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Innervation of the Forearm and Foot of the Domestic Pig

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INTRODUCTION

In order to accomplish various nerve blocks to perform satisfactory surgery a comprehensive knowledge about the innervation of the forearm and foot of the domestic pig is of prime importance. This study will also enable us to have a better understanding of the domestic species differences, if any.

Very little information, to date, is available in the literature, especially in English, on the nerve supply to the appendages of the pig, although the pig is frequently used as an experimental animal in various research institutions around the country and abroad. With these objectives in mind, this investigation has been undertaken.

REVIEW OF LITERATURE

The nerve supply of the forelimb and foot of the domestic pig has been described in standard anatomical textbooks.^{2-5,8-10,14,16} There are also a few articles relative to the innervation of these regions.^{1,6,11-13,15} A detailed literature review will be incorporated in the discussion.

MATERIAL AND METHODS

Ten forelimbs of the pig were dissected for this investigation. The animals were sacrificed in the Department of Veterinary Anatomy, College of Veterinary Medicine, Iowa State University, Ames, Iowa, between June, 1964, and June, 1966. Breed, age, sex and body weight of the animals were not considered in this study.

The animals were anesthetized with pentobarbitol sodium and exsanguinated via a canula from the right carotid artery. At times, dissection was accomplished on fresh specimens. When embalmed speci-

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mens were used, the following embalming solution was employed: isopropyl alcohol, 60% ; formalin, 4% ; phenol, 6% ; corn syrup, 2.5% ; and water, 27.5% .

RESULTS

The innervation of the forearm, or antebrachium, and foot, or manus, in the domestic pig is accomplished by:

1. The N. ulnaris,
2. The N. medianus (including the Ramus musculocutaneus, which, in reality, is the Ramus muscularis distalis n. musculocutanei),
3. The N. radialis, and
4. The N. cutaneus antebrachii cranialis n. axillaris.

I. N. ulnaris (Figs. 1, 2)

The ulnar nerve, in the pig, disassociated from the median nerve (N. medianus) at the level of a transverse plane passing through the medial tuberosity at the proximal extremity of the humerus.

Within the proximal half of the arm (usually one inch below its separation from the median nerve) it gave off, cranially, the caudal cutaneous nerve of the forearm (N. cutaneus antebrachii caudalis) which descended distally in front of the ulnar nerve. At a transverse plane through the point of the elbow it split into two branches. The cranial branch soon split again and ramified in the fascia and skin approximately half-way down on the medial aspect of the forearm. The caudal branch coursed somewhat backward and furnished the fascia and skin on the proximal third of the caudal aspect of the forearm.

The ulnar nerve stretched caudodistally and was related laterally to the medial head of the M. triceps brachii. About half an inch above the olecranon process of the ulna, it detached a twig of considerable size, caudally, which soon split into several filaments to innervate the ulnar head of the M. flexor carpi ulnaris and the ulnar head of the M. flexor digitorum (digitalis) profundus. The main trunk extended beneath the two heads of the M. flexor carpi ulnaris and, about half an inch below the point of the elbow, released two twigs almost at the same place. The caudal twig supplied the ulnar head of the M. flexor

digitorum (digitalis) profundus, while the cranial twig was destined to innervate the belly of the M. flexor carpi ulnaris, the M. flexor digitorum (digitalis) superficialis and the humeral head of the M. flexor digitorum (digitalis) profundus. The ulnar nerve continued distally under the strong deep fascia of the forearm and, near the middle of the same region, divided into a dorsal and a palmar branch.

The dorsal branch (Ramus dorsalis n. ulnaris) of the ulnar nerve, following its separation from the palmar branch (Ramus palmaris n. ulnaris) near the middle of the caudal aspect of the forearm, coursed along the caudolateral aspect of the forearm and furnished twigs to the fascia and skin of the region. The main branch continued distally and, near the carpus, divided into a medial and a lateral branch.

