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Ultrasound-guided anaesthetic blockade of the pelvic limb in calves

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ABSTRACT

This study aimed to describe a suitable acoustic window to facilitate access to the sciatic and femoral nerves in calves and to study the effects of their blockade with local anaesthetics. The neuroanatomical and ultrasound (US) study was performed on the cadavers of 10 calves, and the effects of 2% lidocaine with epinephrine (0.2 mL/kg) were determined in five healthy calves.

The sciatic nerve in the cadavers was easily visualised as a hyperechoic band distal to the femoral greater trochanter and caudal to the femoral shaft. The femoral nerve in the cadavers was not easily identified, and was visualised as a hyperechoic oval structure situated immediately medial to the psoas major muscle and lateral to the femoral artery. The sciatic nerve was stained by methylene blue, injected under US guidance, in 9/10 cases, and the femoral nerve was stained in 6/10 cases.

Sciatic nerve blockade under US guidance produced adduction of the limb with metatarsophalangeal joint flexion, while the femoral nerve blockade produced reduced weight bearing. The sciatic nerve blockade produced a reduced response to the noxious stimulus, mainly in the phalanges, proximal and distal metatarsus, tarsus and tibia and, following the femoral nerve blockade, in the medial subarea of the femur. However, femoral nerve blockade produced a more variable degree of blockade. In conclusion, US -guided anaesthetic blockade of the sciatic nerve in calves may be considered for surgery in the distal pelvic limb, although further studies are necessary to determine its clinical application.

Introduction

Loco-regional anaesthetic techniques are commonly employed in cattle under sedation to perform most common surgeries, potentially reducing the risks associated with general anaesthesia while providing adequate analgesia (Edmondson, 2008). When surgical procedures are required in the distal part of the pelvic limbs, local and regional anaesthesia can be performed using different techniques, such as ring blocks, intravenous regional anaesthesia, epidural anaesthesia, nerve block (Skarda, 1996) or general anaesthesia. Nerve block of the pelvic limbs usually involves the peroneal and tibial nerves (Thurmon and Ko, 1997), although this method is rarely used in clinical practice due to the difficulty of identifying the proper injection site for the local anaesthetic (Skarda, 1996).

In people, combined anaesthetic block of the sciatic and femoral nerves has been shown to provide adequate analgesia of the legs (Enneking et al., 2005), and recent data support the usefulness of these techniques in dogs and cats (Campoy et al., 2010; Echeverry et al., 2010, 2012; Shilo et al., 2010; Haro et al., 2012). Blockade of the peripheral nerves can be improved through nerve stimulation (Mahler and Adogwa, 2008; Rioja et al., 2012) and ultrasound (US) guidance (Campoy et al., 2010; Echeverry et al., 2010, 2012; Shilo et al., 2010; Costa-Farre et al., 2011). Both techniques are complementary. Peripheral nerve blockade should be based on the neuroanatomy of the species considered (Mahler and Adogwa, 2008). In calves, there are no studies describing the neuroanatomy of the sciatic and femoral nerves.

The objective of the present study was to describe in cadavers an acoustic window that facilitated access to the sciatic and femoral nerves and to describe, in live calves the clinical application of blockade of these nerves produced by the administration of local anaesthetics under US guidance.

Materials and methods

All animal use was approved by the University Complutense Institutional Animal Care and Use Committee (CEA-UCM 100/2012, 14 June 2012).

Phase 1: Anatomical study of the sciatic and femoral nerves

For the anatomical dissection of the sciatic and femoral nerves, cadavers of four calves (19 ± 9 days old, weighing 37 ± 5 kg) were used. For the sciatic nerve, a skin incision was made from the greater trochanter, caudal and distal to the crural region, to expose the lateral aspect of the pelvic limb. A transverse incision was made in the gluteobiceps muscle to expose the nerve. For the femoral nerve, the incision was

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Table 1
Maximum score and duration in minutes (in parentheses) obtained following sciatic nerve blockade in 10 pelvic limbs from five calves in the different subareas: lateral (L), dorsal (D), medial (M) and plantar (P) subareas of the phalanx, distal and proximal metatarsus and lateral, cranial (Cr), medial and caudal (Ca) subareas of the tibia and the tarsus and lateral subarea of the femur and the knee (0, positive normal response to stimuli; 1, diminished response to the stimulus; 2, negative response). Duration of 0 min indicates that the maximum score was achieved only at one time point. The number of limbs where a score of 2 was determined is shown in the last row.

