

The spinal nerves that constitute the brachial plexus in the red squirrel (*Sciurus vulgaris*)

A. AYDIN

Faculty of Veterinary Medicine, Firat University, Turkey

ABSTRACT: The brachial plexus in adult red squirrels (*Sciurus vulgaris*) was found to be formed by the rami ventralis of C5, C6, C7, C8. A thin branch of C5 and C6 constituted the cranial trunk, and the caudal trunk was formed completely by the rami ventralis of C7 and C8. Thus, in squirrels, the spinal nerves which form the brachial plexus and the joining of these spinal nerves to each other differ from other rodents and mammals.

Keywords: spinal nerves; rami ventralis; brachial plexus; red squirrels

List of abbreviations

m = musculus, C5 = ramus ventralis of C5, C6 = ramus ventralis of C6, C7 = ramus ventralis of C7, C8 = ramus ventralis of C8

Rodents (*Rodentia*), which are the widest order of placental mammals, comprise more than half of all known mammals. The red squirrel is a representative of the Sciuridae family, which constitutes a group of the order *Rodentia* (Karol, 1963; Weichert, 1970; Kuru, 1987; Demirsoy, 1992). Several studies have investigated the spinal origins of the brachial and lumbosacral plexus which give off nerve branches dispersing to the fore and hind limbs. These include reports on the brachial plexus in dogs (Miller et al., 1964), cats (Getty, 1975), wervet monkeys (Booth, 1991), Chacma baboons (Booth et al., 1997), rabbits (Aslan, 1994; Yilmaz et al., 1995), rats (Green, 1968; Chiasson, 1980) and porcupines (Aydin, 2003, 2004); and on the lumbosacral plexus in dogs (Miller et al., 1964; Getty, 1975), rabbits (Barone et al., 1973; McLaughlin and Chiasson, 1987), rats (Green, 1968; Chiasson, 1980; Asato et al., 2000) and porcupines (Aydin, 2009; Aydin et al., 2009). In squirrels, the presence and localization of calbindin-D28k in the kidney and cerebellum (Aydin et al., 2005), the morphology of circulus arteriosus cerebri (Aydin, 2008), the spinal nerves that constitute the plexus lumbosacrales (Aydin,

2010), as well as the arteries originating from the aortic arch (Aydin, 2011), have been studied. However, there have been no investigations into the spinal origin of the brachial plexus. Hence, the aim of this study was to investigate the spinal nerves forming the brachial plexus in squirrels.

MATERIAL AND METHODS

Ten adult squirrels caught by villagers in Eastern Anatolia were used for this study. To document the spinal nerves forming the brachial plexus, skin and muscles were carefully dissected. The brachial plexus in both forelimbs were examined and pictured. For terminology, the *Nomina Anatomica Veterinaria* was used (World Association of Veterinary Anatomists, 2005).

RESULTS

The brachial plexus was formed by the ventral rami of the C5, C6, C7 and C8 in red squirrels.

