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Development of a peripheral nerve stimulator-guided technique for equine pudendal nerve blockade

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ABSTRACT

The aim of this study was to develop and evaluate a procedure for equine pudendal nerve block using a peripheral nerve locator. In the first experiment, six ponies were used to determine the relationship between elicited muscle contractions (anal, perineal or both) and nerves serving the perineal region (pudendal, caudorectal and perineal nerves) when methylene blue dye was injected using the electrolocation technique. This experiment showed that the pudendal nerve was approached effectively when both anal and perineal twitch were elicited during electrolocation.

In a second experiment, seven Thoroughbred horses were used to evaluate the appropriate volume of anaesthetic solution for the nerve block. Immediately after euthanasia, lidocaine/methylene blue solution was injected after positive electrolocation. A stained segment of 2 cm or more of the nerve was considered effective and this was evaluated after dissection. Both 10 and 20 mL per injection site resulted in effective nerve staining.

Finally, pudendal nerve block was performed and evaluated in 27 horses admitted for selected reproductive surgical procedures including perineoplasty, urethroplasty, clitorectomy in mares and penile examination, phallectomy and urethrostomy in geldings. Surgical time varied from several minutes to 3 h. The choice between lidocaine, mepivacaine or bupivacaine was based on the duration of analgesia required. In mares and males, a volume of 20 mL and 10 mL, respectively, was injected per site. The use of a peripheral nerve stimulator-guided pudendal nerve block is a feasible, safe and reliable alternative for both epidural and general anaesthesia, to provide peri-operative analgesia in clinical equine patients undergoing specific reproductive surgeries.

Introduction

Human randomised controlled studies suggest that regional anaesthetic techniques provide better pain relief, faster postoperative recovery and reduced hospital stay than systemic opioids (Singelyn et al., 1998; Capdevila et al., 1999). Currently, surgery involving the equine genitalia or perineal region often requires either epidural anaesthesia or general anaesthesia. In horses, epidural administration of combinations of alpha2-agonists, lipid soluble opioid drugs and local anaesthetic agents can sometimes lead to undesirable systemic effects such as severe ataxia and recumbency (Chopin and Wright, 1995; Olbrich and Mosing, 2003; Natalini and Driessen, 2007). Epidurally administered morphine has also been associated with pruritus in the horse (Haitjema and Gibson, 2001; Burford and Corley, 2006). Failure of an epidural block may occur due to improperly applied technique, anatomic abnormalities, or fibrous adhesions from previous epidural injections (Natalini and Driessen, 2007). General anaesthesia is a viable alternative when epidural anaesthesia is unsuccessful. However, there are many risks associated with general anaesthesia in horses, including a well-established high mortality rate (Johnston et al., 2002). Moreover, overall morbidity of equine anaesthesia in terms of non-terminal events is even higher (Mair et al., 2013). Therefore, a more selective, targeted regional anaesthetic technique may represent an alternative to provide analgesia to horses undergoing reproductive procedures. Successful nerve block techniques rely on a sound knowledge of the species-specific anatomy and also on the potential anatomical variations between different breeds and age groups. This knowledge base is essential for the establishment of reliable landmarks, the location of the injection site, the angle and depth of needle insertion, and anatomical structures to be avoided.

Our goals were to establish the relationship between evoked muscle twitches (anal, perineal or both) and the nerves of the perineal region (pudendal, caudal rectal and superficial perineal nerves), to determine an appropriate volume for reliable nerve blockade and finally, to apply the developed technique to clinical cases.

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Materials and methods

All procedures were approved by the Cornell University Institutional Animal Care and Use Committee (Protocol No. 2011 – 0002; Date of approval, 10 January 2011).

