Comparative anatomy of the pelvic nerves in bearded capuchins (*Sapajus* sp)

Anatomia comparativa dos nervos da pelve de macacos-prego (Sapajus sp)

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Abstract

Bearded capuchins (*Sapajus* sp), unexpectedly, share with chimpanzees behavioral features such as high cognitive ability, good memory, tool use with intermittent bipedalism, and social tolerance; although its anatomy is still little studied. To test the hypothesis that bearded capuchins might share similar anatomical features with chimpanzees, we investigated the pelvic nerves of the bearded capuchin and compared them with the data in the previous literature for modern humans, chimpanzee, and baboons in terms of origin, trajectory and innervated structures, when the data are available. Variation is very common in the primates because of, *inter alia*, 1) the problem of the anatomical position, i.e., some primatologists used the human anatomical position to describe those in non-human primates, while others used the non-human anatomical position, and the definition of anatomical position (human or non-human position) is not clear; 2) the lateralized and semi-bend pelvis limbs in non-humans primates compared with modern humans; 3) the absence of the some muscles (e.g., scansorius and ilioschiofemoralis) in modern humans in the thigh; and 4) the difference in the numbers of vertebrae among the authors, even in the same species, such as chimpanzees and bearded capuchins.

Keywords: Primatology. Morphology of the Recent Groups. Bearded Capuchins. Pelvic Limbs. Nerves.

Resumo

Macacos-prego (*Sapajus* sp), inesperadamente, compartilham com chimpanzés comportamentos como alta cognição e memória, uso de ferramentas com o bipedalismo intermitente, tolerância social. No entanto, sua anatomia ainda é pouco estudada. Para verificar a hipótese com qual espécie e/ou grupo de primatas os macacos-prego compartilham mais características, o objetivo deste trabalho foi estudar os nervos pélvicos do *Sapajus* e compará-los com dados da literatura anatômica sobre os seres humanos, chimpanzés e babuínos, considerando aspectos como origem, trajetória e estruturas inervadas. Foi observado que existem grandes variações nos nervos pélvicos entre os primatas estudados aqui, quais sejam, 1) o problema da posição anatômica, i.e., alguns primatologistas consideram a posição anatômica humana para os primatas, outros consideram a posição anatômica animal, e a opção por um ou outro não é clara nos textos; 2) o problema dos membros pélvicos em primatas não humanos serem lateralizados e semi-fletidos em relação aos seres humanos modernos; 3) o problema da ausência, nos seres humanos modernos, de alguns músculos da coxa em relação aos outros primatas como o escansório e o iliosquiofemoral; e 4) o problema da diferença do número de vértebras nos primatas estudados aqui, inclusive com diferenças para a mesma espécie citadas por diferentes autores tanto para chimpanzés como para macacos-prego.

Palavras-chave: Primatologia. Morfologia dos Grupos Recentes. Macacos-prego. Membros pélvicos. Nervos.

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Introduction

Bearded capuchins (*Sapajus* sp), unexpectedly, share with chimpanzees (*Pan*) various behavioral features such as high cognitive ability, good memory, tool use with intermittent bipedalism, and social tolerance (ANTINUCCI; VISALBERGHI, 1986; BOESCH; BOESCH, 1990; PHILLIPS, 1998; RYLANDS et al., 2000; TAVARES; TOMAZ, 2002; FRAGASZY et al., 2004; LOPES, 2004; VISALBERGHI et al., 2007; SABBATINI et al., 2008; DEFLER, 2009; MANNU; OTTONI, 2009; DEMES, 2011; DEMES; O´NEILL, 2012). In fact, bearded capuchins are unique New World primates showing those behavioral characteristics (AVERSI-FERREIRA et al., 2014b); however, their anatomical structures are like those of baboons (AVERSI-FERREIRA et al., 2005, 2009, 2010, 2011a, 2011b, 2013, 2014a, 2014b).

On the other hand, anatomical structures of bearded capuchins seem to be closer to those of other New World primates, per its taxonomy, but few studies on its anatomy are reported (AVERSI-FERREIRA et al., 2014a). Nevertheless, in recent years some, but not enough, works about *Sapajus* anatomy associated with its behavioral aspects were performed. Then, the anatomical similarity to baboons (*Papio*) was studied (AVERSI-FERREIRA et al., 2005, 2009, 2010, 2011a, 2011b, 2013, 2014a, 2014b), *inter alia*, because the anatomical descriptions of the apes and baboons are easily found in previous literature, which are lacking in the New World primates.

Anatomical studies should be performed based on correct and reliable taxonomy, phylogeny, evolution of *Sapajus* and its relation to New World and Old World primates (AVERSI-FERREIRA et al., 2005, 2009, 2010, 2011a, 2011b, 2013, 2014a, 2014b; SPAGNOLETTI et al., 2011). Indeed, the taxonomy of the bearded capuchins has been a source of discussion since the 18th century in relation to correct names of the species (ERXLEBEN, 1777; SABBATINI et al., 2008) and recently, the genus was changed; for instance, the *Sapajus* genus was previously called *Cebus* (ALFARO et al., 2012).

These kinds of problems are common and we cannot obtain exact conclusions without sufficient available data about the features of species. Furthermore, to provide new data and contribute to development of other areas including ethology (AVERSI-FERREIRA et al., 2014b), anatomical studies should incorporate both quantity and quality.

We hypothesized that bearded capuchins share similar anatomical features with Old World primates, since they share similar behavioral characteristics with chimpanzees. The aim of this work was to investigate the pelvic nerves of the bearded capuchin and to compare them with those in modern humans (SWINDLER; WOOD, 1973; GARDNER et al., 1988), chimpanzee (CHAMPNEYS, 1871; SWINDLER; WOOD, 1973), and baboons (SWINDLER; WOOD, 1973) in terms of the origin, trajectory and innervated structures of the pelvic nerves, when the data of these other primates were available.