The lateral branch (Ramus lateralis) of the Ramus dorsalis n. ulnaris continued distally as the dorsal proper digital nerve (N. digiti V dorsalis proprius) to the 5th digit. The medial branch (Ramus medialis) joined the lateral branch (Ramus lateralis) of the N. digitalis dorsalis communis III at a variable level along the dorsal surface of the metacarpus to form the N. digitalis dorsalis communis IV. This combined nerve trunk finally split into two dorsal proper digital nerves (Nn. digitales IV et V dorsales proprii) of the 4th and 5th digits.

The palmar branch (Ramus palmaris n. ulnaris) of the ulnar nerve ran in a groove bounded laterally by the ulnar head of the M. flexor digitorum (digitalis) profundus and medially by the M. flexor carpi ulnaris. Slightly below its separation from the dorsal branch (Ramus dorsalis n. ulnaris) the palmar branch released a slender twig to supply the M. flexor carpi ulnaris. Near the accessory carpal bone it coursed along the deep face of the tendon of insertion of the preceding muscle and was deeply related to the M. flexor digitorum (digitalis) profundus. It descended medial to the accessory carpal bone, between the M. flexor carpi ulnaris and the M. flexor digitorum (digitalis) superficialis. It accompanied the lateral face of the tendon of the latter muscle distally. A little

above the middle of the metacarpus it gave off a twig (*Ramus profundus*) which coursed somewhat craniodistally along the lateral aspect of the tendon of the *M. flexor digitorum (digitalis) profundus* and was entirely expended within the *Mm. interossei*. The superficial branch (*Ramus superficialis*) of the *Ramus palmaris n. ulnaris* continued distally and, near the fetlock joint, divided into a medial and a lateral branch.

The lateral branch (*Ramus lateralis*) of the *Ramus superficialis* continued as the palmar proper digital nerve (*N. digiti V palmaris proprius*) along the palmar aspect of the 5th digit. The medial branch (*Ramus medialis*), somewhat deeply situated, furnished a few twigs to the flexors, adductors and abductors of the lateral accessory digit (5th digit) and descended along the opposed surface of the 4th digit as the palmar proper digital nerve (*N. digiti IV palmaris proprius*).

II. *N. medianus* (Fig. 2)

About half an inch above the level of the point of the elbow, the *Ramus muscularis distalis n. musculocutanei* separated cranially from the median nerve and dipped behind the *M. biceps brachii*. Soon it divided into a muscular and a cutaneous branch. The muscular branch, the stronger of the two, split again and was expended inside the *M. brachialis*. The cutaneous branch (*N. cutaneus antebra- chii medialis*) emerged between the *M. biceps brachii*, medially, and the *M. brachiocephalicus*, laterally, and finally innervated the fascia and skin on the dorso-medial aspect of the proximal third of the forearm.

The median nerve coursed along the caudal aspect of the *M. biceps brachii* and obliquely passed under the *M. pronator teres* to which it furnished a twig. Beneath the deep face of the *M. flexor carpi radialis*, it gave off two twigs caudally. One twig was destined to supply the previously mentioned muscle, while the other innervated the *M. flexor digitorum (digitalis) superficialis* and the humeral and radial heads of the *M. flexor digitorum (digitalis) profundus*. The main trunk stretched distally and was related laterally

to the *M. flexor digitorum (digitalis) profundus* and medially to the *M. flexor carpi radialis*. Near the middle of the forearm the median nerve detached a slender twig, cranially, which extended downward and somewhat forward, medial to the insertion of the *M. flexor carpi radialis* and ultimately ramified in the fascia and skin on the medial aspect of the carpus. The median nerve continued distally between the tendons of the *Mm. flexor digitorum (digitalis) superficialis* and *profundus*. Slightly below the carpus, the median nerve divided into medial and lateral palmar nerves. The medial palmar nerve (*N. palmaris medialis*), near the middle of the metacarpus, detached a branch medially (*Ramus medialis*) which released a few twigs to the flexors, adductors and abductors of the medial accessory digit (2nd digit) and continued as the proper palmar digital nerve (*N. digiti II palmaris proprius*) along the palmaromedial aspect of the 2nd digit. Later, the medial palmar nerve continued as the *N. digitalis palmaris communis II* which soon divided into two palmar proper digital nerves (*Nn. digitales II et III palmares proprii*) of the 2nd and 3rd digits.

