the psoas major and minor muscles and continued caudolaterad on the ventral surface of the psoas major muscle. The two roots joined to form the lateral cutaneous femoral nerve.

The lateral cutaneous femoral nerve passed between the psoas major muscle and the circumflex iliac vessels, then turned laterad and ventrad through the origin of the internal abdominal oblique muscle in company with the caudal branch of the circumflex iliac vessels to reach the deep surface of the tensor fascia lata muscle. The nerve proceeded ventrad on the deep surface of the proximal half of the tensor fascia lata muscle and then turned around the cranial border of the latter muscle to become a cutaneous nerve. As the cutaneous nerve it supplied the skin of the craniolateral femoral and crural regions.

The Femoral Nerve

The femoral nerve was the most cranial of the primary nerves of the lumbosacral plexus. Its radicular origin was from the ventral branches of the fourth, fifth, and sixth lumbar spinal nerves (Table 3), (Plate I). The roots coursed caudolaterad for a distance of three centimeters before uniting to form the nerve. The femoral nerve had the most plexiform origin of the nerves of the lumbosacral plexus. This was due to the fact that the

branches to the iliopsoas muscle were given off principally from the roots.

The femoral nerve passed distad in a deep groove in the iliopsoas muscle formed medially by the iliacus muscle and laterally by the psoas major muscle (Plate III). The femoral nerve was covered in its proximal portion by that part of the iliacus muscle which originates from the body of the sixth lumbar vertebrae. Distally the groove became shallower and thus allowed the femoral nerve to come in contact with the lateral surface of the femoral artery which it accompanied. It disappeared with the cranial femoral vessels in the groove between the proximal portions of the rectus femoris and vastus medialis muscles. The main part of the femoral nerve supplied the muscles of the quadriceps femoris group. This part of the nerve constituted 50 per cent of the total nerve and originated entirely from the fifth and sixth lumbar spinal nerves. Most of the muscular branches to the iliopsoas muscle came directly from the roots of the femoral nerve rather than from the femoral nerve itself.

The saphenous nerve composed 25 per cent of the femoral nerve and originated from all three roots in most of the limbs (Table 4). It was given off the femoral nerve at the level of the origin of the sartorius muscle. It passed deep to the sartorius muscle, to which it supplied branches, and then emerged in the middle of the thigh region between the sartorius and the gracilis muscles (Plate III). It supplied branches to the skin of the medial femoral, crural and pes regions.

The pectineal branch of the femoral nerve was quite small, amounting to less than ten per cent of the parent nerve, and originated from the fourth and fifth lumbar nerves only (Table 4). It accompanied the deep femoral vessels to supply the pectineus muscle and the cranioventral aspect of the joint capsule of the hip joint (Plate III).

The Obturator Nerve

The obturator nerve originated from the ventral branches of the fifth and sixth lumbar nerves and usually had a very small root from the fourth lumbar nerve (Table 3). The fourth and fifth lumbar roots joined three centimeters from the intervertebral foramina and passed caudolaterad between the iliacus and psoas major muscles. The roots passed between the wing of the sacrum and the small segment of the iliacus muscle which originated from the body of the sixth lumbar vertebra. As they emerged they received the sixth lumbar root to form the obturator nerve (Plate I). The junction of the roots was just above the site where the iliolumbar vessels crossed the wing of the ilium. The latter vessels passed through the angle formed by the sixth lumbar root to the obturator nerve and the sixth lumbar root to the sciatic and gluteal nerves. The obturator nerve at the junction of its roots was located lateral to the internal iliac vessels and just below the most ventral part of the wing of the sacrum.

The obturator nerve then coursed distad on the medial surface of the shaft of the ilium dorsal to the tendon of insertion of the psoas minor muscle. It continued toward the cranial part of the obturator foramen through which it passed to innervate the adductor group of muscles of the thigh (Plate IV). This group was composed of the obturator internus, obturator externus, adductor, pectineus and gracilis muscles. The nerve also supplied twigs to the ventromedial aspect of the joint capsule of the hip joint.

The Cranial Gluteal Nerve

The cranial gluteal nerve originated from the ventral branches of the sixth lumbar and the first two sacral nerves (Table 5). The roots of

the cranial gluteal nerve did not form a common trunk because each root coursed distad as a separate branch and was distributed to the muscles of the cranial gluteal region (Plate V).

The root from the ventral branch of the sixth lumbar nerve was the largest of the three roots. It emerged from the sixth lumbar intervertebral foramen and coursed caudolaterad just below the wing of the sacrum and in common with the sixth lumbar root of the sciatic nerve to reach toward the greater sciatic foramen. It passed through the ventrolateral angle of the greater sciatic foramen with branches of the cranial gluteal artery and divided into three branches. The cranial branch entered the middle gluteal muscle and passed in a craniodorsal direction toward the tuber coxae. It was accompanied by branches of the cranial gluteal artery and gave numerous twigs to the accessory gluteal muscle and the coxal part of the middle gluteal muscle. The caudal branch passed caudally on the superficial surface of the deep gluteal muscle approximately two centimeters lateral to and parallel with the superior ischiatic spine. In some limbs it consisted of two distinct branches. Numerous twigs were given off the deep surface of the caudal branch to supply the deep gluteal muscle. Some of the twigs penetrated the muscle to supply innervation to the craniodorsal aspect of the joint capsule of the hip joint. Branches of the cranial gluteal artery accompanied the above nerve branches. The long lateral branch passed laterad between the accessory gluteal and the deep gluteal muscles and entered the intermuscular septum which projected laterally from the shaft of the ilium. It entered the deep surface of the tensor fascia lata muscle to which it was distributed. The long lateral branch was not accompanied by branches of the cranial gluteal artery.

The first sacral root of the cranial gluteal nerve emerged from the

first ventral sacral foramen and crossed the ventral surface of the sacrum in a ventrolateral direction. The point of sacral crossing was at the junction of the wing of the sacrum with the lateral part of the sacrum. The fibers in the first sacral root passed through the greater sciatic foramen at the middle of the greater sciatic notch and turned craniodorsad toward the crest of the ilium to enter the middle gluteal muscle. They were distributed principally to those muscle fibers which originated from the crest of the ilium. The first sacral root frequently detached a twig which joined the cranial branch of the sixth lumbar root (Plate V).

The root from the second sacral nerve was the smallest of the three roots and was absent or was not found in eight limbs (Table 5). It emerged through the second ventral sacral foramen and passed through the dorsal part of the greater sciatic foramen. After the root emerged from the greater sciatic foramen it entered the middle gluteal muscle and supplied that part of the muscle which originated from the tuber sacrale.