Materials and Methods

Samples

Eight adult bearded capuchin specimens (one female) were used in this study. One bearded capuchin male was prepared to obtain the skeleton by dissection plus ant actions. Their weights were between one and five kilograms. No animal was killed for the purposes of this study; five of them died accidentally in their natural habitats and were included in the anatomical collection of the Anthropology, Biochemistry, Neuroscience and Behavior of Primates Laboratory (LABINECOP) from the Federal University of Tocantins, Tocantins State, Brazil. The others belonged to the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA) archive and were donated for studies in the 1970s. This work was approved by the Institutional Ethical Committee from the Federal University of Tocantins, Tocantins State, Brazil (CEUA-UFT 23101.003220/2013-85).

Preparation of the animals for dissection

All procedures for the animals were done in accordance with the guidelines of the Brazilian Society of Animal Experimentation (COBEA). After the trichotomy with a razor blade, the animals received perfusion, by the femoral artery, with 10% formaldehyde for fixation. The animals were preserved in 10% formaldehyde.

Nomenclature

We used the human anatomical position and nomenclature for the nerves according the terminology of Swindler and Wood (1973).

Results and Discussion

Nerves of the pelvis

The pelvic nerves of the *Sapajus* and its comparison are summarized in Table 1. It is important to note that Swindler and Wood (1973) did not report the trajectory of the all nerves, and that not all nerves studied here were reported by Champneys (1871) and Hepburn (1892).

Iliohypogastricus nerve

Two trunks, T13 (a subcostal nerve contribution) and T14, form the iliohypogastricus nerve (Figure 1) in bearded capuchins. The collateral branch is the iliohypogastricus nerve (Figure 1), the other one is the ilioinguinalis. Modern humans have different origin of the iliohypogastricus and ilioinguinalis nerves; they originate from L1 and L2 (SWINDLER; WOOD, 1973; GARDNER et al., 1988) and receive fibers from T12 (GARDNER et al., 1988). In *Papio*, the iliohypogastricus nerve originates from L1 and L2, and in *Pan*, in the most cases, it originates from a junction of the subcostalis nerve with L1 (SWINDLER; WOOD, 1973) or T13 (CHAMPNEYS, 1871). Thus, the origin of the iliohypogastricus nerve is different among these primates. However, it is noted that bearded capuchins have 14 thoracic vertebrae (see discussion below).

The iliohypogastricus nerve lies on the lateral wall of abdomen and emits two branches, the lateral and anterior. In modern humans, the lateral cutaneous branch innervates the skin laterally to the buttocks and the anterior cutaneous branch innervates the skin on the pubis bone (GARDNER et al., 1988).

Ilioinguinalis nerve

The ilioinguinalis nerve (Figure 1) originates from T13 (a subcostal nerve contribution) and T14, from ilihypogastricus nerve, in *Sapajus*. In modern humans, it originates from T12 and occasionally from L2 (GARDNER et al., 1988). In *Papio*, it originates from L1 and L2, and, in *Pan*, from T13 and L1, per Swindler and Wood (1973) and only from T13, per Champneys (1871).

In *Sapajus,* it emerges in the abdominal region between the obliquus internus abdominis and transversus abdomis, and emits two muscular branches, one for the transversus abdomis and the other for the rectus abdominis; it continues to travel and crosses the abdominal fascia. In modern humans, the ilioinguinalis nerve passes between the obliquus internus abdominis and transversus abdomis, reaches to the iliac crest, runs along the spermatic cord or the teres ligament through the inguinal canal, and gives off cutaneous branches to the thigh, and innervates the scrotum or labia majora (SWINDLER; WOOD, 1973).

Genitofemoralis nerve

The genitofemoralis nerve (Figure 1) originates from T14 in *Sapajus*, from L3 united with L4 in baboons, in chimpanzees from T13, per Champneys (1871) and from T13 and L1, per Swindler and Wood (1973). In modern humans, it originates from L1, sometimes from L2, L1 plus L2 and rarely from L3 (GARDNER et al., 1988).

In bearded capuchins, the genitofemoralis nerve lies downward obliquely in the abdominal and pelvic region, located between the ilioinguinalis and cutaneous femoris lateralis nerves; in the inguinalis region, it crosses the abdominal wall and innervates the skin in this region. In modern humans, the genitofemoralis nerve lies anteriorly on the psoas major muscle and divides into the genital and femoral branches. The genital branch penetrates the inguinal canal and innervates the cremaster, scrotum or labia majora and medial thigh skin. The femoral branch enters the femoral sheath, laterally to the femoral artery, turns anteriorly and innervates the trigonum femorale skin (GARDNER et al., 1988).

In *Pan,* the genitofermoralis innervates the genital region and anterior-superior thigh per Hepburn (1892). In common with *Sapajus*, the genitofemoralis nerve in the other primates studied here has a L1 origin. However, the innervation and trajectory are dissimilar according to our observations and cited literatures.

Cutaneous femoris lateralis nerve

In *Sapajus,* the cutaneous femoris lateralis (Figure 1) originates from L1 and L2 as a branch from femoralis nerve. In modern humans, it originates from L2, L2 and L3 or L1 and L2 together with the femoralis nerve by connective tissues (GARDNER et al., 1988). According to Champneys (1871), the cutaneous femoris lateralis (called external cutaneous in that work) originates from T13 and L1 in *Pan*. On the other hand, per Swindler and Wood (1973), this nerve innervates the skin in the thigh (as a sensory nerve) and generally displays identical trajectory and innervation across *Papio*, *Pan* and modern humans.

The cutaneous femoris lateralis in bearded capuchins emerges between the psoas minor and major in the pelvis and lies downward on the psoas major under the lumbar vessels; it crosses the anterior wall on the obliquus externus abdominis and appears superficially to innervate the lateral skin of the thigh. In modern humans, it divides into two branches, lateral and other anterior ones that innervate respective regions of the thigh (GARDNER et al., 1988). In *Papio* and *Pan,* the cutaneous femoris lateralis travels in the subcutaneous tissues in the inferior limb to innervate the skin of the lateral and anterior thigh skin (SWINDLER; WOOD, 1973).