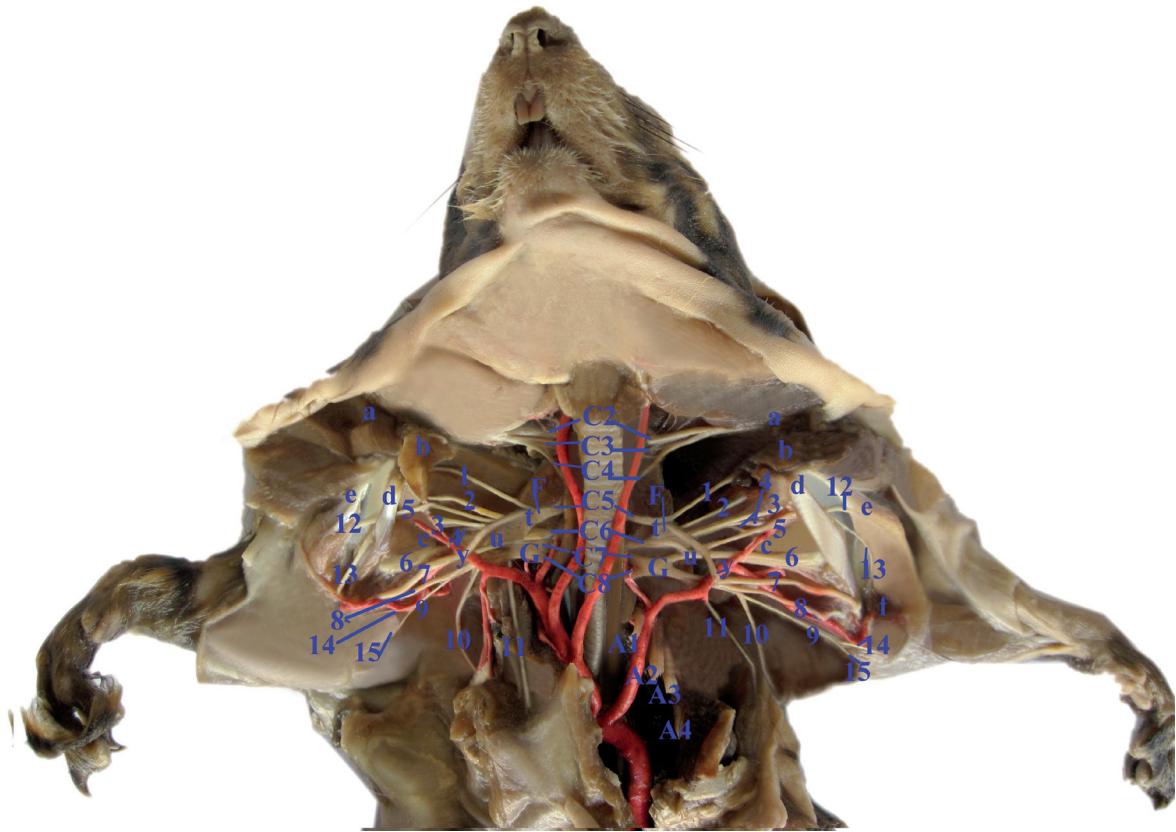


Figure 1. Medial view of the brachial plexus in the red squirrel (*Sciurus vulgaris*). C4 = ramus ventralis of C4, C5 = ramus ventralis of C5, C6 = ramus ventralis of C6, C7 = ramus ventralis of C7, C8 = ramus ventralis of C8, F = cranial gövde, G = caudal gövde, A1 = costa I, A2 = costa II, A3 = costa III, A4 = costa IV, t = branch binding from C5 to C6, u = branch constituted by the union of branches which came from the cranial and caudal trunk, y = branch stretching from C5 to the median nerve, 1 = cranial pectoral nerve, 2 = suprascapular nerve, 3 = axillary nerve, 4 = subscapular nerves, 5 = ramus muscular nerve, 6 = radial nerve, 7 = median nerve, 8 = ulnar nerve, 9 = cutaneus antebrachi medial et caudal nerve, 10 = caudal pectoral nerve (the thoracodorsal nerve), 11 = caudal pectoral nerve (the thoracicus long nerve), 12 = ramus proximalis muscle, 13 = ramus distalis muscle, 14 = cutaneus antebrachi medial nerve, 15 = cutaneus antebrachi caudal nerve, a = pectoralis ascendens muscle, b = pectoralis transversus muscle, c = subscapular muscle, d = coracobrachial muscle, e = biceps brachii muscle, f = brachial muscle, g = pectoralis descendens muscle

While forming the brachial plexus by the ventral rami of C5, C6, C7 and C8, a branch from the ventral ramus of C5 formed the cranial trunk by connecting to C6, and by the complete joining together of the ventral ramus of C7 and C8 the caudal trunk was formed. The main part of the cranial trunk formed by C6 and C5 contributed to this trunk with a thin branch (Figure 1).

The ventral rami of C7 and C8 completely joined to form the caudal trunk. One branch originated from the caudal trunk and one branch originated from the cranial trunk. After joining to each other, the radial and the caudal pectoral nerve (the thoracodorsal nerve) originated from the caudal trunk. After giving a branch to the cranial trunk the ventral ramus of

C5 gave branches, firstly to the cranial pectoral nerve, secondly to the distal and proximal muscular rami dispersing to the coracobrachial, the biceps brachial and brachial muscles and finally the continuation of the ventral ramus of C5 participated in the median nerves on the medial of the axillary artery.