The Caudal Gluteal Nerve

The caudal gluteal nerve had the same roots of origin as the cranial gluteal nerve although the size of each respective root was not similar (Table 5). The root from the ventral branch of the sixth lumbar nerve was small and inconstant. The root from the ventral branch of the first sacral nerve was the largest root while the second sacral root was intermediate in size. The course of the roots was similar to the course of the same respective roots of the cranial gluteal nerve from their exit through the intervertebral foramina to their emergence through the greater sciatic foramen. As the roots emerged from the greater sciatic foramen they united

to form the caudal gluteal nerve. The fibers of the nerve were partially embedded in the epineurium of the sciatic nerve.

The caudal gluteal nerve passed caudally between the middle gluteal muscle laterally and the sacrosciatic ligament medially (Plate V). It gave a small branch to the vertebral head of the middle gluteal muscle and then divided into two branches which entered the deep surface of the vertebral head of the biceps femoris muscle. Each branch immediately subdivided into two or three branches and passed to all parts of the vertebral head of the biceps femoris muscle.

The Sciatic Nerve

The sciatic nerve was the largest nerve of the lumbosacral plexus. It originated from the ventral branches of the sixth lumbar and first and second sacral nerves (Table 6). A small root from the third sacral nerve was present in four limbs. The course of the roots from their exit through the intervertebral foramina to their emergence through the greater sciatic foramen was similar to that of the same respective roots of the cranial gluteal nerve. After emerging through the greater sciatic foramen the roots converged to form the sciatic nerve. The nerve continued distad in a caudolateral direction between the middle gluteal muscle laterally and the sacrosciatic ligament and deep gluteal muscle medially (Plate V). This part of the nerve was very broad and flat. At the caudal border of the deep and middle gluteal muscles the nerve turned downward to pass behind the hip joint. In this region it was related deeply by the gemellus and quadratus femoris muscles and superficially by the biceps femoris muscle. The sciatic nerve passed distad in the femoral region between the adductor and biceps femoris muscles and continued as the tibial nerve by passing between the two

heads of the gastocnemius muscle.

The principal branches of the sciatic nerve were the anastomosing branch to the pudendal nerve, the muscular branches, the caudal cutaneous crural nerve, the common peroneal nerve and the tibial nerve (Plate V). Because the sciatic nerve was so large and supplied so many muscle areas with different functional purposes the radicular origins of each of its branches were determined.

The anastomosing branch of the sciatic nerve to the pudendal nerve was present in all specimens except one (Table 7). It was the smallest branch of the sciatic nerve and in 70 per cent of the limbs it originated entirely from the ventral branch of the second sacral nerve. The sciatic nerve had a third sacral root in four limbs. In these limbs the anastomotic branch originated entirely from the third sacral root. The anastomotic branch passed caudally on the lateral surface of the sacrosciatic ligament and entered the lesser sciatic foramen to join the pudendal nerve (Plate V).

The muscular branches of the sciatic nerve consisted of a group of branches which were given off the caudal aspect of the sciatic nerve. Small muscular branches were given off the deep surface of the sciatic nerve a short distance cranial to the caudal border of the deep gluteal muscle (Plate V). They passed between the latter muscle and the gemellus muscle and were distributed to the gemellus and quadratus femoris muscles and also gave off small twigs to the caudal aspect of the joint capsule of the hip joint. Large muscular branches were given off the caudal border of the sciatic nerve near the level of the hip joint and passed caudodistad to the large muscles of the quarter (Plate V). One of these muscular branches was given off the sciatic nerve proximad to the small muscular

branches and entered the biceps femoris muscle at the level of the tuber ischii. The fibers then turned downward and were distributed to those muscle fibers which originated from the dorsal tubercle of the tuber ischii. Another branch of the large muscular branches passed caudally and distally to be distributed to the semimembranosus and semitendinosus muscles and the ischial head of the biceps femoris muscle. The radicular origins of the muscular branches of the sciatic nerve were similar to that of the sciatic nerve itself.

The common peroneal nerve had its apparent origin from the sciatic nerve below the level of the hip joint (Plate V). Separation of its fibers from the sciatic was quite easily accomplished as the epineurium did not bind it to the sciatic nerve. The actual origin of the common peroneal from the sciatic nerve was near the greater sciatic foramen. The two nerves passed distad in a common sheath until the common peroneal deviated laterad in the distal femoral region. It passed superficial to the lateral head of the gastrocnemius muscle under cover of the biceps femoris muscle. It innervated the digital extensor muscles and the flexor muscles of the hock and was continued as the superficial and deep peroneal nerves which supplied cutaneous innervation to the dorsolateral surface of the crus and pes. The common peroneal nerve had most of its radicular origin from the ventral branches of the sixth lumbar and first sacral nerves (Table 7).

The tibial nerve was the direct continuation of the sciatic nerve (Plate V). Its radicular origin was similar to that of the sciatic nerve except the sixth lumbar root was smaller (Table 6). The tibial nerve disappeared between the heads of the gastrocnemius muscle and supplied the digital flexor muscles, the extensor muscles of the hock and the popliteus muscle. It also supplied cutaneous innervation to the plantar surface of

the pes.

The Pudendal Nerve

The pudendal nerve originated from the ventral branches of the third and fourth sacral nerves with a root from the second sacral nerve in approximately half of the limbs (Table 8). The roots converged approximately five centimeters below the lateral part of the sacrum to form the pudendal nerve (Plate IV).

The pudendal nerve passed caudoventrally on the medial surface of the sacrosciatic ligament. It crossed the lesser sciatic foramen by passing between the sacrosciatic ligament and the medial and lateral coccygeal muscles. It gave off the proximal cutaneous branch which coursed through the fibers of the sacrosciatic ligament and turned downward at the caudal border of the sacrotuberous ligament near the attachment of the ligament to the tuber ischii. A distal cutaneous branch was given off distad to the proximal cutaneous branch. This branch passed caudally on the medial surface of the tuber ischii and turned downward at the ischial arch. The proximal and distal cutaneous nerves supplied the skin of the caudal femoral region.

As the pudendal nerve was traversing caudad within the pelvic cavity at the region of the lesser sciatic foramen, it received the anastomosing branch of the sciatic nerve (Plate IV). The anastomotic branch coursed caudad on the lateral surface of the sacrosciatic ligament and passed through the lesser sciatic foramen to join the pudendal nerve distad to the origin of the cutaneous branches of the pudendal nerve.

The pudendal nerve then continued caudomedially on the floor of the pelvis toward the ischial arch. In the cow it supplied branches to the

vestibule and labia of the vulva and terminated in the clitoris as the nervus clitoridis. A mammary branch turned downward at the ischial arch to supply the skin of the caudal surface of the mammary gland as far distad as the base of the caudal teat.