The origin of the cutaneous femoris lateralis in *Sapajus* is identical to that in *Pan*; as well, the trajectory and innervation are similar among the primates studied here.

Obturatorius nerve

The obturatorius nerve (Figures 1 and 2) originates from L2 and L3 in *Sapajus*. In modern humans, it originates from L3 and L4, sometimes from L2 and rarely from L5; and when the obturatorius accessorius nerve is present, it originates from L3 and L4, per the findings of Gardner et al. (1988), but Swindler and Wood (1973) notes additionally from L2 as one of composition of the obturatorius accessorius. In *Papio,* the obturatorius nerve originates from L4 to L6 (SWINDLER; WOOD, 1973). In *Pan,* it originates from L1 to L3, as per Swindler and Wood (1973) and from T13, L1 and L2, per Champneys (1871). Indeed, this discrepancy putatively can be ascribed to difference in vertebrae count by the different authors.

In *Sapajus,* the obturatorius nerve lies medially to the psoas major, downward anteriorly on the pelvic wall, passes through the foramen obturatum and penetrates the thigh where it innervates the adductor muscles, gracilis and semimembranosus (AVERSI-FERREIRA et al., 2011a). In modern humans, it innervates the adductor muscles, gracilis, pectineus (innervated via obturatorius accessorius when it exists), medial skin of the thigh and hip joints (GARDNER et al., 1988). In *Papio,* the obturatorius innervates the adductor muscles, gracilis and obturatorius internus, and in *Pan,* it innervates the adductor muscles, gracilis, obturatorius externus and pectineus (SWINDLER; WOOD, 1973). No obturatorius accessorius nerve was reported in baboons and chimpanzees and was not present in this work in bearded capuchins.

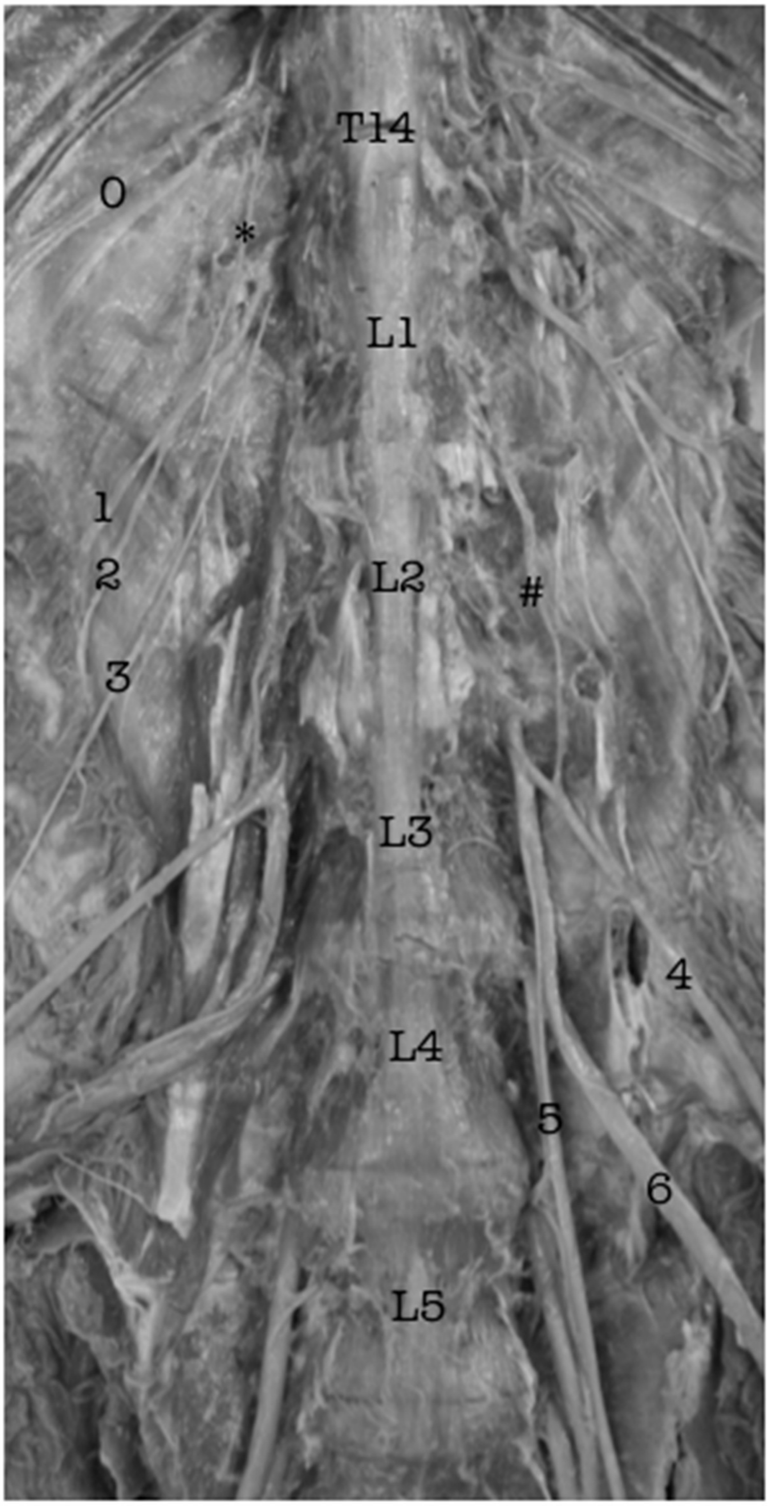

Figure 1 – Anterior view of a bearded capuchin. L) lumbar vertebra; T) thoracic vertebra; 0) the subcostal nerve; 1) the iliohypogastricus nerve; 2) the ilioinguinalis nerve; 3) the genitofemoralis nerve; 4) the cutaneous femoris lateralis nerve; 5) the obturatorius nerve; 6) the femoralis nerve; *) the component from the subcostal nerve to iliohypogastricus and ilioinguinalis nerves; #) the component from L1 to the femoralis nerve (1.4x)