Animal – Limb	Phalanx				Distal metatarsus				Proximal metatarsus			
	L	D	M	P	L	D	M	P	L	D	M	P
1 Left	2 (70)	2 (70)	2 (70)	2 (30)	2 (20)	2 (80)	2 (20)	2 (0)	2 (20)	2 (80)	1 (40)	2 (30)
1 Right	2 (20)	2 (0)	1 (30)	1 (0)	2 (0)	1 (70)	1 (30)	2 (0)	2 (10)	2 (0)	2 (0)	1 (50)
2 Left	2 (0)	2 (0)	1 (80)	1 (80)	2 (0)	2 (0)	2 (0)	2 (40)	1 (60)	2 (0)	2 (0)	2 (0)
2 Right	2 (70)	2 (0)	2 (50)	2 (40)	2 (40)	2 (0)	2 (40)	2 (50)	2 (40)	2 (40)	2 (50)	2 (80)
3 Left	2 (80)	2 (80)	2 (80)	2 (80)	2 (70)	2 (50)	2 (50)	2 (40)	2 (80)	2 (70)	1 (80)	2 (70)
3 Right	2 (80)	2 (80)	2 (80)	2 (60)	2 (40)	2 (40)	2 (80)	2 (30)	2 (80)	2 (80)	1 (70)	2 (10)
4 Left	2 (80)	2 (80)	2 (80)	2 (80)	2 (80)	2 (80)	2 (80)	2 (60)	2 (80)	2 (80)	1 (80)	2 (80)
4 Right	2 (70)	2 (70)	2 (80)	2 (70)	2 (70)	2 (70)	2 (80)	2 (70)	2 (70)	2 (80)	1 (80)	2 (80)
5 Left	2 (40)	2 (40)	2 (30)	2 (30)	2 (40)	2 (40)	2 (30)	2 (30)	2 (40)	2 (40)	1 (50)	2 (40)
5 Right	2 (60)	2 (60)	2 (0)	2 (60)	2 (70)	2 (70)	2 (70)	2 (60)	2 (70)	2 (70)	1 (80)	2 (70)
Score = 2(n)	10	10	8	8	10	9	9	10	9	10	3	9

Animal – Limb	Tarsus				Tibia				Knee	Femur
	L	Cr	M	Ca	L	Cr	M	Ca	L	L
1 Left	2 (50)	2 (10)	1 (20)	2 (50)	2 (10)	1 (40)	0	2 (60)	0	0
1 Right	2 (10)	1 (40)	1 (20)	2 (20)	1 (60)	1 (40)	2 (0)	2 (30)	1 (30)	1 (10)
2 Left	2 (0)	1 (60)	1 (80)	2 (40)	1 (80)	1 (70)	1 (50)	2 (10)	1 (0)	1 (0)
2 Right	2 (80)	2 (10)	2 (20)	2 (50)	2 (50)	1 (80)	2 (20)	2 (80)	0	0
3 Left	2 (80)	2 (70)	1 (80)	2 (80)	2 (80)	1 (80)	1 (80)	2 (80)	0	0
3 Right	2 (80)	2 (30)	1 (30)	2 (60)	2 (60)	1 (80)	1 (80)	2 (60)	0	0
4 Left	2 (80)	2 (80)	2 (0)	2 (80)	2 (80)	1 (80)	2 (0)	2 (80)	1 (80)	1 (80)
4 Right	2 (80)	2 (80)	1 (80)	2 (80)	2 (80)	1 (80)	1 (80)	2 (80)	0	0
5 Left	2 (40)	2 (30)	2 (10)	2 (40)	2 (50)	2 (20)	2 (10)	2 (40)	1 (30)	1 (30)
5 Right	2 (70)	2 (70)	2 (10)	2 (80)	2 (80)	1 (80)	1 (80)	2 (80)	1 (40)	1 (40)
Score = 2(n)	10	8	4	10	8	1	4	10	0	0

made over the tensor fasciae latae muscle, and the muscle was resected to expose the ventral border of the major psoas muscle, where a short free segment of the femoral nerve was found to run towards the quadriceps muscle. One further cadaver was frozen (–20 °C for 8 days) and cryosectioned into 2.5 cm sections from the hip joint to the knee. Photographs were taken for comparison with the US images.