In the bull the pudendal nerve supplied the root of the penis and the ischiocavernosus, bulbocavernosus and retractor penis muscles. It then turned downward at the ischial arch to join its fellow of the opposite side and was continued as the dorsal nerve of the penis. The dorsal nerve passed cranial on the dorsal surface of the penis supplying branches to the body and glans of the penis.

The Pelvic Nerve

The pelvic nerve represented the sacral part of the craniosacral or parasympathetic part of the autonomic nervous system. It originated from the ventral branches of the third and fourth sacral nerves in common with the roots of origin of the pudendal nerve (Table 8) (Plates IV and VI). The roots of the pelvic nerve left the roots of the pudendal nerve approximately two centimeters after the roots emerged from the ventral sacral foramina. The roots converged to form the pelvic nerve.

The pelvic nerve immediately divided into branches which accompanied the hypogastric plexus and the urogenital artery. They were distributed in a very plexiform manner to the organs of the pelvic cavity.

The Hemorrhoidal Nerves

The hemorrhoidal nerves originated from the ventral branches of the fourth and fifth sacral nerves with a root from the third sacral nerve in 25 per cent of the limbs. The third and fourth sacral roots were common to

the third and fourth sacral roots of the pudendal nerve. The hemorrhoidal nerves passed caudally on the medial surface of the sacrosciatic ligament and were distributed to the terminal part of the rectum, the anus, the coccygeal muscles and the skin of the perineum (Plate IV). The course of the hemorrhoidal nerves was subject to much variation.

DISCUSSION

The lumbosacral plexus was composed of those nerves supplying the pelvic limb and the pelvic viscera (Plate VI). This was found to be in agreement with that reported by Miller (1952). Only the primary nerves of the lumbosacral plexus were considered to be the lumbosacral plexus by Sisson and Grossman (1953) and McLeod (1958). There was evidence that variations existed among the different breeds but specimens from some of the breeds were too limited to make a comparison.

The Inguinal and Lateral Cutaneous Femoral Nerves

The course and termination of the inguinal and lateral cutaneous femoral nerves were similar to that described by other investigators, St. Clair (1942), Habel (1955), and McLeod (1958). In this study the inguinal nerve originated mainly from the third lumbar nerve with only small roots from the second and fourth lumbar nerves (Table 2). The third lumbar root comprised 75 per cent of the inguinal nerve. The nerve originated entirely from the third lumbar root in two limbs. The second and fourth lumbar roots were absent in about one-third of the limbs but usually both roots were not absent in the same limb. They each contributed an average of one-eighth of the inguinal nerve. In those limbs where the second lumbar root was present its fibers did not usually pass through the inguinal canal with the inguinal

nerve. Instead they were distributed to the inguinal part of the internal abdominal oblique muscle along with some twigs from the third root. If the root constituted more than 25 per cent of the inguinal nerve, some of its fibers did descend through the inguinal canal.

St. Clair (1942) and Habel (1955) reported the origin of the inguinal nerve was from the third lumbar with smaller roots from the second and fourth lumbar nerves while McLeod (1958) reported that it came entirely from the deep branch of the third lumbar nerve.

The lateral cutaneous femoral nerve originated from the superficial branches of the ventral branches of the third and fourth lumbar nerves. The fourth lumbar root contributed an average of approximately 75 per cent of the fibers to the lateral cutaneous femoral nerve and in five limbs originated the entire nerve (Table 2). The third lumbar root was absent in five limbs. In limb number 21 a small root from the fifth lumbar nerve was demonstrated.

Habel (1955) reported that the lateral cutaneous femoral nerve was formed mostly by the lateral ventral branch of the third lumbar nerve with a contribution from the fourth lumbar nerve. McLeod (1958) described it as the superficial branch of the third lumbar nerve. May (1955) indicated that in sheep it arose from the fourth and fifth lumbar nerves with a small filament occasionally from the third lumbar nerve.

Neither the inguinal nerve nor the lateral cutaneous femoral nerve was found to be vulnerable to damage during parturition since their course did not extend caudally enough to reach the pelvic inlet or pelvic cavity.

The Femoral and Obturator Nerves

The femoral and obturator nerves had radicular origins from the ventral branches of the fourth, fifth and sixth lumbar nerves (Table 3). The fifth lumbar root constituted almost two-thirds the total size of each nerve and was the only root which was present in all the limbs examined. The sixth lumbar root usually constituted about one-fourth the total size of each nerve and was occasionally absent. The fourth lumbar root was usually small and was absent in five limbs. McLeod (1958) reported fifth and sixth lumbar roots while Roberts (1956) indicated only fourth and fifth lumbar roots for the origin of the obturator nerve.

The femoral nerve was not considered vulnerable to damage by the passage of the fetus through the pelvic canal because the femoral nerve did not pass caudal enough to enter the pelvic inlet. It was considered vulnerable in some dystocia cases of hip-lock where the tuber coxae of the fetus exerted pressure on the femoral nerve at the sacroiliac articulation. The psoas major muscle was between the nerve and the lumbar transverse processes and the iliacus muscle separated it from the wing of the sacrum. The latter muscle was quite thin at the cranial aspect of sacroiliac articulation where the femoral nerve crossed ventrolaterad over the joint (Plate I). The femoral nerve was also considered vulnerable to damage in the inguinal region by pressure exerted from a protruding osseous part of the fetus (Plate III). Frank (1953) reported that the femoral nerve was subject to damage from overstretching of the nerve due to kicking or extreme extension of the hip joint.

The obturator nerve was the most vulnerable to injury by the passing fetus. The nerve was most subject to damage at the ventral surface of the

sacrum and at the shaft of the ilium especially near the iliopubic junction (Plates I and IV). The iliopubic area was usually convex in the young heifers in comparison to the normal concavity of the pelvic inlet in adult cows.

The obturator nerve was reported by Williams (1947) to be vulnerable to damage as it passed through the obturator foramen. Since the obturator foramen was depressed below the level of the pelvic floor the nerve was not considered vulnerable at this site in the limbs examined. The obturator nerve supplied the adductor muscles of the thigh including the obturator internus muscle. This was in agreement with the previous findings of Peterson (1958). Habel (1955) and McLeod (1958) reported the internal obturator muscle was supplied by a branch of the sciatic nerve.

The Cranial and Caudal Gluteal Nerves

The gluteal nerves received their radicular origin from the ventral branches of the sixth lumbar and the first and second sacral nerves (Table 5) (Plate I). The sixth lumbar and first sacral roots were the main roots of the cranial gluteal while the sacral roots of the caudal gluteal nerve accounted for most of its fibers. McLeod (1958) and May (1955) failed to indicate the presence of the smallest root of each nerve while Habel (1955) did not report the radicular origin of the gluteal nerves. The roots of the cranial gluteal nerve did not form a common nerve trunk because each root coursed distad as a separate branch and innervated the muscles of the cranial gluteal region.