Figure 2 – Anterior view of the pelvis of the bearded capuchin. L) the lumbar vertebra; S) the sacral vertebra; 5) the obturatorius nerve; 6) the femoralis nerve; 11) the ischiadius nerve (2x)

Femoralis nerve

The femoralis nerve (Figures 1 and 4) originates from L2 and L3 in *Sapajus*, and additionally L1 in one specimen. The origins of the femoral nerve are identical to those of the obturatorius nerve according to Swindler and Wood (1973) in *Papio*, *Pan* and modern humans (see section 3.1.5), but Champneys (1871) for *Pan* reported that the femoralis nerve (called anterior crural in that work) originates from T13 to L3.

The femoralis nerve in *Sapajus* emerges in the pelvis laterally to psoas major muscle, runs downward between the last one and the iliacus and penetrates in the thigh together with the artery and vein femoralis. In the thigh it emits muscular branches to the sartorius and quadriceps coxae muscles (AVERSI-FERREIRA et al., 2011a).

The femoralis nerve is bigger in modern humans than those in other primates, and it innervates the iliacus, quadriceps coxae, pectineus and sartorius muscles, anterior-medial skin thigh, medial skin leg, hip and knee joints (GARDNER et al., 1988).

The femoralis in *Pan* and *Papio* innervates the psoas major, psoas minor, iliacus, quadriceps coxae and pectineus (SWINDLER; WOOD, 1973).

Muscular branches to the piriformis, obturatorius internus, gemelli and quadratus femoris muscles

Small branches from the ischiadicus nerve to the piriformis, obturatorius internus, gemelli and quadratus femoris were observed in *Sapajus*. In modern humans, *Papio* and *Pan,* they have identical origins and pattern of innervation (CHAMPNEYS, 1871; SWINDLER; WOOD, 1973; GARDNER et al., 1988).

Gluteus Superior Nerve

The gluteus superior nerve (Figure 3) originates from ischiadicus in *Sapajus*, from L3-L4 in *Papio*, from T12-L2 in modern humans and from T13-L1 in *Pan* (SWINDLER; WOOD, 1973).

In *Sapajus,* the gluteus superior nerve passes through the ischiadicum foramen and emits muscular branches to the gluteus medius, minimus and scansorius. In modern humans, it innervates the tensor fasciae latae, gluteus medius and minimus (GARDNER et al., 1988), identically as in chimpanzees and baboons, but in chimpanzees, it also innervates the scansorius muscle (SWINDLER; WOOD, 1973).

Gluteus Inferior Nerve

In *Sapajus,* the gluteus inferior nerve (Figure 4) originates from the ischiadicus nerve. In modern humans, it originates from L5, S1 and S2 (GARDNER et al., 1988).

The gluteus inferior innervates the gluteus maximus in the non-human primates cited here (SWINDLER; WOOD, 1973; GARDNER et al., 1988) and additionally the ischiofemoralis muscles in bearded capuchins.

Cutaneous Femoris Posterior nerve

In *Sapajus,* the cutaneous femoris posterior (Figure 5) originates from two branches, S1 and ischiadicus nerve, runs under the piriform muscle, and emerges at the posterior lateral border of the tendon of the biceps femoris. In one case, it originated via L5 and ischiadicus nerve. However, we could not find the innervation in bearded capuchins.

In *Pan*, the cutaneous femoris posterior nerve originates from L3-L4 (CHAMPNEYS, 1871). In modern humans, it originates from S1, S2 and S3, and emits the gluteus branch to buttocks skin, and the perineal branch, which crosses the posterior muscles in the thigh, and innervates the posterior thigh and sural regions, and the external genitalia (GARDNER et al., 1988). In *Papio,* it runs subcutaneously between the lateral border of the tuber schiadicum and gluteus maximus and is located more laterally than in *Pan* and modern humans; in modern humans, *Pan* and *Papio,* it innervates the lateral thigh skin (SWINDLER; WOOD, 1973).

In modern humans, chimpanzees and baboons, the cutaneous femoris posterior nerve has identical origins and innervations. However, in *Papio,* the trajectory is different according to Swindler and Wood (1973), as noted above.

