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Variations of formation of n. femoralis, n. obturatorius and n. ischiadicus in pigs

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ABSTRACT

Research was carried out on 135 pigs from the Sljeme Farm in Sesvete during 1999. Differences in n. femoralis, n. obturatorius and n. ischiadicus were noticed in pigs with six and seven lumbal vertebra. N. femoralis emerged by connecting ventral branches of two final lumbal nerves in 65.92% of pigs, equally often in pigs with six (31.11%) lumbal vertebrae and in pigs with seven (34.81%) lumbal vertebrae. Ventral branches of final lumbal nerves in pigs with six and seven lumbal vertebrae showed n. femoralis in 26.66% of observed pigs, and somewhat more often in pigs with seven lumbal vertebrae. N. obturatorius most frequently emerged from ventral branches of final lumbal nerves in pigs with six and seven lumbal vertebrae in 66.66% of animals, and somewhat more often in pigs with seven lumbal vertebrae. Much more rarely it emerges from ventral branches of prefinal lumbal nerves more often in pigs with seven lumbal vertebrae. In pigs with six lumbal vertebrae, emergence of n. obturatorius from ventral branches of the 4th, 5th and 6th lumbal nerves was noticed in 2.96% of cases and from the ventral branch of the 5th lumbal nerve in only 1.48% of observed pigs. N. ischiadicus demonstrated the largest variation from the most frequently described emergence. In only 19.25% cases did it emerge from the ventral branches of 5th and 6th lumbal nerves and 1st and 2nd sacral nerves, and more rarely in pigs with seven lumbal vertebrae. It was observed most frequently in the ventral branches of the two final lumbal nerves and 1st sacral nerve (52.58%), more often in pigs with seven lumbal vertebrae. Ventral branches of the final lumbal and 1st and 2nd sacral nerves participated in the emergence of 20.70% cases, and somewhat more frequently in pigs with six lumbal vertebrae. Emergence of n. ischiadicus from the ventral branches of the final lumbal and the 1st sacral nerves was noticed, more frequently in pigs with seven lumbal vertebrae.

Key words: pig, lumbal nerve, sacral nerve

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Introduction

Plexus lumbosacralis emerges by the connecting of the ventral branches of nerves, which participate in the growth of lumbal nerve medley and in growth of outgoing nerves, where plexus lumbosacralis divides on plexus lumbalis and plexus sacralis.

Plexus lumbalis in pigs emerges by the connecting of the ventral branches of 3rd, 4th and 5th nerves, while the ventral branches of the 6th and 7th lumbal nerves and the 1st and 2nd sacral nerves and plexus sacralis. Outgoing nerves of this medley innervated the abdominal wall, skin and back limb muscles, as well as part of the foot and tail. Numerous authors have described the emergence of n. femoralis in pig by connecting the ventral branches of the 4th and 5th lumbal nerves, and they have also mentioned that one of the possibilities is the participation of the ventral branches of not only the 3rd but also the 6th lumbal nerve.

N. obturatorius in pig emerges by connecting the ventral branches of the 5th and 6th lumbal nerves. GETTY (1975) described the emergence of n. obturatorius by the connecting of ventral branches of the 5th and 6th lumbal nerves in pigs, and also the possible participation of the 3rd and 6th ventral branches of lumbal nerves. NICKEL et al. (1984) mentioned emergence of n. obturatorius by connecting the ventral branches of the 4th, 5th and 6th lumbal nerves.

According to descriptions by numerous authors (KLIMOV, 1947; KLIMOV and AKAEVSKI, 1955; BERG, 1973; KOCH, 1976; NICKEL et al., 1984; KOCH and BERG, 1985; DYCE et al., 1987; ELLENBERGER and BAUM, 1987) n. ischiadicus emerges by the connecting of the ventral branches of the 5th and 6th lumbal nerves and the 1st and 2nd sacral nerves. SISSON and GROSSMAN (1962) and GETTY (1975) mentioned that in the emergence of n. ischiadicus, together with the already numbered ventral branches of the 5th and 6th lumbal nerves and the ventral branches of the 1st and 2nd sacral nerves, the somewhat more liable branches of the ventral branches of the 4th (and also the 3rd) lumbal nerves may also take part.