The cranial gluteal nerve supplied all the muscles which originated from the dorsolateral surface of the ilium (Plate V). These muscles included the middle, accessory and deep gluteal muscles and the tensor fascia

lata. The caudal gluteal nerve supplied the vertebral or sacral origins of the middle gluteal and biceps femoris (superficial gluteal) muscles (Plate V). McLeod (1958) reported an anastomotic branch to the pudendal nerve and a muscular branch to the ischial head of the biceps femoris muscle. In all the limbs examined in this study they were found to be branches of the sciatic nerve.

The sixth lumbar roots to the gluteal nerves were considered quite vulnerable to damage by the passage of the fetus because the roots were in contact with the wing of the sacrum for a distance of eight centimeters in the limbs from mature animals. The first sacral roots of the gluteal nerves crossed the ventral surface of the sacrum at the junction of the lateral part of the sacrum with the wing of the sacrum. The roots were in contact with bone for a distance of four centimeters in the limbs from adult animals and were also considered vulnerable to damage. The second sacral roots were not considered vulnerable since they were protected by the attachment of the sacrosciatic ligament. The second sacral nerve was caudal to the sacroiliac articulation and thus would not have to sustain the full pressure of the fetus at parturition time. Since parturition was accompanied by relaxation of the sacrosciatic ligament it would cause the sacrum to rotate upward and thus enlarge the pelvic canal.

The Sciatic Nerve

The sciatic nerve had its radicular origin from the ventral branches of the sixth lumbar and the first two sacral nerves (Table 6). The first sacral root was the largest and contributed about 50 per cent of the fibers while the sixth lumbar and the second sacral nerves each contributed about 25 per cent of the fibers to the sciatic nerve. A small third sacral root

was present in four limbs (Table 6).

The sciatic nerve gave off the anastomotic branch to the pudendal nerve. The anastomotic branch originated entirely from the second sacral nerve in 21 limbs. When a third sacral root of the sciatic nerve was present it supplied the fibers to the anastomotic branch. The course and termination of the anastomotic branch was in agreement with Habel (1956) and McLeod (1958) but the latter interpreted it to be a branch of the caudal gluteal nerve. May (1955) indicated that it was distributed to the internal obturator muscle in the sheep but this was not demonstratable in this study of the ox.

The muscular branches of the sciatic nerve supplied those muscles which originated from the ventrolateral surface of the ischium including the tuber ischii (Plate V). Although three muscular branches were present from a descriptive anatomical standpoint they could be divided into two groups from a functional anatomical standpoint. The small muscular branches supplied the small pelvic association muscles composed of the gemellus and quadratus femoris muscles. The large muscular branches supplied the muscles of the quarter composed of the ischial head of the biceps femoris, the semitendinosus and the semimembranosus muscles. The fibers of the muscular branches came from all three roots of the sciatic nerve and when a third sacral root was present it also contributed fibers to the muscular branches.

The common peroneal nerve had roots from the sixth lumbar and the first sacral nerves which contributed an average of almost 50 per cent each but there was considerable variation (Table 7). An occasional small root from the second sacral nerve was present. The common peroneal nerve supplied the dorsolateral muscles of the crural region and cutaneous innervation to the dorsolateral region of the crus and pes.

The tibial nerve had the same origin as the sciatic nerve but the comparative size of each root was different (Table 6). The sixth lumbar root was smaller and the sacral roots were larger than those of the sciatic nerve. The caudal cutaneous crural nerve was a separate branch of the sciatic nerve but was included with the tibial nerve since it originated from that portion of the sciatic nerve destined to become the tibial nerve (Plate V). The radicular origin of the caudal cutaneous crural nerve was included with the tibial nerve since the epineurium did not allow a good separation of the caudal cutaneous femoral nerve fibers from those of the tibial nerve.

The sciatic nerve and all of its branches were considered to be vulnerable to damage by the passage of the fetus during parturition. The course of their roots was similar to each other and to those of the gluteal nerves from their emergence from the intervertebral foramina to their passage through the greater sciatic foramen. The same criteria for assessing the vulnerability of the gluteal nerve was used on the sciatic nerve and its branches. The common peroneal nerve was the most vulnerable since its origin was primarily from the sixth lumbar nerve and the first sacral nerve. The muscular branches, the tibial nerve and the anastomotic branch were less vulnerable to damage in the order named.

No other investigators have reported the radicular origins of the branches of the sciatic nerve. Habel (1955) did infer, on the basis of clinical evidence from man, that the common peroneal came mostly from the sixth lumbar and the tibial and muscular branches came mostly from the sacral roots. This inference was not completely substantiated by the information obtained in this study (Tables 6 and 7).

The Pudental, Pelvic and Hemorrhoidal Nerves

The pudental nerve originated mainly from the ventral branches of the third and fourth sacral spinal nerves (Table 8). In approximately one-third of the limbs a second sacral root was present. The fourth sacral root was absent in one limb. Its average size in 29 limbs was 33.5 per cent of the pudental nerve.

Habel (1955) reported the same radicular origin for the pudental nerve but indicated that the fourth sacral root was only sometimes present. McLeod (1958) indicated the pudental nerve came from the third sacral nerve. In the sheep May (1955) found the origin to be from the second and third sacral nerves. Habel (1956) was first to report the pudental nerve receiving the anastomotic branch of the sciatic nerve but McLeod considered this branch to be coming from the caudal gluteal nerve. Larson (1953) and Roberts (1956) called the pudental nerve the internal pudental nerve which was found to have merit from the comparative neurology and angiology of the area.

The pelvic nerve represented the sacral part of the parasympathetic part of the autonomic nervous system. The roots from the third and fourth sacral nerves contributed an average of 50 per cent each to this nerve (Table 8). In only one limb were there any fibers originating from the second sacral nerve. The pelvic and pudental nerves have generally been considered to have the same origin.

The hemorrhoidal nerves originated from the fourth and fifth sacral nerves with an occasional root from the third sacral nerve. It was subject to considerable variations and in many limbs the middle hemorrhoidal nerve was combined with the pudental nerve. It was damaged by the necropsy

procedures in so many of the specimens that a table of its radicular origin was not presented.

The course and innervation of the pelvic, pudendal and hemorrhoidal nerves were in agreement with that described by other investigators, Habel (1955), McLeod (1958).

SUMMARY

The radicular origin of the nerves of the lumbosacral plexuses of thirty bovine limbs was described.

The radicular origin of the inguinal nerve was from the deep branches of the ventral branches of the third and fourth lumbar nerves while the lateral cutaneous femoral nerve originated from the superficial branches of the same nerves. The inguinal nerve had an additional root from the second lumbar nerve in more than half of the limbs.