The ventral ramus of C6 formed the cranial trunk by taking a thin branch from C5, and the suprascapular, the axillary and the subscapular nerves originated from this trunk.

The ventral rami of C7 and C8 formed the caudal trunk by joining completely from this trunk. From this trunk the median, the ulnar, the caudal pectoral (the thoracicus long nerve) and the caudal and medial cutaneous antebracheal nerves originated.

DISCUSSION

There are contradictory reports in certain species regarding the formation of the brachial plexus. According to Green (1968) and Chiasson (1980), the brachial plexus of rats is formed through the contribution of ventral rami of C5, C6, C7, C8, T1 and T2. However, Bertelli et al. (1992) reported that the ramus ventralis of T2 is not involved. Yilmaz et al. (1995) reported that the brachial plexus of rabbits is formed by the ventral rami of C5, C6, C7, C8, T1 and T2, while Aslan (1994) and McLaughlin and Chiasson (1987) reject the contribution of C5 and T2. The brachial plexus is formed by the ventral rami of C5, C6, C7, C8 and T1 in mice (Bogusch, 1987), by the rami ventralis of C5, C6, C7, C8, T1 and T2 in the Wervet monkeys (Booth, 1991) Chacma baboons (Booth et al., 1997) and in porcupines (Aydin, 2003), and through the contribution of the ventral rami of C6, C7, C8 and T1 in cats (McClure et al., 1973; Getty, 1975). Tipirdamaz and Erden (1988) and Dursun et al. (1994) reported that in dogs the brachial plexus is formed by the ventral rami of C6, C7, C8, T1 and T2, while Miller et al. (1964) and Getty (1975) reported that T2 is occasionally involved. Our results are not in agreement with all reports due to the fact that the ventral rami of T1 and T2 did not join to the formation of the brachial plexus in squirrels.

The brachial plexus in red squirrels (*Sciurus vulgaris*) was reported to consist of caudal and cranial trunks as is the case in rabbits (Yilmaz et al., 1995) and in porcupines (Aydin, 2003); in this respect it differs from the brachial plexus of rats (Bertelli et al., 1992) and Chacma baboons (Booth et al., 1997), which are formed from caudal, medial and cranial trunks.

In conclusion, although the brachial plexus resembles a network in rats, mice and other mammals, in red squirrels (*Sciurus vulgaris*) it has been determined to consist of two cranial and caudal trunks formed by the ventral rami of C5, C6, C7, C8, similar to rabbits (Yilmaz et al., 1995), and porcupines (Aydin, 2003).