The lateral palmar nerve (*N. palmaris lateralis*) of the median nerve extended distally as the *N. digitalis palmaris communis III* and, below the fetlock joint, released a branch laterally (*Ramus lateralis*) which continued as the palmar proper digital nerve (*N. digiti V palmaris proprius*) of the 5th digit, while its continuation divided into two palmar proper digital nerves (*Nn. digitales III et IV palmares proprii*) of the 3rd and 4th digits.

III. *N. radialis* (Fig. 1)

Close to the lateral epicondyle of the humerus and deeply situated under the *M. extensor carpi radialis*, the radial nerve divided into a superficial and a deep branch.

The superficial branch (*Ramus superficialis*) of the radial nerve, while coursing between the *M. brachialis* and *M. extensor carpi radialis*, detached a very delicate cutaneous branch from the cranial aspect which, at first, pierced the lateral head of the *M. triceps brachii* and finally disap-

Figure 1. Nerves of Distal Part of Right Forelimb of Pig; Dorsal View (Schematic)

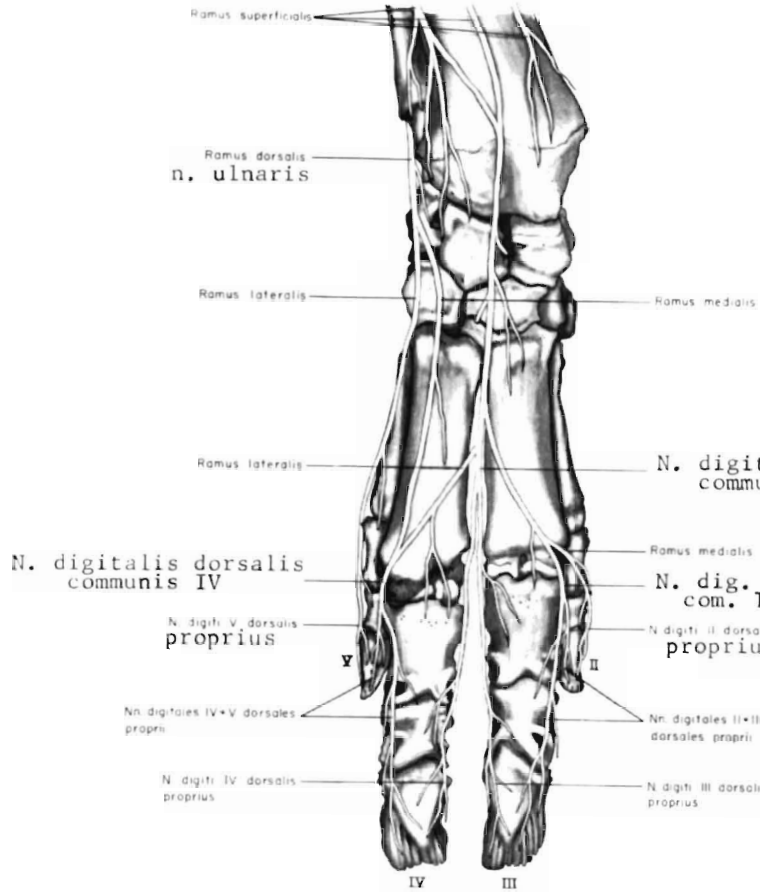
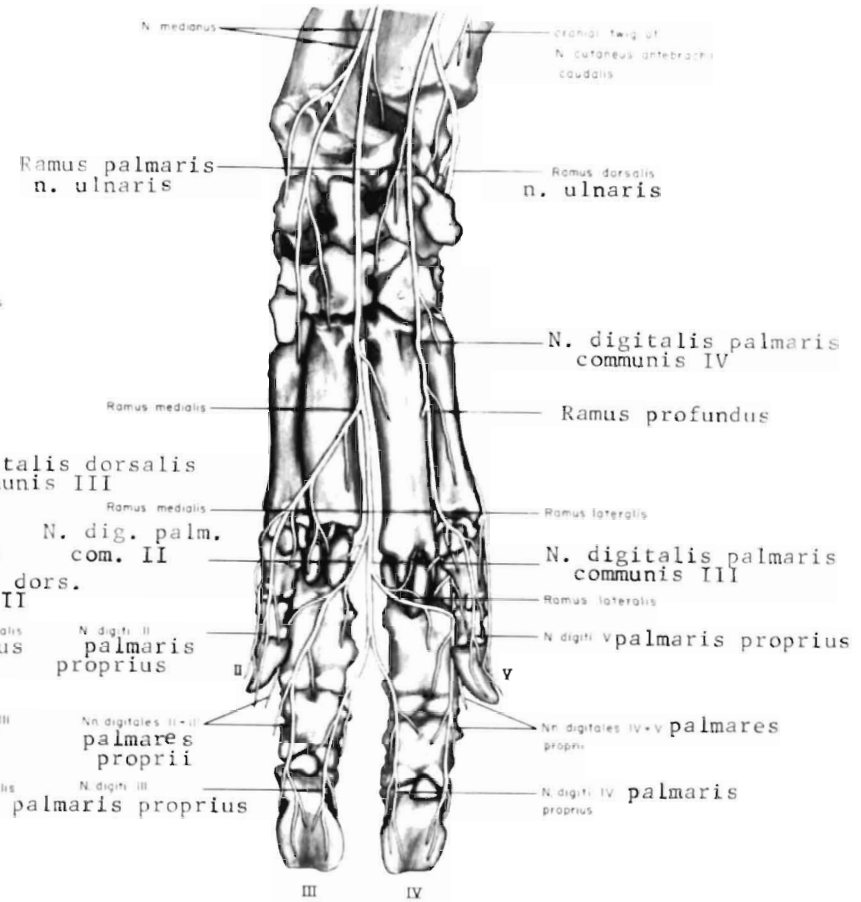


