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Ultrasound-guided femoral nerve block as a diagnostic aid in demonstrating quadriceps involvement in bovine spastic paresis

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ABSTRACT

The aim of this study was to evaluate the clinical effects of a femoral nerve block via a dorsal paralumbar injection in healthy calves and calves suffering from spastic paresis. Based on bony landmarks and using ultrasound guidance, the femoral nerves of eight healthy calves were blocked bilaterally with a 4% procaine solution containing blue dye. In 11/16 nerve blocks, paralysis of the quadriceps muscle was obtained after dorsal paralumbar injection. Paralysis was total in 8/16 cases. The injection site was confirmed by post mortem dissection, and in 12/16 cases, the blue dye was found <2 mm from the nerve. Clinical use of the technique was then demonstrated in two cases of atypical bovine spastic paresis. In such calves an objective diagnostic tool is required to identify those calves which are suitable for partial tibial neurectomy. The femoral nerve block used in this study has the potential to be such a method and can be used to establish the involvement of the quadriceps femoris in calves suffering from the quadriceps or mixed presentation form of spastic paresis.

Introduction

Bovine spastic paresis (BSP) is a long-standing developmental neuromuscular disorder (Götze, 1932). An overactive stretch reflex, primarily involving the gastrocnemius muscle (BSP-G), causes repeated spastic hyperextension of the affected hind limb of the standing animal in a posterior direction (De Ley and De Moor, 1977). However, specific quadriceps involvement (BSP-Q) has been reported as a new pathologic entity in this syndrome (Touati et al., 2003). Differentiation between BSP-G and BSP-Q affected calves is based on posture or gait analysis of symptoms. BSP-Q calves demonstrate repeated spastic hyperextension of one or both hind limbs in anterior direction contrary to BSP-G. However, to the authors' knowledge, the involvement of the quadriceps muscle in BSP-Q has never been confirmed. Furthermore, in recent years the authors have been confronted with increasing numbers of mixed presentations of bovine spastic paresis (BSP-M) in double-muscled Belgian Blue calves. Depending on the dominant spastic muscles, hyperextension of the affected limb can be directed anteriorly, posteriorly or laterally complicating diagnosis.

Treatment of BSP-G principally includes tenectomy or partial tibial neurectomy (Pavaux et al., 1985; Vlaminck et al., 2000). However, tibial neurectomy applied to BSP-Q or BSP-M can aggravate symptoms, for example, it can result in exaggerated anterior hyperextension of the hind limb which can prevent normal movement (C. De Vlamynck, unpublished observation). To the authors' knowledge, no therapy has been described for these atypical spastic paresis cases, but they need to be clearly distinguished from BSP-G, in order to avoid surgery on unsuitable patients.

BSP-G and BSP-Q can be distinguished based on clinical observation. However, some animals show clinically obvious quadriceps spasticity, alongside overlooked spasticity of other muscles. Epidural injection of 0.38% procaine solution can resolve BSP-G symptoms (De Ley and De Moor, 1979) but does not resolve those associated with BSP-Q and BSP-M (Vertenten, 2006). Significantly increased gastrocnemius muscle activity has been reported in electromyography studies on BSP-G calves but voluntary muscle activity might falsely contribute to the electromyographic read-out and hinder objective identification of the involved muscles (Denniston et al., 1968; Bijleveld and Hartman, 1976). As quadriceps activity is solely controlled by the femoral nerve (Budras and Habel, 2003), diagnostic anaesthesia may be a better tool for identifying the muscles involved in spastic paresis. Nerve blocks have been performed routinely in humans to identify muscles contributing to spasticity, for example in patients following traumatic brain injury or stroke (Filipetti and Decq, 2003; Esquenazi, 2004; Buffenoir et al., 2005). Observing post-injection posture and gait in calves could help in decision making about treatment options.

The aim of the present study was to evaluate a technique for perineural injection of the femoral nerve in healthy calves. It was hypothesized that the technique could reliably induce femoral

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nerve paralysis in a safe and reversible manner. Implementation of the technique was then further evaluated in two calves – one with BSP-Q one with BSP-M.

Materials and methods

In vivo femoral nerve block in healthy calves

The study design was approved by the Ethical Committee for Animal Research of Ghent University (EC 2011-079). Eight healthy male Holstein Friesian calves aged 4 weeks, with a median weight of 50 kg (range 47–53 kg) were used.

All procedures were performed by the same operator (C. De Vlamynck). Calves were positioned in lateral recumbency by applying gentle physical restraint without sedatives. The hair was clipped and the skin washed and disinfected with alcohol. An ultrasound-guided dorsal paralumbar approach was used, as this had been shown in a pilot study in cadavers to be the most reliable perineural injection technique (C. De Vlamynck et al., unpublished observations). The transverse processes of L5 and L6, were identified ultrasonographically using a 5 mHz curved linear array transducer (Pro Series, GE Medical System). The transducer was then placed in a transverse plane at the level of the sacrum and advanced in a cranial direction along the spinal axis to identify the space between the spinous processes of L5 and L6. The transducer was rotated 90° to a longitudinal plane and repositioned 2–3 cm lateral to the spinous process axis to visualize the inter-transverse process area.