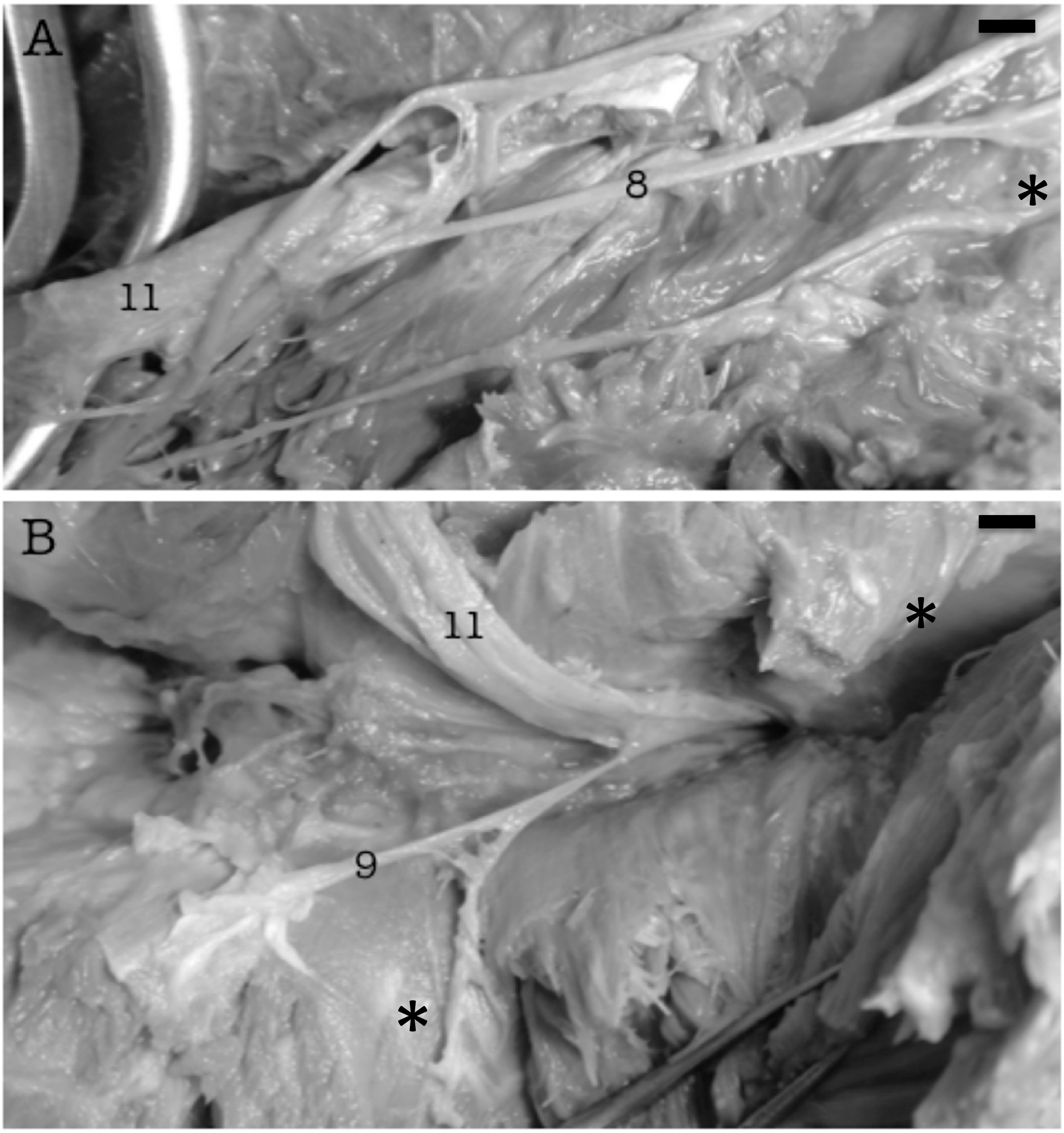

Figure 3 – Posterior lateral left view of the pelvic region of the bearded capuchin. A) in detail the gluteus superior nerve (8); B) in detail the gluteus inferior (9) and ischiadicus nerve (11); *) indicate a part of the gluteus muscles (1.1x)

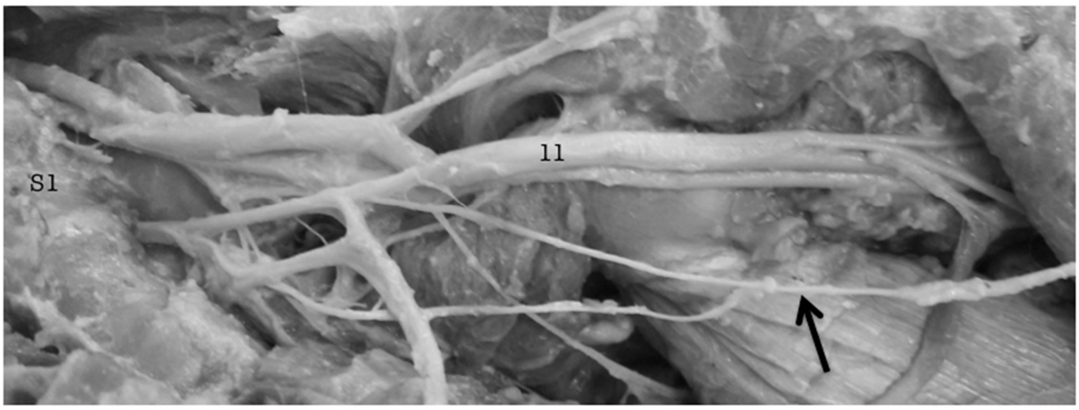

Figure 4 – Anterior lateral left view of the pelvis of the bearded capuchin. S1) the sacral vertebra 1; 11) the ischiadicus nerve. Arrow indicates the cutaneous femoris posterior nerve (1.1x)

Figure 5 – Anterior view of the pelvis and genital of the bearded capuchin. 11) the ischiadicus nerve; 12) the pudendus nerve; *) the penis; #) indicates the root of penis (2x)

Ischiadicus nerve

In *Sapajus*, the ischiadicus nerve (Figures 2, 3, 4, 5, 6 and 7) is the largest nerve analyzed here. It originates from L3, L4, L5, S1 and S2, emerges in the pelvis under the iliacus muscle, and runs inferiorly and posteriorly. Then, it passes through the greater ischiadicum foramen to emerge in the gluteus region on the gluteus minimus, gemelli muscles and obturatorius internus. It travels between the trochanter major and ischium bone, and innervates the biceps femoris, semitendinosus, semimembranosus, ischiofemoralis (AVERSI-FERREIRA et al., 2011a) and scansorius.

In *Papio,* the ischiadicus nerve originates from L5 to L7, and S1, in *Pan,* from L3-L4 and unites with S1-S3 (SWINDLER; WOOD, 1973). According to Champneys (1871), it originates from L3-L4 and S1-S2 in chimpanzees. The ischiadicus nerve originates from L4-L5 and S1-S3 in modern humans (SWINDLER; WOOD, 1973).

The ischiadicus nerve has identical origin and innervation in primates analyzed here except the innervation of the ischiofemoralis muscle that does not exist in modern humans.

Pudendus nerve

In *Sapajus*, the pudendus nerve (Figure 5) originates from S1, S2 and reaches the pudenda region.