The femoral and obturator nerves received their radicular origins primarily from the fifth and sixth lumbar nerves. The fourth lumbar roots were small and inconstant. They were not considered important from a functional anatomical standpoint. The femoral nerve was not affected by the normal passage of the fetus through the pelvic cavity during parturition because the nerve did not traverse the pelvic inlet. The femoral nerve was vulnerable to damage in those dystocia cases of hip-lock where the tuber coxae of the fetus caused undue pressure on the femoral nerve as it crossed caudoventrad below the sacroiliac articulation. The femoral nerve was also subject to pressure damage in the inguinal region. The obturator nerve was the most vulnerable to damage at parturition time because it coursed distad near the dorsal and lateral limits of the pelvic inlet. It was most subject to damage at the wing of the sacrum and the

shaft of the ilium near the iliopubic junction.

Two radicular origins of the cranial and caudal gluteal nerves were from the sixth lumbar and the first two sacral nerves, although the size of each root was not the same in the two nerves. The two most cranial roots were the main source of fibers for the cranial gluteal nerve. The sacral roots contributed most of the fibers to the caudal gluteal nerve. The cranial and caudal gluteal nerves supplied the muscles of the cranial and caudal gluteal region respectively. They did not emerge through the muscles to become cutaneous nerves. The cranial gluteal nerve was considered vulnerable to injury by the passing fetus but the caudal gluteal nerve was not.

The sciatic nerve was the largest of the nerves of the lumbosacral plexus. Its main root of origin was from the first sacral nerve with smaller roots from the sixth lumbar and first sacral nerves. The main branches of the sciatic nerve had similar roots of origin as the sciatic nerve but their comparative sizes were different. The common peroneal originated primarily from the sixth lumbar and first sacral nerves. The common peroneal nerve was considered vulnerable to damage because its main roots had to cross the wing of the sacrum where pressure could be exerted by the passing fetus. The muscular branches of the sciatic nerve and the tibial nerve were less vulnerable because most of their fibers originated from the sacral roots. The sacral roots were less affected by pressure because the sacrum can rotate upward to create a greater diameter of the pelvic cavity.

The pudendal and pelvic nerves originated primarily from the third and fourth sacral roots. The hemorrhoidal nerves came from the third,

fourth and fifth sacral nerves but were subject to considerable variation.

There was some evidence that a variation may exist in the radicular origin of the nerves of the lumbosacral plexus among the breeds of the bovine species.

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LITERATURE CITED

- Arnold, J. P. and R. L. Kitchell.
Experimental studies of the innervation of the abdominal wall
of cattle. *Am. J. of Vet. Res.* 18:229-240. 1957.
- Ellenberger, W. and H. Baum.
Handbuch der vergleichenden anatomie der haustiere.
Berlin: Springer-Verlag, 1943.
- Emerson, Mack A.
Studies on the macroscopic anatomy of the bovine udder and teat.
University of Penn. Bul. Vol. XLI:80-81, 1941.
- Frank, E. R.
Veterinary surgery notes. Minneapolis: Burgess, 1953.
- Fraser, A.
Some observations on postparturient paralysis in cows.
Vet. Record. 64:100. 1952.
- Habel, Robert D.
Guide to the dissection of the cow. Ann Arbor: Edwards Brothers,
1955.
- Habel, Robert E.
A source of error in the bovine pudendal nerve block.
J. Amer. Vet. Med. Assn. 128:16-17. 1956.
- Martin, P.
Lehrbuch der anatomie der haustiere. Stuttgart: Schickhardt and
Ebner, 1938.
- May, Neil D. S.
The anatomy of the sheep. Brisbane: Queensland, 1955.
- McLeod, W. M.
Bovine anatomy. Minneapolis: Burgess, 1958.
- Miller, Malcolm E.
Guide to the dissection of the dog. Ann Arbor: Edwards Brothers,
1952.
- Larson, Lester L.
The internal pudendal (pudic) nerve block for anesthesia of the
penis and relaxation of the retractor penis muscle. *J. Am. Vet.
Med. Assn.* 123:18-27. 1953.
- Nickel, R., A. Schummer and E. Seiferle.
Lehrbuch der anatomie der haustiere. Berlin: Parey, 1954.

- Peterson, D. R.
Laboratory guide to the dissection and study of the anatomy of the domestic ruminants. Published by author, Stillwater, Oklahoma, 1958.
- Ramakrishnan, M. and K. Aranthapadmanabhan.
A preliminary note on the investigation into bovine paralysis in South Kanara district, Madras State. Indian Vet. J. 29:291-303. 1953.
- Roberts, Stephen J.
Veterinary obstetrics and genital diseases. Ann Arbor: Edward Brothers, 1956.
- St. Clair, L. E.
The nerve supply to the bovine mammary gland. Amer. J. Vet. Res. 3:10-16. 1942.
- Sakasegawa, S.
Lumbar paralysis. N. Amer. Vet. 32:620. 1951.
- Saunders, L. Z. and S. J. Roberts.
A case of posterior paralysis in a cow. Cornell Vet. 40:283-286. 1950.
- Sisson, S., and J. D. Grossman.
The anatomy of the domestic animals. Saunders: Philadelphia, 1953.
- Williams, W. L.
Veterinary obstetrics. Published by author, Ithaca, New York, 1947.
- Worthman, R. P.
Demonstration of specific nerve paralysis in the dog. J. Amer. Vet. Med. Assn. 131:174-178. 1957.

Handwritten text, possibly a name or address, including the word "UNITED STATES".

APPENDIX

Table 1. The description of the specimens used in this study.

Limb number	Side	Breed	Age	Sex
1	Right	Holstein	18 months	Female
2	Left	Holstein	18 months	Female
3	Right	Jersey	10 months	Female
4	Left	Jersey	10 months	Female
5	Right	Holstein	8 months	Female
6	Left	Holstein	8 months	Female
7	Right	Hereford	48 months	Female
8	Left	Hereford	48 months	Female
9	Right	Jersey	3 months	Male
10	Left	Jersey	3 months	Male
11	Right	Guernsey	1 day	Female
12	Left	Guernsey	1 day	Female
13	Right	Hereford	48 months	Female
14	Left	Hereford	48 months	Female
15	Right	Jersey	1 month	Male
16	Left	Jersey	1 month	Male
17	Right	Shorthorn	12 months	Female
18	Left	Shorthorn	12 months	Female
19	Right	Hereford	72 months	Female
20	Left	Hereford	72 months	Female
21	Right	Jersey	24 months	Female
22	Left	Jersey	3 months	Male
23	Right	Jersey	6 months	Female
24	Left	Holstein	4 months	Female
25	Right	Hereford	14 months	Female
26	Left	Hereford- Holstein	4 months	Female
27	Right	Hereford	2 months	Male
28	Left	Hereford	Stillborn	Male
29	Right	Hereford	24 months	Female
30	Left	Angus	10 months	Female

Table 2. The radicular origin of the inguinal and the lateral cutaneous femoral nerves.