Study 1—pudendal nerve identification

A convenience sample of six ponies was used after completion of a non-survival surgical teaching exercise for veterinary students. Animals were assigned to three groups prior to starting this experiment, and the intended motor responses induced by electrostimulation in the respective groups were coded as E1 (anal twitch alone), E2 (perineal twitch alone) or E3 (combination of anal and perineal twitch). After appropriate electrolocation, 1 mL of 2% lidocaine mixed with 1 mL of methylene blue was injected bilaterally while ponies were still under general anaesthesia. All injections were performed with the ponies in dorsal recumbency. A small injection volume was chosen to limit the spread of the solution and gauge the proximity to the pudendal nerve. The needle insertion point was ventrolateral and abaxial to the external anal sphincter in all groups and the angulation and needle depth varied based on the desired muscle response. After euthanasia, the pelvic region of each pony was dissected, and the pudendal nerve and its terminal branches were inspected for methylene blue staining. A block was considered successful if the nerve was directly stained or if dye was present in surrounding tissue immediately adjacent to the nerve. Macroscopically, the presence of a hematoma or any other complication was recorded.

Study 2—injection volume

Seven Thoroughbred horses, including both mares and geldings, were used to evaluate the appropriate volume of lidocaine solution for the nerve block. A solution containing an equal volume of 2% lidocaine and methylene blue was used as the injectate. Horses were randomly allocated into two groups (group L: low volume –10 mL or group H: high volume –20 mL per site) by means of a coin toss. The horses were also enrolled in unrelated studies that required euthanasia. They were placed in either left or right lateral recumbency based on the experimental exigencies of the other investigators. Electrolocation of the pudendal nerve was performed by evoking both anal and perineal twitch prior to injection, based on the conclusion of the first study (the injection technique was the same as in group E3). The assigned injection volume was administered after positive electrolocation immediately after euthanasia. A stained segment of 2 cm or more of the nerve was considered as evidence of adequate blockade (Raymond et al., 1989; Campoy et al., 2010) and was evaluated after dissection (Fig. 1).

Study 3—evaluation in clinical cases

Bilateral pudendal nerve block was used to provide anaesthesia and analgesia in 27 reproductive surgical procedures in both mares and geldings to determine the feasibility of the procedure.

Prior to the nerve block procedure, horses were placed in stocks and were chemically restrained with standard doses of an alpha2-agonist given IV, typically detomidine hydrochloride. Fig. 2 illustrates the limits of the superficial boundary of the perineum, marked by a white dotted line. This indicates the region of the injection site and the area desensitised by the nerve block. The tuber ischiadicum was palpated and a horizontal line depicted to create the ventral boundary of the injection site. The external anal sphincter along with either the dorsal vulvar lips or retractor penis muscle constituted the medial boundaries, as the rectum and vaginal cavities should be avoided. The nerve plexus runs in a fascial plane abaxially to the anal sphincter and upper commissure of the vulva. Due to variations in the perineal conformation in mares, it is important to use the ischial tuberosity as a landmark for determining the lower limits for needle insertion. The upper limit is at the ventral aspect of the external anal sphincter. The semimembranosus muscle indicates the lateral boundary (area marked/surrounded by red dotted line; Fig. 2). Deeper to the latter muscle was the sacrosciatic ligament, which also constituted the deep lateral boundary of the perineum. It was important that the needle remained medially to this ligament as the sciatic nerve and caudal gluteal nerves were immediately lateral to the ligament (Figs. 3 and 4). If these nerves were inadvertently blocked, complications such as ataxia could have resulted. The rectum was emptied of faeces prior to this procedure. Following aseptic preparation of the perineal area, a bleb of lidocaine 2% was raised at the site of needle insertion. The technique differed slightly depending on the sex of the horse: in mares, a gloved hand was placed in the vestibule to palpate the needle and guide its insertion path away from the rectal or vaginal wall. The left hand would be inserted for blocking the right side and the right hand would be inserted for blocking the left side. A 30° bevel, 21G, 100 mm insulated needle (Stimuplex A, B Braun Medical) attached to a peripheral nerve stimulator (Stimuplex HNS 11, B Braun Medical) was inserted through the skin in the perineum at a point ventrolateral to the external anal sphincter at an angle of 45° to the sagittal plane (Figs. 2 and 4). The negative electrode was connected to the needle and the positive electrode was attached to the horse's skin. The needle was advanced through the perineum towards the nerve while the peripheral nerve stimulator delivered the electrical stimuli to evoke an appropriate muscle contraction. A stimulation frequency of 1–2 Hz, stimulus duration of 0.1 ms, and current of 1 mA was used initially to induce a motor response. The strength of the observed contraction of both the anal sphincter and perineal muscles/vulvar lips helped determine the optimal needle location. The current was gradually decreased to refine the approach, as an evoked response obtained at low output indicates close proximity to the nerve. If a current reduction did not result in muscular contraction before reaching 0.4–0.6 mA, the needle was redirected until the previous muscle response reappeared and subsequently, the anaesthetic solution was injected. Needle depth varied between 5 and 10 cm depending on the size of the horse and perineal conformation. Before each injection, a small volume was aspirated to test for intravascular puncture.