Phase 2: Ultrasound-guided nerve blockade in cadavers

For the US-guided nerve blockade both pelvic limbs from five fresh cadavers (aged 15 ± 8 days, weighing 38 ± 5 kg) were examined using a Logik Book XP (G&E Healthcare) with a 6–10 MHz linear transducer. The transducer was placed between the greater trochanter of the femur and the ischial tuberosity to visualise the sciatic nerve, and it was moved distally, following the path of the nerve, to obtain transverse images. To identify the femoral nerve, the transducer was placed ventral to the wing of the ilium and along the longitudinal axis of the femoral nerve and rotated 90° to obtain transverse sections. The depths at which the sciatic and femoral nerves were located were recorded. Finally, a suitable acoustic window was selected to perform the blockade of these nerves. The sciatic and femoral nerves (transverse sections) were then injected with 0.2 mL/kg of methylene blue using a 20G spinal needle (Becton Dickinson). The needle was inserted perpendicular to the nerves, with the direct observation of the advancement of the needle. Once the tip of the needle approached within 1 mm of the nerves, the dye was administered. The pelvic limbs were immediately dissected to macroscopically to verify the staining of the nerves and the length of the stain.

Phase 3: Ultrasound-guided nerve blockade in live calves

For the US-guided nerve blockade, five calves (three Friesians and two crossbreds, aged 2.9 ± 1.4 months and weighing 86 ± 48 kg) were used. The left and right sciatic and femoral nerves were blocked unilaterally using the acoustic window defined in Phase 2. Nerves were blocked in a random order at 1-week intervals, so each calf was used four times. For 2 weeks before the start of the experiment, the calves were acclimated to the restraining device in a standing position with the head fixed (1 h daily). Food, but not water, was withheld overnight prior to blockade.

Within 5 min of being put into the restraining device, the calves were sedated with 0.1 mg/kg IV xylazine (Xilagesic, Calier), the areas for US clipped and cleaned with alcohol, and acoustic gel applied. The sciatic and femoral nerves were then blocked with 0.2 mL/kg of a lidocaine (2%) and epinephrine (0.002%) mixture (Anesvet, Ovejero). A negative aspiration test was performed before injection. After the injection of the local anaesthetic, each calf received 0.01 mg/kg IV atipamezole (Antisedan, Pfizer) to reverse sedation (Iwamoto et al., 2012).

Sciatic motor blockade was determined by assessing the ability of the animals to maintain a standing position, the presence of adduction of the affected extremity and the presence of flexion of the fetlock joint (metatarsophalangeal joint). The femoral nerve blockade was assessed using the weight-bearing capacity of the extremity. To evaluate analgesia, the nociceptive withdrawal response was assessed by applying pinpricks with a 21G needle as noxious stimulus. This was always done by the same investigator to minimise variation.

The response was measured as follows: 0, positive normal response; 1, diminished response; 2, negative response. The nociceptive withdrawal response following sciatic and femoral nerve blockade was evaluated at seven anatomical areas shown in Tables 1 and 2. The nociceptive response was assessed at baseline and every 10 min for 90 min. However, in the last four limbs the response to the noxious stimulus was recorded until baseline values were restored.

Statistical analysis

A descriptive statistical analysis of the quantitative variables was performed with the data expressed as means ± standard deviation or medians (range) where appropriate. The effects of local anaesthetic on the sciatic and femoral nerves in the different anatomical areas were analysed using the non-parametric Friedman test for related (repeated) samples with pairwise comparisons in order to compare each time point with the baseline value. All analyses were performed using SPSS 19.0 (IBM).

Results

Phase 1: Anatomical study and dissection of the sciatic and femoral nerves

The gross dissection of the sciatic nerve was performed easily in all cadavers. The nerve exited the pelvic cavity through the greater sciatic foramen continued caudally and then turned distally to pass deeper and caudally to the greater trochanter of the femur. Then, the nerve passed distally along the lateral surface of the thigh and deep to the biceps femoris, where the nerve was divided into two large branches: the tibial and the common peroneal nerves. Nerve branching was found to be more proximal in one cadaver than in the other three. The gross dissection of the femoral nerve was more difficult than the sciatic nerve due to the topography and length of this nerve, where a short free segment runs from the ventral border of the major psoas muscle to the quadriceps femoris muscle. The anatomical structures identified with ultrasonography and the corresponding anatomical sections are shown in Figs. 1 and 2.