Limb number	Inguinal nerve			Lateral cutaneous femoral nerve		
	*L2	L3	L4	L3	L4	L5
1	10	85	5	20	80	0
2	15	80	5	25	75	0
3	0	70	30	0	100	0
4	0	75	25	0	100	0
5	15	80	5	30	70	0
6	20	70	10	25	75	0
7**						
8**						
9	15	85	0	40	60	0
10	20	80	0	35	65	0
11	0	75	25	0	100	0
12	0	65	35	0	100	0
13	5	70	25	30	70	0
14	0	75	25	25	75	0
15	10	80	10	20	80	0
16	10	85	5	25	75	0
17	20	70	10	35	65	0
18	25	70	5	30	70	0
19	10	75	15	25	75	0
20	15	70	15	20	80	0
21	0	65	35	25	65	10
22	10	80	10	20	80	0
23**						
24	0	100	0	35	65	0
25	0	70	30	0	100	0
26	35	65	0	30	70	0
27	40	60	0	15	35	0
28	20	80	0	65	35	0
29	0	100	0	35	65	0
30	35	65	0	90	10	0
Average						
Per cent	12.2	75.8	12.0	25.9	73.7	0.4

*L designates lumbar spinal root percentage.

** incised during necropsy examination.

Table 3. The radicular origin of the femoral and the obturator nerves.

Limb number	Femoral nerve			Obturator nerve		
	*L4	L5	L6	L4	L5	L6
1	10	55	35	2	65	33
2	8	50	42	3	65	32
3	0	55	45	0	50	50
4	2	55	43	0	55	45
5	10	60	30	3	65	32
6	10	55	35	2	70	28
7	5	55	40	0	30	70
8	5	60	35	0	35	65
9	5	80	15	2	78	20
10	10	75	15	5	75	20
11	5	45	50	3	57	40
12	3	37	60	2	55	43
13	20	70	10	7	68	25
14	25	65	10	5	75	20
15	5	75	20	5	65	30
16	10	65	25	5	65	30
17	10	75	15	5	90	5
18	10	70	20	5	85	10
19**	22	60	15	5	80	15
20	25	65	10	5	75	20
21	3	50	47	2	50	48
22	5	75	20	5	65	30
23	5	70	25	2	63	35
24	17	70	13	3	72	25
25	3	60	37	0	50	50
26	20	80	0	8	75	17
27	12	80	8	2	90	8
28	10	60	30	2	70	28
29	5	50	45	2	50	48
30	20	80	0	20	80	0
Average						
Per cent	10.0	63.4	26.5	3.7	65.6	30.7

*L designates lumbar spinal root percentage.

** three per cent of the femoral nerve originated from L3.

Table 4. The radicular origin of the *branches of the femoral nerve.

Limb number	Saphenous branch			Pectineal branch		Quadriceps branch	
	**L4	L5	L6	L4	L5	L5	L6
1	25	75	0	10	90	20	80
2	15	85	0	10	90	25	75
3	0	70	30	0	100	40	60
4	0	65	35	0	100	45	55
5	20	75	5	15	85	35	65
6	15	80	5	10	90	30	70
7	10	65	25	0	100	20	80
8	15	85	0	40	60	35	65
9	45	50	5	40	60	70	30
10	50	45	5	30	70	75	25
11	5	50	45	35	65	40	60
12	5	60	35	30	70	40	60
13	25	65	10	50	50	70	30
14	20	75	5	50	50	75	25
15	10	50	40	40	60	60	40
16	10	55	35	30	70	55	45
17	25	65	10	10	90	45	55
18	30	50	20	10	90	40	60
19	30	65	5	60	40	80	20
20	25	70	5	60	40	80	20
21	5	65	30	10	90	45	55
22	10	50	40	40	60	60	40
23***							
24	35	65	0	50	50	40	60
25	5	65	30	10	90	45	55
26	15	85	0	80	20	100	0
27	40	60	0	30	70	100	0
28	10	90	0	40	60	50	50
29	30	70	0	60	40	40	60
30	40	60	0	100	0	100	0
Average Per cent	19.7	65.8	14.5	32.8	67.2	53.7	46.3

* Since the iliopsoas branches were derived from the roots of the femoral nerve, their radicular origin was not computed.

** L designates lumbar spinal root percentage.

*** Branches destroyed during necropsy examination.

Table 5. The radicular origin of the cranial and the caudal gluteal nerves.

Limb number	Cranial Gluteal nerve			Caudal Gluteal nerve		
	*L6	S1	S2	L6	S1	S2
1	50	35	15	3	57	40
2	60	30	10	2	60	38
3	60	25	15	20	20	60
4	55	25	20	20	35	45
5	65	25	10	0	60	40
6	80	15	5	0	60	40
7	50	50	0	0	60	40
8	45	50	5	0	80	20
9	45	40	15	5	65	30
10	50	40	10	3	62	35
11	45	45	10	0	55	45
12	45	50	5	0	55	45
13	60	20	20	10	75	15
14	55	25	20	10	70	20
15	55	30	15	4	55	42
16	60	30	10	2	60	38
17	45	55	0	5	75	20
18	40	60	0	5	65	30
19	65	20	15	25	65	10
20	65	25	10	20	65	15
21	60	25	15	15	25	60
22	55	30	15	4	55	41
23	40	60	0	0	95	5
24	55	45	0	3	52	45
25	60	40	0	0	70	30
26	80	20	0	10	60	30
27	85	5	10	10	50	40
28	60	30	10	5	30	65
29	70	30	0	5	50	45
30	67	30	3	15	45	40
Average						
Per cent	57.6	33.7	8.7	6.7	57.7	35.6

*L and S designates lumbar and sacral spinal root percentage.

Table 6. The radicular origin of the sciatic and the *tibial nerves.

Limb number	Sciatic nerve			Tibial nerve		
	**L6	S1	S2	L6	S1	S2
1	20	40	40	3	50	47
2	20	35	45	3	52	45
3	20	50	30	5	50	45
4	20	50	30	5	45	50
5	15	45	40	20	50	30
6	20	45	35	15	60	25
7***	10	40	40	0	40	60
8***	15	40	35	40	60	0
9	25	55	20	15	60	25
10	20	55	25	10	65	25
11	15	60	25	5	60	35
12	20	50	30	5	65	30
13	30	50	20	25	55	20
14	25	55	20	15	60	25
15	30	50	20	15	70	15
16	20	55	25	5	85	10
17	35	40	25	20	60	20
18	35	40	25	25	60	15
19	25	55	20	20	60	20
20	30	50	20	35	55	20
21	18	60	22	2	58	40
22	30	50	20	15	70	15
23	25	40	35	0	55	45
24	30	45	25	15	75	10
25***	20	40	30	5	25	70
26	35	45	20	30	50	20
27	30	50	20	10	75	15
28	20	40	40	15	55	30
29***	20	40	35	3	57	40
30	35	45	20	15	75	10
Average						
Per cent	23.8	47.2	27.9	11.5	58.1	30.4

* The tibial nerve was the continuation of the sciatic nerve and its radicular origin included the caudal cutaneous crural nerve.