In available literature we have noticed that there are variations in n. femoralis, n. obturatorius and n. ischiadicus descriptions of emergence. In their descriptions of researches already carried out, authors did not mention

how often these deviations occur and whether or not they are connected to the number of lumbal spinal vertebrae. In our own researches we have attempted to determine the existence and re-appearance of deviations in n. femoralis, n. obturatorius and n. ischiadicus emerging in pigs and to determine the existence of a connection between deviations in the emergence of researched nerves and the number of lumbal vertebrae.

Materials and methods

Sections on the carcasses of 135 pigs aged from 1 to 6 months from the Sljeme Farm in Sesvete were made.

Carcasses were delivered to the Department of Pathology and Pathological Morphology, Faculty of Veterinary Medicine, University of Zagreb. After sections were made, emergence of n. femoralis, n. obturatorius and n. ischiadicus was observed. Observations and research results were processed by "Statistics" USA-Stat. Saft. Inc. 1993, Release 4.5, version 2000 for PC Sis 730S. Methods for descriptive statistics for manifestation characteristics distribution were used. To establish reality of theoretical aberration allowable, we calculated standard error, quoutil and congregation interval. Variable testing was made with Student's *t*-test. For proportion testing we used proportion test (*Z*). For correlation in testing the explicit border for level of reliable $P < 0.05$ (reliable 95%), $P < 0.01$ (reliable 99%), $P < 0.001$ (reliable 99.9%).

Results

We found that in 46.66% of observed pigs n. femoralis emerges by the connecting of the ventral branches of the 5th and 6th lumbal nerves. In pigs with a 6th lumbal vertebra we found this form of emergence of n. femoralis in 31.11% and in pigs with 7 lumbal vertebrae in 15.55% of cases. In 34.81% observed pigs with 7 lumbal vertebrae, n. femoralis confirmed the ventral branches of the 6th and 7th lumbal nerves. From the ventral branches of the 4th and 5th lumbal nerves, n. femoralis emerged in 11.11% cases. From the ventral branches of three final lumbal nerves (4th, 5th and 6th) in pigs with six lumbal vertebrae n. femoralis emerged in 7.40% of cases (Table 1).

Table 1. Creation of n. femoralis, n. obturatorius and n. ischiadicus

N. femoralis		N. obturatorius		N. ischiadicus	
Nerve	N ^o animals	Nerve	N ^o animals	Nerve	N ^o animals
L4, L5, L6	157	L4, L5, L6	142	L6, L7, S1	184
L3, L4, L5	36	L4, L5	35	L7, S1, S2	11
L5, L6, L7	5	L5, L6	20	L6, L7, S1, S2	11
L3, L4, L5, L6	5	L4, L5, L6, L7	10	L7, S1	6
L4, L5, L6, L7	5	L5, L6, L7	5		
L4, L5	4				

L3-ventral branch of 3rd lumbar nerve; L4- ventral branch of 4th lumbar nerve; L5- ventral branch of 5th lumbar nerve; L6- ventral branch of 6th lumbar nerve; L7- ventral branch of 7th lumbar nerve; S1- ventral branch of 1st sacral nerve; S2- ventral branch of 2nd sacral nerve

N. obturatorius emerged from the ventral branches of the 5th and 6th nerves in 51.84% of observed pigs, in pigs with 6 lumbar vertebrae (34.07%) and in pigs with 7 lumbar vertebrae in 17.77% of cases. In pigs with seven lumbar vertebrae, ventral branches from the two final lumbar nerves (6th and 7th) formed n. obturatorius in 32.59% of cases which, also considering pigs with six lumbar vertebrae, leads to the conclusion that from the two final ventral branches of lumbar nerves, n. obturatorius emerged in 66.66% of observed pigs. The ventral branch of the 4th and 5th lumbar nerves formed n. obturatorius in 11.11% of observed pigs with six lumbar vertebrae, and more rarely, in 2.96% of cases, emerged by the connecting of the ventral branches of the 4th, 5th and 6th lumbar nerves. Ventral branches of the 5th lumbar nerve formed n. obturatorius in 1.48% of observed carcasses of pigs with six lumbar vertebrae (Table 1).