In *Papio,* it originates from S1-S2, in *Pan,* from S2-S3, and in modern humans, from S2-S4. However, specific innervation by this nerve was not reported by Swindler and Wood (1973). In modern humans the pudendus nerve innervates the most part of the perineum, and divides into the rectal, perineum and dorsal nerves of the penile or clitoris nerve (GARDNER et al., 1988).

Figure 6 – Lateral view of the thigh of the bearded capuchin. 11) the ischiadicus nerve; 13) the flexores femoris innervating the hamstring muscles (1.2x)

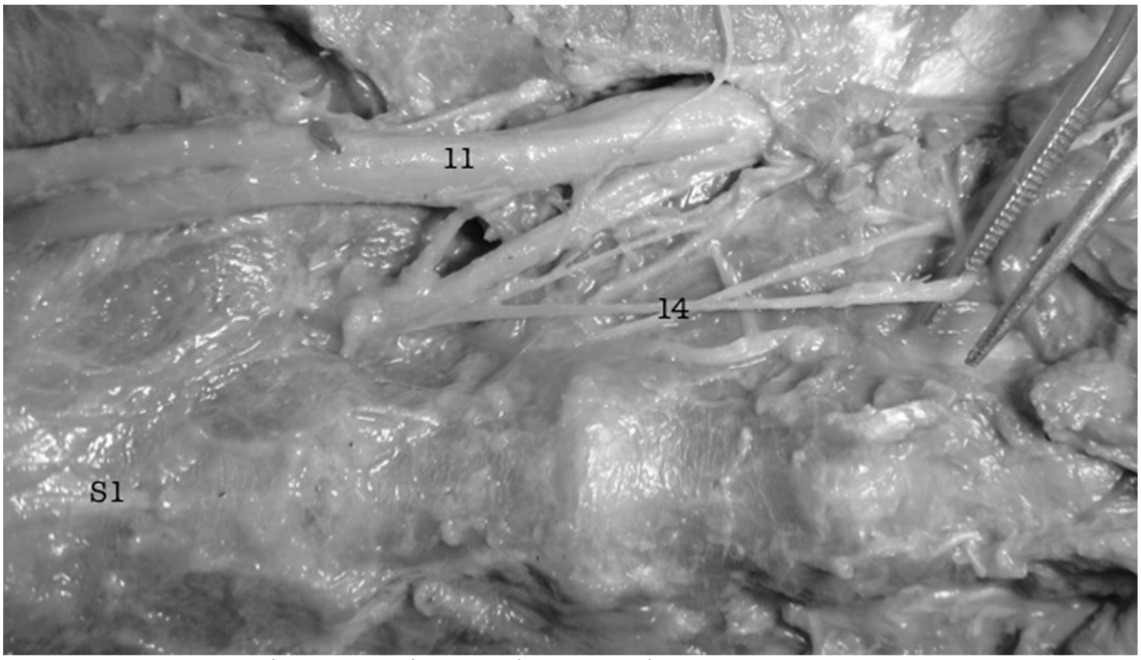

Figure 7 – Anterior view of the lateral left aspect of the pelvis of the bearded capuchin. S1) the sacral vertebra 1; 11) the ischiadicus nerve; 14) the puboischiofemoralis nerve (1.2x)

Flexores Femoris Nerve

In *Sapajus*, the flexores femoris (Figure 6) originates from ischiadicus nerve and innervates the hamstrings muscles.

The flexores femoris nerve is absent in modern humans and is only occasionally observed in *Pan* but always observed in *Papio* (SWINDLER; WOOD, 1973); it originates from a ventral part of the ischiadicus nerve and innervates the hamstring muscles in *Papio* and when it is present in *Pan* (SWINDLER; WOOD, 1973).

Puboischiofemoris nerve

In *Sapajus*, the puboischiofemoris nerve (Figure 7) originates from S1. It is absent in modern humans and *Pan*. However, according to Swindler and Wood (1973), it might correspond to a separate muscular branch to the short ischiofemoralis muscles in the hip.

In *Papio*, the puboischiofemoris innervates the gemelli muscles and obturatorius internus (SWINDLER; WOOD, 1973), in *Sapajus* it innervates the ischiofemoralis muscle.

Lumbar and Sacral plexus

In *Sapajus,* there is a lumbosacral plexus; the lumbar part is united with sacral part via L3, which is different from those by Barros (2002) reporting the existence of separate lumbar and sacral plexus in *Sapajus*. However, divergences are observed, i.e., Barros (2002) and Barros et al. (2003) reported 12 thoracic vertebrae. The discrepancy could be ascribed to presence of the 5 lumbar vertebrae in bearded capuchins in that study.

However, in a detailed study of *Sapajus* axial skeleton in this work, there were 7 cervical, 14 thoracic (with 14 ribs, the last 2 were very small), 4 lumbar, 3 sacral and 20 coccygeal vertebrae (Figure 8).

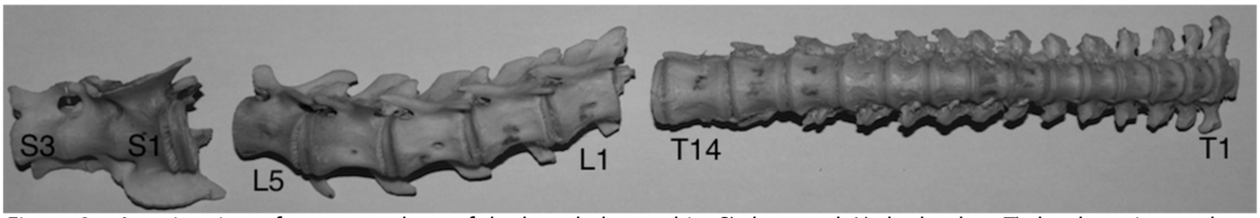

Figure 8 – Anterior view of some vertebrae of the bearded capuchin. S) the sacral; L) the lumbar; T) the thoracic vertebrae (0.5x)

Swindler and Wood (1973) note that in *Pan* there are 7 cervical, 13 thoracic, 4 lumbar and 6 sacral vertebrae; and in *Papio* there are 7 cervical, 13 thoracic, 7 lumbar and 3 sacral vertebrae. The numbers of cervical, thoracic and lumbar vertebrae are the same as those in Champneys (1871) and Swindler and Wood (1973). However, the last author reported 5 sacral and 4 coccigeal vertebrae as usually observed in *Pan*.