A 90 mm 19 G spinal needle was inserted 1 cm through the skin, lateral to the transducer (Fig. 1a) and advanced in a caudomedial direction towards the cranial border of the transverse process of L6. Once the needle tip reached a position less than 1 cm lateral to the vertebral body of L6, it was further advanced over a distance of maximum 1 cm under the transverse process (Fig. 1b). A home-made solution including 1 mL of methylene blue mixed with 4 mL of procaine 4% (VMD, Arendonk) was then injected.

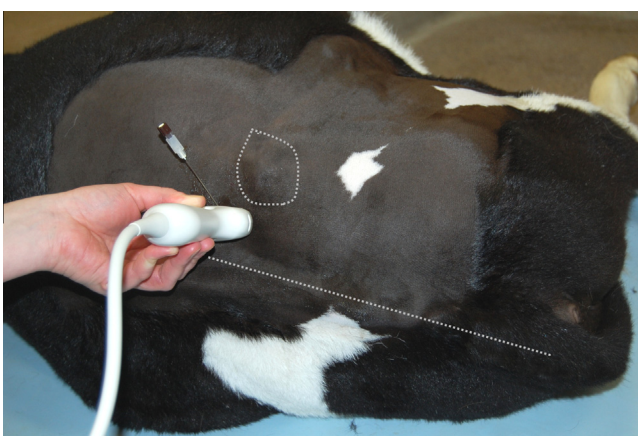

Fig. 1a. Dorsal view of a calf in left lateral recumbency illustrating needle and transducer position for a dorsal paralumbar femoral nerve block. The straight dotted line outlines the spinal axis of the calf and the dotted circle the right tuber coxae.

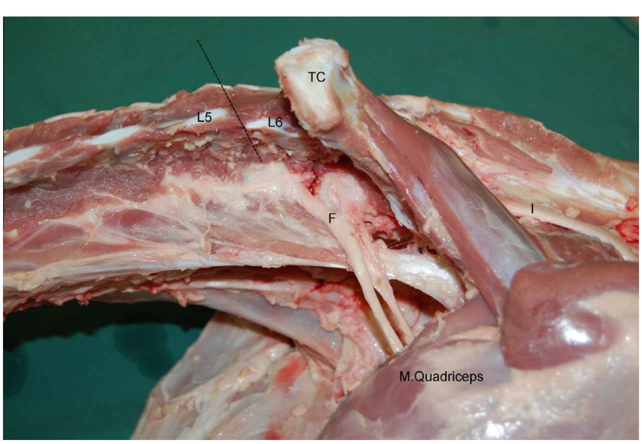

Fig. 1b. Left lateral view of the dissected lumbosacral region of a cadaver of a calf illustrating the needle pathway (black dashed line) in relation to the transverse processes of lumbar vertebrae 5 (L5) and 5 (L6) as well as the femoral nerve (F). TC, tuber coxae; I, sciatic nerve.

Table 1
Criteria used for evaluation of ultrasound image quality during femoral nerve block in calves.

Image quality	Ultrasonography
Excellent	Bony landmarks clearly identified Needle clearly identified
Good	Bony landmarks clearly identified Needle fairly visualized
Poor	Bony landmarks clearly identified Needle poorly visualized

Table 2
Paralysis score following femoral nerve block in calves.

	Paralysis score	Characteristics of posture and gait
1	Total paralysis	Not fully weight baring with semi-flexion of the fetlock joint at rest Animal is unable to fix the femorotibial joint; hind leg is dragged at walk
2	Partial paralysis	Normal posture at rest Incomplete extension of the femorotibial joint at walk
3	No paralysis	Normal posture at rest Normal gait at walk

Table 3
Injection score based on dye localization in relation to the femoral nerve.

Injection score	Identification of blue dye	
1	Epineural	Nerve stained
2	Perineural	Nerve not stained, dye in perineural tissues (connective and muscle tissue) <5 mm from femoral nerve
3	Peripheral	Dye >5 mm from femoral nerve

Ultrasound image quality was scored according to the criteria outlined in Table 1. The number of attempts to advance the needle to the correct position was recorded. Following injection, calves were placed in a rubber padded box. Twenty minutes later, sensitivity of the ipsilateral medial thigh was tested at the level of the femur by stimulating the skin with a needle and comparing the animal's reaction to the same procedure on the contralateral non-treated limb. A positive result was recorded if the animal showed no reaction to stimulation. Any reaction was recorded as a negative result. Repeat injections were not performed in these cases. After this, the calves' posture and gait were observed and the success of the nerve block was categorized using a paralysis score (Table 2).

Nerve blocks were performed bilaterally. The second injection, in the contralateral limb was done 60 min following the first injection (if that was successful), after complete disappearance of paralysis symptoms and the return of sensitivity of the medial thigh, or 20 min after the first injection if the first block had been unsuccessful. Following recording of all data, calves were euthanased using IV xylazine (0.16 mg/kg, Xyl-M 2%, VMD) and embutramide (20 mg/kg, T61, Intervet). The spinal musculature was carefully dissected to expose the femoral nerve and verify the accuracy of the injection using an injection score (Table 3).

Statistical analysis was performed using SPSS Statistics 19 (IBM) to evaluate the association between the ultrasonographic image quality, paralysis score and injection score using Fisher's exact test.

Clinical application of femoral nerve block in spastic paresis cases

The same nerve block was performed in two clinical cases referred for bilateral spastic paresis where treatment with a partial tibial neurectomy had been proposed. The injection was performed on the most prominently affected limb and the resulting relief of symptoms was used to guide the treatment decision.