Deviation from emergence as described in the literature was noticed most often in n. ischiadicus. N. ischiadicus emerged from the ventral branches of the 6th and 7th lumbar nerves and from the ventral branches of the 1st sacral nerve in 33.33% pigs with seven lumbar vertebrae, although somewhat more rarely (in 19.25% of pigs) it emerged by connecting the ventral branches of the 5th and 6th lumbar and 1st sacral nerves in pigs with six lumbar vertebrae. Rarely, in 13.33% of observed pigs, n. ischiadicus was formed from the ventral branch of the 6th lumbar nerve and the 1st and 2nd sacral nerves in pigs with six lumbar vertebrae, but in pigs with seven lumbar vertebrae n. ischiadicus emerged by connecting the ventral branch of the 7th lumbar nerve and the 1st and 2nd sacral nerves in 7.40% of cases.

Emergence of n. ischiadicus by connecting ventral branches of the final lumbal and the 1st sacral nerves was confirmed in 7.40% of observed pigs, in 4.44% in pigs with six lumbal vertebrae and in 2.56% in pigs with seven lumbal vertebrae.

Ventral branches of the two final lumbal nerves and the 1st and 2nd sacral nerves formed n. ischiadicus in 19.25% of observed pigs. This form was present in pigs with six lumbal vertebrae in 12.59% of cases, and in pigs with seven lumbal vertebrae in 6.66% of observed cases (Table 1).

Discussion

We noticed that n. femoralis emerged in 46.66% of observed pigs by connecting the ventral branches of two pre-final lumbal nerves, which is similar to descriptions of others (KLIMOV, 1947; KLIMOV and AKAEVSKI, 1955; BERG, 1973; KOCH, 1976; NICKEL et al., 1984; KOCH and BERG, 1985; DYCE et al., 1987; ELLENBERGER and BAUM, 1987).

The frequency of this form of emerging n. femoralis is not the same in animals with six, and animals with seven, lumbal nerves. In pigs with six lumbal vertebrae n. femoralis emerges by connecting the ventral branches of the 5th and 6th lumbal nerves in 31.11% of cases, while in animals with seven lumbal vertebrae it emerges by connecting ventral branches of two pre-final and final lumbal nerves (ventral branches of the 6th and 7th lumbal nerves) in 34.81% cases. N. femoralis emerging from ventral branches of two prefinal lumbal nerves was observed in 65.92% of observed pigs, in pigs with six lumbal vertebrae and in pigs with seven lumbal vertebrae. These results are statistically significant when compared to results of research when the number of flank vertebrae is not taken into consideration. However, if we observed the number of lumbal vertebrae, considering in our observations whether it occurs in two pre-final lumbal nerves, the statistical significance in deviation does not appear. Results of our research could partially be in accord with conclusions made by GETTY (1975) and AKAEVSKI (1987), since these authors described the emerging of n. femoralis from the ventral branches of the 3rd to 6th lumbal nerves. In the literature available to us we noticed no data regarding the emergence of n. femoralis, nor with n. obturatorius and n. ischadicus in pigs with seven lumbal

vertebrae. As one category in the emergence of n. femoralis we took the ventral branches of two final lumbal nerves in pigs with six and seven lumbal vertebrae. Secondly, in the larger group were pigs in which the ventral branches of the pre-final and pre-pre-final lumbal nerve participated in emergence of n. femoralis in 26.66% of observed pigs. Statistically, this result is significant at level $P < 0.001$. We also noticed emergence of n. femoralis from the ventral branches of the 4th, 5th and 6th lumbal nerves in pigs with six lumbal vertebrae in 7.40% of cases, which agrees with the descriptions given by GETTY (1975) and AKAEVSKI (1987). In 7.40% of observed pigs, n. femoralis was formed by the ventral branches of the 4th, 5th and 6th lumbal nerves, in pigs with six lumbal vertebrae. Deviations of this kind are not statistically significant, but from an anatomical point of view they are significant as one of the possibilities of the emergence of n. femoralis.