According to Champneys (1871) the general patterns of the nerves and those of the lumbar and sacral plexus of the pelvic limbs are very similar in *Pan* and modern humans. However, there is a big difference in composition of the plexus because of the divergence in the number of the thoracic vertebrae. Indeed, these anatomical dissimilarities induce mistakes in descriptions of the plexus formation and distributions of the nerves hampering the construction of a general model.

Conclusions

Although Swindler and Wood (1973) noted that arteries and nerves in the gluteal region in bearded capuchins display similar patterns to those in modern humans, chimpanzees and baboons, the present study indicated that the patterns of the pelvic nerves in the pelvis of the bearded capuchins are generally different in origins and innervation, probably because of the divergence in the number of the thoracic, lumbar, and sacral vertebrae (CHAMPNEYS, 1871); although the trajectories are more similar.

On the other hand, variation in the primates' nerves is common according to Swindler and Wood (1973), and those dissimilarities in trajectories could be more extensive because of the problem of the anatomical position; i.e., some primatologists used the human anatomical positions to describe anatomical structures in non-human primates, while others used anatomical positions in non-human primates, and the definition of anatomical positions (human or non-human position) was not clearly described. For instance, Swindler and Wood (1973) used the human anatomical positions in their extensive studies in primates.

Other sources of variations in description of the nerves, *inter alia*, are 1) the lateralized and semi-bend of the pelvis limbs in nonhumans primates compared with modern humans and 2) the absence of the some muscles (e.g., scansorius and ilioschiofemoralis) in the thigh in modern humans.

It is also essential to define specific anatomical positions in primate research. When the anatomical data are applied to evolutionary, taxonomy and phylogenetic studies, errors could be propagated indefinitely and incorrect conclusions and hypothesis will be obtained (AVERSI-FERREIRA et al., 2014a).

Therefore, it is impossible to make exact correspondence among the pelvic nerves in the primates studied in this work, because of, *inter alia*, the difference in the numbers of vertebrae among the authors even in the same species, such as chimpanzees and bearded capuchins.

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Table 1 – Comparative descriptions of the pelvic nerves of the *Sapajus* sp, *Papio, Pan* and modern humans. O = Origin from; E = Emits – Palmas – 2015

	***Sapajus* sp**		***Papio***		***Pan***		**Modern humans**	
	O	**E**	**O**	**E**	**O**	**E**	**O**	**E**
Iliohypogastricus nerve	T13 (a subcostal nerve contribution)-T14.	It lies on the lateral wall of abdomen and emits two branches, the lateral and anterior branches.	L1, L2 (SWINDLER; WOOD, 1973).	No data in the consulted literature.	Subcostalis nerve, L1 (SWINDLER; WOOD, 1973) T13 (CHAMPNEYS, 1871).	No data in the consulted literature.	T12, L1, L2 (GARDNER et al., 1988).	The lateral cutaneous branch innervates the skin laterally to the buttocks and the anterior cutaneous branch innervates the skin up to the pubis bone (GARDNER et al., 1988).
Ilioinguinalis nerve	T13 (a subcostal nerve contribution)-T14. From Iliohypogastricus nerve.	It has two muscular branches, one for the transversus abdominis and other for the rectus abdominis; it continues and cross the abdominal fascia.	L1, L2 (SWINDLER; WOOD, 1973).	No data in the consulted literature.	T13, L1 (SWINDLER; WOOD, 1973). T13 (CHAMPNEYS, 1871).	No data in the consulted literature.	T12 and occasionally from L2 (GARDNER et al., 1988).	Cutaneous branches to the thigh, innervates the scrotum or labia majora (GARDNER et al., 1988).

Genitofemoralis nerve	T14.	It lies in downward obliquely for the region abdominal and pelvic, placed between the ilioinguinalis and cuteaneus femoris lateralis; in the inguinalis region, it crosses the abdominal wall and innervates the skin in this place.	L3, L4 (SWINDLER; WOOD, 1973).	No data in the consulted literature.	T13, L1 (CHAMPNEYS, 1871; SWINDLER; WOOD, 1973).	It innervates the genital region and anterior-superior thigh according (HEPBURN, 1892).	It is formed via L1, sometimes via L2, L1 plus L2 and rarely via L3 (GARDNER et al., 1988).	Genital and a femoral branch (GARDNER et al., 1988).
Cutaneous femoris lateralis nerve	L1-L2.	It crosses the anterior wall on the obliquus externus abdominis and appears superficially to innervate the lateral skin of thigh.	Sensorial branch associated to deep motor nerves (SWINDLER; WOOD, 1973).	It distributes into subcutaneous tissues in the inferior limb to supplies the skin of the lateral and anterior thigh skin (SWINDLER; WOOD, 1973).	T13, L1 (CHAMPNEYS, 1871).	It distributes into subcutaneous tissues in the inferior limb to supplies the skin of the lateral and anterior thigh skin (SWINDLER; WOOD, 1973).	L2, L2 and L3 or L1 and L2 in association with the femoralis nerve by connective tissue (GARDNER et al., 1988).	It divides into two branches, a lateral and other anterior that innervate respective regions of the thigh (GARDNER et al., 1988).
Obturatorius nerve	L2-L3	It innervates the adductor muscles, gracilis and semimembranosus.	L4, L5, L6 (SWINDLER; WOOD, 1973).	It innervates the adductor muscles, gracilis and obturatorius internus (SWINDLER; WOOD, 1973).	L1, L2, L3 (SWINDLER; WOOD, 1973). T13, L1 and L2 (CHAMPNEYS, 1871).	It innervates the adductor muscles, gracilis, obturatorius externus and pectineus (SWINDLER; WOOD, 1973).	It originates from L3 and L4, sometimes from L2 and rarely from L5; and when is present an obturatorius accessorius nerve, it originates from L3 and L4 (GARDNER et al., 1988), and additionally L2 (SWINDLER; WOOD, 1973).	It supplies the adductor muscles, gracilis, pectineus (innervated via obturatorius accessorius when present), medial skin of thigh and the hip joints (GARDNER et al., 1988).

