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RESEARCH PAPER

Maxillary nerve blocks in horses: an experimental comparison of surface landmark and ultrasound-guided techniques

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Abstract

Objective The aim of this preliminary proof-of-concept study was to evaluate and compare the success and complication rate of infiltration of the maxillary nerve of cadaver heads using previously described surface landmarks, standard ultrasound and a novel needle guidance positioning ultrasound system (SonixGPS).

Study design Prospective anatomical method-comparison study.

Animals Thirty-eight equine cadaver heads.

Methods Twenty-six veterinary students performed the three methods consecutively on cadaver heads using an 18 gauge, 3.5-inch spinal needle and 0.5 mL iodinated contrast medium. Computed tomography was used to quantify success (deposition of contrast in contact with the maxillary nerve) and complication rate (contrast identified within surrounding vasculature or periorbital structures) associated with each method.

Results Perineural injection of the maxillary nerve was attempted 76 times, with an overall success rate of 65.8% (50/76) and complication rate of 53.9% (41/76). Success rates were 50% (13/26) with surface landmark, 65.4% (17/26) with standard ultrasound guidance and 83.3% (20/24) with SonixGPS guidance approaches (Fisher's exact test, $p = 0.046$). No significant difference in complication rate was found between the three methods.

Conclusions Ultrasound-guided maxillary nerve blocks were significantly more successful than surface landmark approaches when performed by inexperienced operators, and the highest success rate was achieved with guidance positioning system (GPS) needle guidance.

Clinical relevance Local anaesthesia of the equine maxillary nerve in the fossa pterygopalatina is frequently used for diagnostic and surgical procedures in the standing sedated horse. Due to vague superficial landmarks with various approaches and the need for experience via ultrasound guidance, this block remains challenging. GPS guidance may improve reliability of maxillary and other nerve blocks, and allow a smaller volume of local anaesthetic solution to be used, thereby improving specificity and reducing the potential for side effects.

Keywords equine, maxillary nerve, perineural anaesthesia, trigeminal nerve, ultrasound guidance positioning system.

Introduction

Many surgical procedures of the equine head can be performed in the standing position with the use of sedation and regional anaesthesia (Young & Taylor 1993; Johnston et al. 1995; Mee et al. 1998). The maxillary branch of the trigeminal nerve provides sensory innervation to the ipsilateral maxillary cheek teeth, the nasal cavity and paranasal sinuses, and is commonly desensitized for dental surgery, or to facilitate the diagnosis of head shaking in horses (Newton et al. 2000). The maxillary nerve is accessible at the pterygopalatine fossa, ventral to the periorbita, between the foramen rotundum and the maxillary foramen, in a location where the nerve is surrounded by multiple large arteries and veins. In

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close proximity lie the deep facial vein, the periorbita, which includes the intraperiorbital compartment, and the maxillary artery that branches into the infraorbital artery, the descending palatine artery and the buccal artery (Tremaine 2007; Staszyk et al. 2008). Complications have arisen from inadvertent puncture of these structures, and it is important to minimize these risks in clinical practice.

Complications range in severity from transient retrobulbar haematomata and facial swellings, to variable exophthalmos and potentially prolapse of the globe (Archer 2011). Horner's syndrome, exophthalmos and ocular muscle paralysis have been reported with excessive volumes of local anaesthetic (Tremaine, 2007). More severe complications including collapse, blindness, retrobulbar infection and meningitis have been reported in horses (Staszyk et al. 2008; Simhofer 2013), and convulsions, neurological deficits and cardiac arrest have been reported in other species (Rubin 1995; Pearce et al. 2003; Staszyk et al. 2008). Some of these reports specifically described complications even when the procedure was performed by experienced clinicians (Bardell et al. 2010).

Desensitization of the maxillary nerve at the pterygopalatine fossa is well described using surface landmarks for guidance, but these are vague, making the block difficult and potentially unreliable, which is of particular concern when being used diagnostically (Schumacher & Perkins 2005; Staszyk et al. 2008; Bardell et al. 2010). An ultrasound-guided approach has been described to minimize the risks and visualize optimal needle placement (O'Neill et al. 2014). This appears to be beneficial, however, to the best of our knowledge, no direct comparison has been made between the surface landmark and ultrasound-guided approaches. In addition, ultrasound-guided approaches require a high level of operator skill, and a good understanding of the regional sonographic anatomy, or the potential for complications and inaccuracies may not be anticipated.

A novel tool has been developed for training and clinical application, utilizing a needle guidance positioning system (GPS) to aid practitioners in developing and applying the skill of ultrasound-guided nerve blocks (Tang et al. 2014; Tielens et al. 2014). The GPS system (SonixGPS; Ultrasonix Medical Corporation, BC, Canada) calculates and displays the position and trajectory of the needle, allowing visualization of the needle trajectory during both in-plane and out-of-plane techniques. This technology therefore has potential advantages over conventional ultrasonography for which the whole needle and its trajectory is only visible during an in-plane approach and during the out-of-plane approach only the needle tip is visible as it crosses the ultrasound plane.

The objective of this method-comparison study was to compare two previously described approaches to maxillary nerve infiltration (surface landmark and ultrasound-guided) with a novel needle GPS, and to quantify the success and complication rates of each method when performed by inexperienced operators. We hypothesized that the ultrasound-guided approaches would result in significantly greater success, defined as successful deposition of contrast in contact with the maxillary nerve, with fewer complications, defined as inadvertent penetration of vascular and periorbital structures, than the surface landmark approach, and that the needle GPS would result in significantly greater success with fewer complications than regular ultrasound.

Materials and methods

This study was authorized by the Ethics and Welfare Committee of the Royal Veterinary College (local approval reference number 2014/S35).

Three preliminary cadaver heads were used to pilot protocols for quantifying infiltration of the maxillary nerve using the three injection techniques. Injection of 0.5 mL iohexol radiopaque contrast solution (Omnipaque; GE Healthcare, UK) provided the best balance for assessment of needle placement and contrast diffusion pattern. Computed tomography (CT) (GE Lightspeed Pro 16; GE Medical Systems, UK) indicated that the soft tissue structures of the pterygopalatine fossa, including the maxillary nerve, were most clearly visualized with CT settings of 120 kV, 300 mA and slice thickness of 2.5 mm. The three pilot cadaver heads were bilaterally dissected to confirm normal anatomy and variations and were not included in the statistical analysis.

Thirty-eight cadaver heads from adult Warmblood-type horses were sourced from an abattoir. All horses had no known history and showed no obvious external signs of abnormalities of the head. The heads were sectioned at the level of the atlanto-occipital junction and were each placed on a table to imitate the position of a standing, sedated horse. Sample size was derived from the maximum number of students available to participate in this study during the study time frame.

Twenty-six clinical veterinary students between their third and fifth (final) year of training and with no previous experience of maxillary nerve blocks

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