** L and S designates lumbar and sacral spinal root percentage.

*** These limbs had a third sacral root to the sciatic nerve.

Table 7. The radicular origin of the branches of the sciatic nerve.

Limb number	Common peroneal			Muscular			Anastomotic	
	branch			branches			branch	
	*L6	S1	S2	L6	S1	S2	S1	S2
1	35	63	2	25	20	55	0	100
2	40	58	2	30	20	50	0	100
3	32	65	3	20	20	60	0	100
4	35	60	5	20	25	55	0	100
5	30	68	2	30	20	50	0	100
6	30	67	3	25	15	60	0	100
7**	60	40	0	0	35	50	0	0
8**	40	60	0	0	45	40	0	0
9	65	35	0	30	30	40	0	100
10	60	40	0	25	35	40	0	100
11	35	63	2	30	25	45	0	100
12	37	60	3	30	20	50	0	100
13	60	40	0	25	40	35	10	90
14	65	35	0	25	45	30	10	90
15	55	45	0	30	30	40	10	90
16	55	45	0	20	30	50	0	100
17	70	30	0	50	25	25	0	100
18	70	30	0	45	25	30	0	100
19	70	28	2	20	35	45	0	100
20	65	32	3	25	25	50	10	90
21	40	58	2	15	25	60	0	100
22	55	45	0	30	30	40	0	100
23	60	40	0	0	60	40	0	100
24	55	43	2	35	35	30	0	100
25**	25	75	0	20	40	25	0	0
26	60	40	0	40	40	20	0	100
27	65	35	0	30	30	40	0	100
28***	50	48	2	20	25	55		
29**	35	60	5	5	45	35	0	0
30	60	30	10	40	35	25	0	100
Average								
Per cent	50.5	47.9	1.6	24.7	31.0	42.3	1.4	84.8

* Since the iliopsoas branches were derived from the roots of the femoral nerve, their radicular origin was not computed.

** L designates lumbar spinal root percentage.

*** Branches destroyed during necropsy examination.

Table 8. The radicular origin of the pudendal and the pelvic nerves.

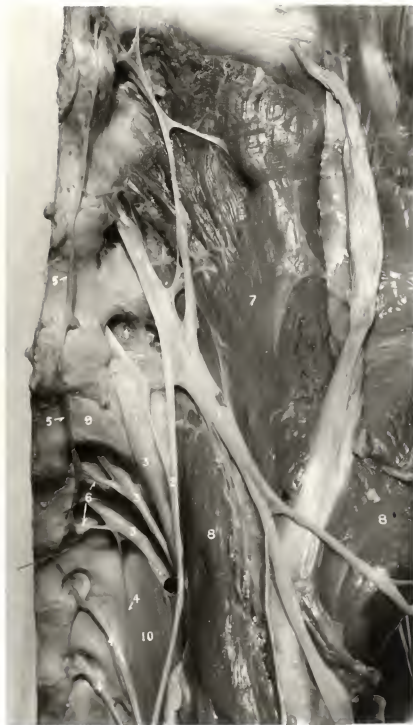
Limb number	Pudendal nerve			Pelvic nerve		
	*S2	S3	S4	S2	S3	S4
1	0	75	25	0	45	55
2	0	75	25	0	45	55
3	0	60	40	0	40	60
4	0	65	35	0	45	55
5	0	75	25	0	40	60
6	0	80	20	0	45	55
7	0	50	50	0	50	50
8	0	50	50	0	45	55
9	15	55	30	5	35	60
10	10	65	25	4	38	58
11	5	60	35	0	50	50
12	5	60	35	0	50	50
13	15	60	25	0	75	25
14	15	60	25	0	65	35
15	0	65	35	0	35	65
16	0	70	30	0	45	55
17	0	20	80	0	35	65
18	0	15	85	0	35	65
19	10	65	25	0	75	25
20	10	65	25	0	65	35
21	0	65	35	0	50	50
22	0	65	35	0	35	65
23	5	60	35	0	40	60
24	0	85	15	0	80	20
25	0	55	45	0	45	55
26	30	70	0	0	65	35
27	20	50	30	0	75	25
28	0	70	30	0	60	40
29	0	60	40	0	50	50
30	20	65	15	0	60	40
Average						
Per cent	5.3	61.2	33.5	0.3	50.6	49.1

* S designates sacral spinal root percentage.

EXPLANATION OF PLATE I

The ventral view of the lumbosacral region showing the radicular origin of the primary nerves of the lumbosacral plexus. 1, Femoral nerve with its fourth, fifth and sixth lumbar roots; 2, obturator nerve with its fourth, fifth and sixth lumbar roots; 3, sixth lumbar and first and second sacral roots of the cranial and caudal gluteal nerves and the sciatic nerve; 4, second, third and fourth sacral roots of the pudendal nerve; 5, sympathetic nerve trunk; 6, rami communicantes; 7, psoas major muscle; 8, iliacus muscle; 9, wing of the sacrum; 10, sacrosacral ligament.

PLATE I



EXPLANATION OF PLATE II

The ventral view of the lumbosacral region showing the radicular origin and the course of the inguinal and lateral cutaneous femoral nerves. 1, Third and fourth lumbar roots of the inguinal nerve; 2, branches of the inguinal nerve to the internal abdominal oblique muscle; 3, inguinal nerve in the inguinal canal; 4, third and fourth lumbar roots of the lateral cutaneous femoral nerve; 5, lateral cutaneous femoral nerve piercing the internal abdominal oblique muscle; 6, psoas major muscle; 7, psoas minor muscle (the right psoas minor muscle was cut and reflected); 8, internal abdominal oblique muscle; 9, inguinal ligament; 10, circumflex iliac vessels.

PLATE II



EXPLANATION OF PLATE III

The ventral view of the right sublumber and inguinal regions showing the origin and course of the femoral nerve. 1, Femoral nerve showing fifth and sixth lumbar roots; 2, saphenous branch supplying muscular branches to the sartorius muscle; 3, cutaneous branches of the saphenous nerve; 4, pectineal branch; 5, continuation of the femoral nerve supplying the quadriceps femoris muscles; 6, lateral cutaneous femoral nerve; 7 inguinal nerve; 8, psoas major muscle; 9, psoas minor muscle; 10, iliacus muscle; 11, sartorius muscle; 12, pectineus muscle; 13, vastus medialis muscle; 14, rectus femoris muscle; 15, tensor fascia lata muscle; 16, abdominal wall (reflected).