Femoralis nerve	L2-L3.	It emits muscular branches to sartorius and quadriceps coxae[6].	L4, L5, L6 (SWINDLER; WOOD, 1973).	It innervates the psoas major, psoas minor, iliacus, quadriceps coxae and pectineus (SWINDLER; WOOD, 1973).	L1, L2, L3 (SWINDLER; WOOD, 1973). T13, L1, L2, L3 (CHAMPNEYS, 1871).	It innervates the psoas major, psoas minor, iliacus, quadriceps coxae and pectineus (SWINDLER; WOOD, 1973).	It originates from L3 and L4, sometimes from L2 and rarely from L5 (GARDNER et al., 1988).	It innervates the iliacus, quadriceps coxae, pectineus and sartorius muscles, anterior-medial skin thigh, medial skin leg and hip and knee joints (GARDNER et al., 1988).
Gluteus superior Nerve	It is a branch from ischiadicus.	It emits muscular branches to gluteus medius, minimus and scansorius.	No data in the consulted literature.	It innervates the tensor fasciae latae, scansorius, gluteus medius and minimus (SWINDLER; WOOD, 1973).	L3, L4, S1 (CHAMPNEYS, 1871; SWINDLER; WOOD, 1973).	It innervates the tensor fasciae latae, scansorius, gluteus medius and minimus (SWINDLER; WOOD, 1973).	L4, L5, S1 (GARDNER et al., 1988).	It innervates the tensor fasciae latae, gluteus medius and minimus (GARDNER et al., 1988).
Gluteus inferior Nerve	It is a branch from ischiadicus.	It innervates the gluteus maximus and the ischiofemoralis.	No data in the consulted literature.	It innervates the gluteus maximus (SWINDLER; WOOD, 1973).	No data in the consulted literature.	It innervates the gluteus maximus (SWINDLER; WOOD, 1973).	L5, S1, S2 (GARDNER et al., 1988).	It innervates the gluteus maximus (SWINDLER; WOOD, 1973; GARDNER et al., 1988).
Cutaneous femoris posterior nerve	It is a branch from S1 and ischiadicus nerve. In one case, it originated from L5 and ischiadicus nerve.	It was not possible to observe.	No data in the consulted literature.	It innervates the ischial callosity and lateral thigh skin (SWINDLER; WOOD, 1973).	No data in the consulted literature.	It innervates the ischial callosity and lateral thigh skin (SWINDLER; WOOD, 1973).	S1, S2, S3[20].	It emits the gluteus branches for buttocks skin, the perineal branches that cross the posterior muscles of thigh and innervates the posterior thigh and sural regions, and innervates the external genitalia (GARDNER et al., 1988). It innervates the ischial callosity and lateral thigh skin (SWINDLER; WOOD, 1973).
Ischiadicus nerve	L4, L5, S1 and S2.	It innervates the biceps femoris, semitendinosus, semimembranosus, ischiofemoralis[6] and scansorius.	L5, L6, L7, S1 (SWINDLER; WOOD, 1973).	It innervates the biceps femoris, semitendinosus, semimembranosus and ischiofemoralis (SWINDLER; WOOD, 1973).	L3, L4, S1, S2, S3 (SWINDLER; WOOD, 1973). L3, L4, S1, S2 (CHAMPNEYS, 1871).	It innervates the biceps femoris, semitendinosus, semimembranosus and ischiofemoralis (SWINDLER; WOOD, 1973).	L4, L5, S1, S2 e S3[20].	It innervates the biceps femoris, semitendinosus, semimembranosus (SWINDLER; WOOD, 1973).
Pudendus nerve	S1-S2.	It innervates the pudenda region.	S1, S2 (SWINDLER; WOOD, 1973).	No data in the consulted literature.	S2, S3 (SWINDLER; WOOD, 1973).	No data in the consulted literature.	S2, S3 e S4[20].	S2, S3; S4 (GARDNER et al., 1988).

Flexores femoris Nerve	It originates from ischiadicus nerve.	It innervates the hamstrings muscles.	It originates from ventral part of the ischiadicus nerve (SWINDLER; WOOD, 1973).	It innervates the hamstrings muscles (SWINDLER; WOOD, 1973).	When it is present, it originates from ventral part of the ischiadicus nerve (SWINDLER; WOOD, 1973).	When it is present, it innervates the hamstrings muscles (SWINDLER; WOOD, 1973).	Absent.	Absent.
Puboischiofemoris nerve	S1.	The branches innervate the ischifemoralis.	No data in the consulted literature.	It innervates the gemelli muscles and obturatorius internus (SWINDLER; WOOD, 1973).	No data in the consulted literature.	When it is present, it innervates the ischiofemoralis muscle (SWINDLER; WOOD, 1973).	Absent.	Absent.
Muscular branches to the piriformis, obturatorius internus, gemelli and quadratus femoris muscles	They originate via small branches from ischiadicus nerve	They innervate the muscles with its respective names.	From small branches from ischiadicus nerve (SWINDLER; WOOD, 1973).	They innervate the muscles with its names (SWINDLER; WOOD, 1973).	From small branches from ischiadicus nerve (SWINDLER; WOOD, 1973).	They innervate the muscles with its names (SWINDLER; WOOD, 1973).	From small branches from ischiadicus nerve.	They innervate the muscles with its names (SWINDLER; WOOD, 1973).

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