Results of our research on emergence of n. obturatorius matched the descriptions of the above mentioned authors in 66.66% of cases, and which have been described in numerous anatomy books (KLIMOV, 1947; KLIMOV and AKAEVSKI, 1955; BERG, 1973; KOCH, 1976; NICKEL et al., 1984; KOCH and BERG, 1985; DYCE et al., 1987; ELLENBERGER and BAUM, 1987). However, we also determined that n. obturatorius emerges from the ventral branches of the 5th and 6th lumbal nerves in pigs with six lumbal vertebrae in 34.07% of cases, and in 32.59% of cases in pigs with seven lumbal vertebrae (6th and 7th lumbal nerves). At the same time, while observing the emergence of n. obturatorius in pigs with six lumbal vertebrae, we confirmed emergence from the ventral branches of the 4th and 5th lumbal nerves in 11.11% of cases, and in pigs with seven lumbal vertebrae, emerging from the 5th and 6th lumbal nerve in 18.51% of cases. This finding points to pre-pre-final and pre-final lumbal nerves participating in emergence of n. obturatorius in 29.62% of observed pigs, which is a significant deviation ($P < 0.05$). A finding of this kind of n. obturatorius emerging would match the descriptions by GETTY (1975) and AKAEVSKI (1987). Even though of no statistical significance, we observed emergence of n. obturatorius by connecting ventral branches of the 4th, 5th and 6th lumbal nerves in 2.96% of cases, and the ventral branch of the 5th lumbal nerve alone in 1.48% of observed pigs with six lumbal vertebrae. N. femoralis and n. obturatorius

emerge by connecting the pre-final and final ventral branch of the lumbal nerve in the same percentage (65.92% n. femoralis and 66.66% n. obturatorius), but a smaller deviation connected to the number of lumbal spinal vertebrae has been noticed. Therefore, n. femoralis emerges more often by connecting the ventral branches of the pre-final and final lumbal nerves in pigs with seven lumbal vertebrae, while n. obturatorius emerged more often by such a connection in pigs with six lumbal vertebrae, even though this deviation has no statistical significance. In all pigs with six lumbal vertebrae, n. femoralis and n. obturatorius were formed by the ventral branches of the 4th and 5th lumbal nerves, which accords with the conclusion made by many authors (KLIMOV, 1947; KLIMOV and AKAEVSKI, 1955; BERG, 1973; KOCH, 1976; NICKEL et al., 1984; KOCH and BERG, 1985; DYCE et al., 1987; ELLENBERGER and BAUM, 1987), whereas in other forms of emerging nerves there is a very small deviation.

N. ischiadicus had the biggest variation. Numerous authors (KLIMOV, 1947; KLIMOV and AKAEVSKI, 1955; BERG, 1973; KOCH, 1976; NICKEL et al., 1984; KOCH and BERG, 1985; DYCE et al., 1987; ELLENBERGER and BAUM, 1987) have described n. ischiadicus emerging from the ventral branches of the 5th and 6th lumbal nerves, and the 1st and 2nd sacral nerves, which we observed in 19.25% of observed pigs in our research. This form of n. ischiadicus emerging occurred more often in pigs with six lumbal vertebrae (12.59%) compared to pigs with seven lumbal vertebrae (6.66%). In our research, n. ischiadicus was most often formed by the ventral branches of the 6th and 7th lumbal nerves and the 1st sacral nerve (33.33%) in pigs with seven lumbal vertebrae, and pigs with six lumbal vertebrae (19.25% of cases). Therefore, in our research we found 52.58% of pigs in which n. ischiadicus was formed by connecting the ventral branches of two final lumbal and first sacral nerves, which agrees with descriptions of emergence of n. ischiadicus by GETTY (1975). The ventral branches of the final lumbal and the first and second sacral nerves formed n. ischiadicus in 20.70% of cases, which is almost twice as frequent in animals with six lumbal vertebrae (13.33%) than in animals with seven lumbal vertebrae (7.40%).

In a somewhat smaller percentage (7.40%) we confirmed n. ischiadicus emerging by the connecting ventral branches of the final lumbal nerve and first sacral nerve in pigs with six lumbal vertebrae, in 4.44% and pigs with

seven lumbal vertebrae (2.96% of cases). Excluding the results of research in pigs with six lumbal vertebrae, it is obvious that in n. ischiadicus emerging in pigs with seven lumbal vertebrae, are mostly in the ventral branches of two final lumbal (6th and 7th) and 1st sacral nerves in 52.58% of observed pigs. However, several other forms of this nerve are recognized. In majority of cases, n. ischiadicus is other than this main common form of communion, less represented form of n. ischiadicus is the one composed of ventral branches of the 7th lumbal nerve and 1st and 2nd sacral nerve as well as a form composed of the ventral branches of 6th and 7th and 1st and 2nd sacral nerves.

During the research we observed that as well as the more frequently described form of n. femoralis, n. obturatorius and n. ischiadicus emerging there is deviation in emergence for one segment, cranially or caudally. This form of the emergence of these nerves matches the description by FLETCHER (1970) in dogs, where he described variations that were found as prefixed, medial-fixed and post-fixed forms. A similar variation in forming n. femoralis, n. obturatorius and n. ischiadicus was described by MIHELJIĆ et al. (1994), and MIHELJIĆ et al. (1996).