REFERENCES

- Asato F, Butler M, Blomberg H, Gordh T (2000): Variation in rat sciatic nerve anatomy: Implications for a rat model of neuropathic pain. *Journal of the Peripheral Nervous System* 5, 19–21.
- Aslan K (1994): The comparative macroanatomic investigation on the brachial plexus of the native cat (*Felis domestica*) and White New Zealand Rabbit (*Oryctolagus cuniculus*). *Istanbul University, Faculty of Veterinary Medicine Journal* 20, 197–208.
- Aydin A (2003): Brachial plexus in the porcupine (*Hystrix cristata*). *Veterinarni Medicina* 48, 301–304.
- Aydin A (2004): Nerves originating from brachial plexus in the porcupine (*Hystrix cristata*). *Veterinarni Medicina* 49, 123–128.
- Aydin A (2008): The morphology of circulus arteriosus cerebri in the red squirrel (*Sciurus vulgaris*). *Veterinarni Medicina* 53, 272–276.
- Aydin A (2009): The dissemination of pelvic limb nerves originating from the lumbosacral plexus in the porcupine (*Hystrix cristata*). *Veterinarni Medicina* 54, 333–339.
- Aydin A (2010): The spinal nerves that constitute the plexus lumbosacrales of the red squirrel (*Sciurus vulgaris*). *Veterinarni Medicina* 55, 183–186.
- Aydin A (2011): The arteries originating from the aortic arch and the branches of these arteries in red squirrels (*Sciurus vulgaris*). *Veterinarni Medicina* 56, 131–134.
- Aydin A, Karan M, Timurkaan S (2005): Presence and localization of calbindin-D28k in the kidney and cerebellum of the red squirrel (*Sciurus vulgaris*). *Revue de Medecine Veterinaire* 136, 434–436.
- Aydin A, Dinc G, Yilmaz S (2009): The spinal nerves that constitute the plexus lumbosacrales of porcupines (*Hystrix cristata*). *Veterinarni Medicina* 54, 194–197.
- Barone R, Pavaux C, Blin PC, Cuq P (1973): *Atlas of Rabbit Anatomy*. Masson & Cie, Paris. 158–174.
- Bertelli JA, Mira JC, Gilbert A, Michot G.A, Legagneux J (1992): Anatomical basis of rat brachial plexus reconstruction. *Surgical and Radiologic Anatomy* 14, 85–86.
- Bogusch G (1987): Innervations of the dermatomes in the neck of the mouse. *Acta Anatomy* 129, 275–278.
- Booth KK (1991): The brachial plexus in the vervet monkey (*Cercopithecus pygerythrus*). *Journal of Medical Primatology* 20, 23–28.
- Booth KK, Baloyi FM, Lukhele OM (1997): The brachial plexus in the chacma baboon (*Papio ursinus*). *Journal of Medical Primatology* 26, 196–203.
- Chiasson RB (1980): *Laboratory Anatomy of the White Rat*. Wm. C. Brown Company Publishers, USA.
- Demirsoy A (1992): *Rodentia. The Basic Rules of Life*. Meteksan Anonim Sirketi, Ankara. 695–729.
- Dursun N, Tipirdamaz S, Gezici M (1994): Macroanatomic investigations on the brachial plexus in Kangal dogs. *Journal of Veterinary Science, University of Selcuk* 10, 78–80.

- Getty R (1975): Sisson and Grossman's the Anatomy of the Domestic Animals. 5th ed. W.B. Saunders Company, Philadelphia. 1700–1718.
- Green CE (1968): Anatomy of the Rat. Hafner Publishing Company, New York, London. 124–153.
- Karol S (1963): Dictionary of the Zoology Terms. Turkish History Institution Press, Ankara. 192–193.
- Kuru M (1987): Rodentia. The Vertebrate Animals. Atatürk University, Basım, Erzurum. 551–564.
- McClure RC, Dallman MJ, Garret PG (1973): Cat Anatomy. Lea and Febiger, Philadelphia. 66 pp.
- McLaughlin CA, Chiasson RB (1987): Laboratory Anatomy of the Rabbit. Wm. C. Brown Company Publishers, Dubuque, Iowa. 60–62.
- Miller M, Christensen G, Evans H (1964): Anatomy of the Dog. W.B. Saunders Company, Philadelphia. 578–589.
- Nomina Anatomica Veterinaria (2005): 4th ed. Copyright by the World Association of Veterinary Anatomists. 79–80.
- Tipirdamaz S, Erden H (1988): Macroanatomic investigations on the brachial plexus of the dogs. Journal of Veterinary Science, University of Selcuk 4, 317–332.
- Weichert CK (1970): The Anatomy of the Choradates. 4th ed. McGraw-Hill, London. 500–738.
- Yilmaz O, Yildiz H, Yildiz B, Serbest A (1995): Morphological and morphometrical investigations on fascicle of ventral branches forming brachial plexus and nerves originating from plexus in White New Zealand Rabbits (*Oryctolagus cuniculus*). Hundredth year University, Faculty of Veterinary Medicine Journal 6, 67–75.

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Corresponding Author:

Dr. Ali Aydin, DVM, PhD, University of Firat, Faculty of Veterinary Medicine, Department of Anatomy, 23119 Elazig, Turkey
Tel. +90 424 237 00 00-3958, Fax +90 424 238 81 73, E-mail: aydina@firat.edu.tr; aliydin02@hotmail.com