Figure 2. Nerves of Distal Part of Right Forelimb of Pig; Palmar View (Schematic)



peared in the skin around the distal end of the humerus and adjacent dorsal surface of the elbow joint. Close to the preceding branch it released a second, slender branch from the cranial aspect which was directed downward and forward and, after repeated branching, ramified in the fascia and skin in front of the elbow joint and about half-way down the dorsolateral aspect of the forearm. About an inch below it detached the third branch from the caudal aspect which accompanied the main trunk while emerging between the M. brachialis and M. pectoralis transversus, medially, and the M. extensor carpi radialis, laterally. It stretched downward along the medial face of the latter muscle, innervated the fascia and skin of the dorso-medial aspect of the forearm and, near the middle of the region, joined the main trunk of the superficial branch of the radial nerve at an acute angle. Both of the previously mentioned branches (second and third branches) were somewhat disposed on either side of the main trunk on the dorsal surface of the forearm and correspondingly innervated the adjacent areas. The cutaneous branches which arose directly from the Ramus superficialis of the radial nerve were collectively considered as Nn. cutanei antebrachii laterales.

In one specimen, the third branch (N. cutaneus antebrachii lateralis) of the Ramus superficialis did not join the main trunk near the middle of the dorsal surface of the forearm as mentioned above. On reaching the dorsal surface of the forearm this branch ran almost parallel to its parent trunk of the superficial branch of the radial nerve, being placed medially. On the dorsal surface of the carpus it released an anastomotic twig which passed obliquely and joined the main trunk slightly below the level of the carpus. This anastomotic twig (N. digitalis dorsalis communis II) received, in turn, filaments from the main trunk and continued distally. At a variable level on the metacarpus it divided into two dorsal proper digital nerves (Nn. digitales II et III dorsales proprii) of the 2nd and 3rd digits, whereas the rest of this branch (Ramus medialis) continued as the dorsal proper digital nerve (N. digiti