PLATE III



EXPLANATION OF PLATE IV

The medial view of the pelvic and thigh regions showing the origin, course and termination of the pudendal, pelvic and hemorrhoidal nerves and the course and termination of the obturator nerve. 1, Obturator nerve; 2, muscular branches of the obturator nerve; 3, sixth lumbar and first and second sacral roots of the cranial and caudal gluteal and the sciatic nerve; 4, third and fourth sacral roots of the pudendal nerve; 5, proximal cutaneous branch of the pudendal nerve; 6, distal cutaneous branch of the pudendal nerve; 7, anastomotic branch of the sciatic nerve to the pudendal nerve; 8, continuation of the pudendal nerve; 9, third and fourth sacral roots of the pelvic nerve; 10, middle hemorrhoidal nerve; 11, caudal hemorrhoidal nerve; 12, internal obturator muscle; 13, external obturator muscle; 14, adductor muscle; 15, pectineus muscle; 16, gracilis muscle (reflected); 17, medial coccygeal muscle; 18, lateral coccygeal muscle; 19, shaft of the ilium; 20, iliopubic junction; 21, internal iliac artery; 22, sacrosiatic ligament.

PLATE IV



EXPLANATION OF PLATE V

The lateral view of the pelvic and thigh regions showing the origin, the course and the termination of the cranial gluteal nerve, the caudal gluteal nerve and the sciatic nerve. 1, Sixth lumbar root of the cranial gluteal nerve with its cranial, lateral and caudal branches; 2, first sacral root of the cranial gluteal nerve; 3, caudal gluteal nerve with roots from the sixth lumbar and the first two sacral nerves; 4, muscular branch of the caudal gluteal nerve to the vertebral part of the middle gluteal muscle; 5, muscular branches to the vertebral head of the biceps femoris (gluteus superficialis) muscle; 6, sciatic nerve with its origin from the sixth lumbar and the first two sacral roots and showing its course in the gluteal and femoral region; 7, anastomotic branch of the sciatic nerve to the pudendal nerve; 8, small muscular branches of the sciatic nerve; 9, large muscular branches of the sciatic nerve; 10, caudal cutaneous crural nerve; 11, common peroneal nerve; 12, tibial nerve; 13, tensor fascia lata muscle; 14, middle gluteal muscle (reflected); 15, accessory gluteal muscle; 16, deep gluteal muscle; 17, vertebral head of the biceps femoris (gluteus superficialis) muscle (reflected); 18, gemellus muscle; 19, quadratus femoris muscle; 20, ischial head of the biceps femoris muscle (reflected); 21, semitendinosus muscle; 22, semimembranosus muscle; 23, gastrocnemius muscle; 24, adductor muscle; 25, vastus lateralis muscle; 26, cranial gluteal vessels; 27, caudal gluteal vessels; 28, deep femoral vessels; 29, sacrosiatic ligament; 30, greater sciatic foramen; 31, lesser sciatic foramen; 32, greater trochanter; 33, tuber coxae.

PLATE V



EXPLANATION OF PLATE VI

The ventral view of the lumbosacral region showing some of the nerves of the lumbosacral plexus and their relation to the vessels, muscles and osseous structures of the area. 1, Psoas minor muscle; 2, psoas major muscle; 3, lateral cutaneous femoral nerve; 4, inguinal nerve; 5, inguinal ligament; 6, internal abdominal oblique muscle; 7, external iliac vessels; 8, circumflex iliac vessels; 9, femoral vessels; 10, pubofemoral vessels; 11, deep femoral vessels; 12, pudendoepigastric artery; 13, external pudendal artery; 14, caudal deep epigastric artery; 15, femoral nerve; 16, deep inguinal lymph node; 17, internal iliac lymph node; 18, wing of the sacrum; 19, middle sacral artery; 20, internal iliac vessels (stump near origin was umbilical-middle uterine artery); 21, sixth lumbar and first and second sacral roots of the cranial and caudal gluteal nerves and the sciatic nerve; 22, cranial gluteal vessels; 23, urogenital vessels; 24, iliolumbar vessels; 25, sympathetic nerve trunk; 26, obturator nerve; 27, third and fourth sacral roots of the pudendal and pelvic nerves; 28, pudendal nerve; 29, pelvic nerve; 30, pelvic viscera (reflected caudad).

PLATE VI



THE RADICULAR ORIGIN OF THE NERVES OF THE LUMBOSACRAL
PLEXUS OF THE BOS TAURUS

by

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Limited research on the radicular origin of the lumbosacral plexus of the ox has been done because the ox has the same vertebral formula as the horse and it has been assumed by anatomists that the root origins in the two species were the same. This study was undertaken because a need existed for more complete information concerning the lumbosacral plexus of the ox. The fetus of the bovine species is very large at birth and during parturition it frequently injures some of the nerves of the lumbosacral plexus.

Thirty limbs, selected at random from animals submitted to the Department of Pathology for necropsy, were used in this study. The necropsy procedures were altered to permit the proper preparation of the specimens for study. Some of the specimens were preserved and the arteries injected to show the relationships of the nerves of the lumbosacral plexus. Special dissections were made to determine the radicular origin of each nerve.

The radicular origin of some of the nerves of the lumbosacral plexus was different from that reported in the literature. The inguinal and lateral cutaneous nerves varied considerably in their origins. The radicular origins of the femoral and obturator nerves showed a minimum of variation. The radicular origins of the gluteal nerves were from the sixth lumbar and the first two sacral nerves. These root origins were more extensive than had been previously reported. The course and termination of the caudal gluteal nerve was different from that previously reported. The sciatic nerve was the largest nerve and its origin conformed to that recorded in the literature. The radicular origins of the major branches of the sciatic nerve had never been reported for the bovine species and therefore they were computed and reported in this study. The radicular

origins of the pudendal, pelvic and hemorrhoidal nerves were in general agreement with other anatomists' findings.

The obturator, common peroneal and the cranial gluteal nerves were considered to be the most vulnerable to injury by the passage of the fetus through the pelvic canal during parturition. All of these nerves had major roots from the sixth lumbar nerve. This root was in contact with the wing of the sacrum for a distance of eight centimeters. The obturator nerve was also in contact with the shaft of the ilium. The femoral nerve was vulnerable to damage in those dystocia cases of hip-lock where the tuber coxae of the fetus caused undue pressure on the femoral nerve as it crossed caudoventrad below the sacroiliac articulation. It was also vulnerable to damage in the inguinal region.

There was some evidence that a variation may exist in the radicular origin of the nerves of the lumbosacral plexus among the breeds of the bovine species. This may point to an increased susceptibility to specific paralyzes among the various breeds.