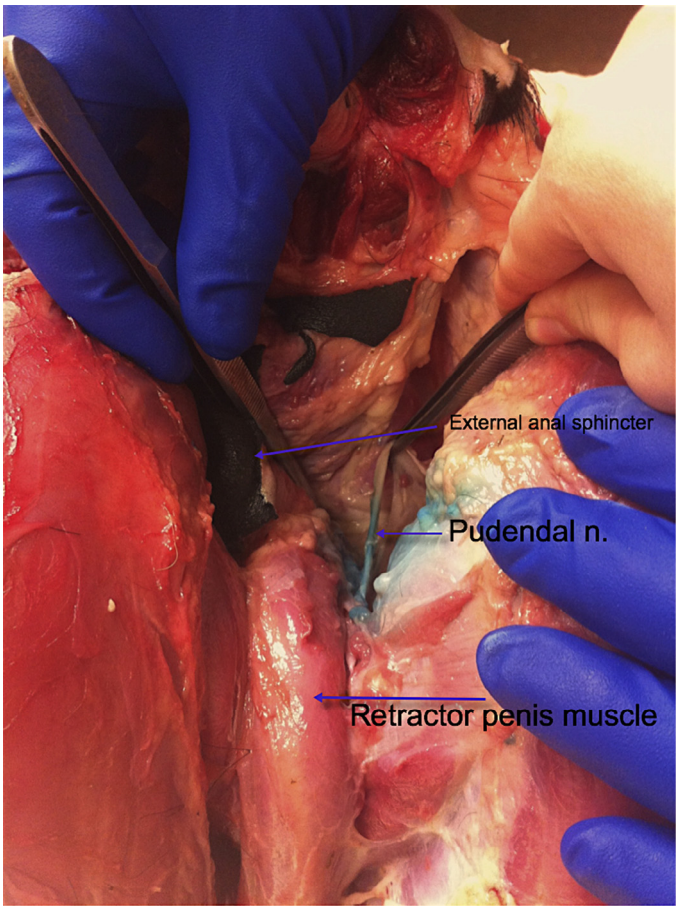

Fig. 1. Dissection of the pelvic cavity showing the pudendal nerve stained with methylene blue after injection in a Thoroughbred gelding (study 2).

Results

Study 1—pudendal nerve identification

E1 (anal twitch group)

Two male ponies showed bilateral anal twitch response. In one of these ponies, the needle was placed 2.5 cm deep to gain motor response. No dye was visible on the pudendal nerve of this particular pony. Caudal distribution of dye near the caudal rectal and superficial perineal nerves was seen on both sides. In the second pony, a bilateral anal twitch was elicited when the needle was placed 5 cm deep. No dye was visible bilaterally over the pudendal nerves. On the left side, dye was identified around the caudal rectal nerve region. On the right side, dye could not be found and there was evidence of possible vascular laceration.

E2 (perineal twitch group)

Two male ponies showed perineal twitch. One of them showed bilateral perineal twitch when the needle was placed 5 cm deep. First, when the needle was placed perpendicular to the skin, an anal