II dorsalis proprius) to the 2nd digit. In this case, the main trunk of the superficial branch of the radial nerve, while descending along the dorsal aspect of the carpus, released a few twigs to the joint capsule. Thereafter, it received the anastomotic twig from the third branch coursing medially to which it also contributed fibers. Within the distal half of the metacarpus, it detached twigs to the thick fascia of the region and divided into a medial and a lateral branch. The medial branch (N. digitalis dorsalis communis III) extended distally and finally divided into two dorsal proper digital nerves (Nn. digitales III et IV dorsales proprii) to the 3rd and 4th digits. The lateral branch (Ramus lateralis) joined the medial branch (Ramus medialis) of the Ramus dorsalis n. ulnaris at a variable distance along the dorsal surface of the metacarpus to form the N. digitalis dorsalis communis IV. This combined trunk finally divided into two dorsal proper digital nerves (Nn. digitales IV et V dorsales proprii) to the 4th and 5th digits.

In general, the superficial branch (Ramus superficialis) of the radial nerve received the third branch coursing medially on the dorsal surface of the forearm, approximately near the middle of the forearm, at an acute angle. The nerve trunk descended along the dorsal surface of the carpus, where it released a few twigs to the joint capsule. Later, at a variable distance on the metacarpus (usually near the middle of the metacarpus), it divided into two branches. The medial branch (Ramus medialis) soon divided into a medial branch and the N. digitalis dorsalis communis II. The former continued as the dorsal proper digital nerve (N. digiti II dorsalis proprius) to the 2nd digit, whereas the latter (N. digitalis dorsalis communis II), after coursing a short distance, divided into two dorsal proper digital nerves (Nn. digitales II et III dorsales proprii) to the 2nd and 3rd digits. Similarly, the lateral branch (Ramus lateralis) of the superficial branch of the radial nerve divided into the N. digitalis dorsalis communis III and a lateral branch. The former divided into the dorsal proper digital nerves (Nn. digitales III et IV dorsales proprii) to the 3rd and 4th digits. Its lateral branch joined

the medial branch (Ramus medialis) of the Ramus dorsalis n. ulnaris to constitute the N. digitalis dorsalis communis IV which soon divided into two dorsal proper digital nerves (Nn. digitales IV et V dorsales proprii) to the 4th and 5th digits.

The deep branch (Ramus profundus) of the radial nerve, near its separation from the superficial branch (Ramus superficialis), detached three successive muscular branches from the caudal aspect to furnish the M. extensor carpi radialis and, cranially, at least one twig, deeply situated, for the M. brachialis, close to its insertion. After a short course, it detached a strong muscular twig to innervate the medial, middle and lateral bellies of the M. extensor digitorum (digitalis) communis. Thereafter it extended along the dorsal aspect of the shaft of the radius and gave off a slender twig which was destined to innervate the M. abductor digiti primi (pollicis) longus (s. M. extensor carpi obliquus). The main continuation released successive small twigs to furnish the Mm. extensor digiti IV and V proprii [s. M. extensor digitorum (digitalis) lateralis] and ultimately ramified inside the M. ulnaris lateralis (s. M. extensor carpi ulnaris).

IV. N. axillaris

The axillary nerve passed along the flexor surface of the shoulder joint and lay in the space formed by the Mm. coracobrachialis, teres major and subscapularis. At this place, the axillary nerve divided primarily into a dorsal and a ventral branch. The dorsal branch, the smaller of the two, stretched and finally disappeared within the M. teres minor. The ventral branch was relatively thick and, on reaching the deep face of the M. deltoideus, gave off a few twigs to innervate the latter muscle (both parts). The ventral branch continued craniodistally and detached a strong twig, which at first passed between the M. teres minor and M. deltoideus. It then passed between the latter muscle and the humerus, entered the deep face of the M. brachiocephalicus and ramified inside same. The continuation of the ventral branch (N. cutaneus antebrachii cranialis) emerged between the two parts

of the M. deltoideus, being deeply related to the lateral head of the M. triceps brachii, furnished sensory twigs to the fascia and skin on the lateral aspect of the arm, and finally disappeared on the dorsolateral aspect of the elbow joint.