Conclusions

N. femoralis, n. obturatorius and n. ischiadicus emerging in pigs depend upon the number of lumbal vertebrae. In pigs with six lumbal vertebrae n. femoralis is formed by the ventral branches of the pre-final and final lumbal nerves in 31.11% of cases, and pigs with seven lumbal vertebrae in 34.81% of cases, which results in a percentage of 65.92% of observed pigs. Emergence of n. femoralis from the ventral branches of two pre-final lumbal nerves (4th and 5th) in pigs with six lumbal vertebrae, i.e. the 5th and 6th lumbal nerve in pigs with seven lumbal vertebrae, was observed in 26.66% of observed pigs.

Three pre-final ventral branches of lumbal nerves in pigs with six lumbal vertebrae formed n. femoralis in 7.40% of cases.

The ventral branches of two pre-final lumbal nerves form n. obturatorius in 66.66% of observed animals in equal numbers of pigs with six and seven lumbal vertebrae.

Two pre-final ventral branches of lumbal nerves form n. obturatorius more often in pigs with seven lumbal vertebrae.

In pigs with six lumbal vertebrae, n. obturatorius emerged from the ventral branches of three pre-final lumbal nerves, and also from the ventral branch of the fifth lumbal nerve only. This finding has no statistical significance.

The ventral branches of two final lumbal nerves connect to the ventral branch of the 1st lumbal nerve in n. ischiadicus emerging in 52.58% of observed pigs, more often than in pigs with seven lumbal vertebrae.

In pigs with six lumbal vertebrae, nerves participated in n. ischiadicus emerging more often in pigs with seven lumbal vertebrae.

N. ischiadicus emerged by connecting of the ventral branches of the final lumbal and first sacral nerve in pigs with seven lumbal vertebrae in a very small number of observed pigs.

N. femoralis, n. obturatorius and n. ischiadicus emerging in pigs can be divided into three main forms: prefixed, medialfixed and postfixed.

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SAŽETAK

Istraživanja su provedena na 135 svinja podrijetlom s farme "Sljeme" Sesevete tijekom 1999 godine. Ustanovljena je razlika u nastanku n. femoralis, n. obturatorius i n. ischiadicus u svinja sa šest i sedam slabinskih kralježaka. N. femoralis je nastao povezivanjem ventralnih grana posljednjih dvaju slabinskih živaca u 65,92% svinja podjednako učestalo u svinja sa šest (31,11%) i sedam (34,81%) slabinskih kralježaka. Ventralne grane posljednjih slabinskih živaca u svinja sa šest i sedam slabinskih kralježaka tvorile su n. femoralis u 26,66% pretraženih svinja, a n. obturatorius je najučestalije nastajao iz ventralnih grana posljednjih slabinskih živaca u svinja sa šest i sedam slabinskih kralježaka u 66,66%, a neznatno učestalije u svinja sa 7 slabinskih kralježaka. Znatno rjeđe nastaje iz ventralnih grana pretposljednjih slabinskih živaca (28,88%), a učestalije u svinja sa šest slabinskih kralježaka (18,51%). U svinja sa šest slabinskih kralježaka zapažen je nastanak n. obturatorius iz ventralnih grana 4., 5. i 6. slabinskog živca u 2,96%, a samo iz ventralne grane 5. slabinskog živca u 1,48% pretraženih svinja. N. ischiadicus pokazao je najveće odstupanje od najčešće opisivanog nastanka. U svega 19,25% slučajeva nastao je iz ventralnih grana 5. i 6. slabinskog te 1. i 2. križnog živca, rjeđe u svinja sa 7 slabinskih kralježaka. Najučestalije su ga tvorile ventralne grane dvaju posljednjih slabinskih živaca i prvog križnog živca (52,58%), znatno češće u svinja sa sedam slabinskih kralježaka. Ventralne grane posljednjeg slabinskog te 1. i 2. križnog živca sudjelovale su u nastanku 20,70% pretraženih svinja sa 6 slabinskih kralježaka. Zabilježen je nastanak n. ischiadicusa iz ventralnih grana posljednjeg slabinskog i prvog križnog živca češće u svinja sa sedam slabinskih kralježaka.

Ključne riječi: svinja, slabinski živci, križni živci