DISCUSSION AND SUMMARY

In the pig, the N. cutaneus antebrachii caudalis was given off by the N. ulnaris from its cranial aspect, close to the proximal extremity of the humerus. Frequently, it divided into a cranial and a caudal branch and furnished the fascia and skin of the proximal half on the medial aspect and the proximal third of the caudal aspect of the forearm. But Schneider and Zintzsch¹³ stated that the cranial branch was distributed in the skin of the volar (caudal) two-thirds of the medial side of the forearm downwards to the carpal joint. The caudal branch supplied the skin of the volar (caudal) half of the forearm to the carpal joints.

The muscular branches of the ulnar nerve innervated the Mm. flexor carpi ulnaris, flexor digitorum (digitalis) superficialis and the humeral and ulnar heads of the M. flexor digitorum (digitalis) profundus. Besides, it also supplied, below the carpus, the Mm. interossei.

According to Reimers,¹² Dobberstein and Hoffmann,⁴ and Koch⁸ the Ramus musculocutaneus of the median nerve should be regarded as the Ramus muscularis distalis of the musculocutaneous nerve due to comparative anatomical reasons.

In the pig, the median nerve supplied muscular twigs to the Mm. pronator teres, flexor carpi radialis, flexor carpi ulnaris, flexor digitorum (digitalis) superficialis, and the humeral and radial heads of the M. flexor digitorum (digitalis) profundus.

The muscular branches of the radial nerve furnished the extensors of the carpus and digit. Besides, Reimers¹¹ asserted that in about half of the cases in the pig the radial nerve gave off a delicate twig to the M. brachialis, close to its insertion. We also observed this radial innervation to the M. brachialis in the pig. The M. brachialis is a flexor of the elbow joint, whereas the radial nerve, in general, supplies the extensors of the elbow, carpus

and digits. This innervation allows us to recognize the remnant of the previously present *M. brachioradialis* which is fused with the *M. brachialis*.

The axillary nerve furnished the flexors of the shoulder joint and the *Pars clavicularis*¹² or *Pars cleidobrachialis*⁸ of the *M. brachiocephalicus*. The latter was originally a part of the *M. deltoideus*, which is a flexor of the shoulder.

The cutaneous branch of the axillary nerve, the *N. cutaneus antebrachii cranialis*, frequently emerged between the two parts of the *M. deltoideus* and furnished the fascia and skin around the dorsolateral aspect of the elbow joint.

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(STREPTOTHRICOSIS CONT.)

laboratory. The result of the biopsy was the finding of a Gram + mycelia in the hyperkeratotic scab covering. The epithelium was intact but had dermal lymphoid accumulations. The histopathological diagnosis was Cutaneous Streptothricosis.

Five days after the treatment with penicillin-streptomycin the horny lesions began to loosen and many were easily removed by brushing. This improvement continued for about four days after which the skin condition appeared to remain the same. At this time it was decided to resume therapy with penicillin-streptomycin. From February 10 to February 12, 25 cc of Pen-strep. were administered daily to the calf. The day following the last treatment with penicillin-streptomycin quite a bit of the horny material began to loosen and fall off. By February 17, most of the skin lesions were off and the skin underneath was healing quite normally

with no secondary complications. The calf was sent home on March 1, 1967.

DISCUSSION

The typical lesions seen with this condition are highly suggestive but positive diagnosis can only be made from skin scrapings or histopathological sections. Response to different forms of therapy is variable and difficult to assess because of the possibility of spontaneous recovery.

Although Streptothricosis is not a problem in this area it may be more prevalent than formally believed and may be going undiagnosed.

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