Tutorial Article

Local analgesic techniques for the equine head

W. H. TREMAINE

Department of Clinical Veterinary Sciences, University of Bristol, Langford BS40 5DT, UK.

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Introduction

Horses are excitable animals by nature and are often particularly sensitive to and intolerant of palpation around their head and ears. However, it is frequently necessary to perform procedures around the head, during routine veterinary examination and treatments, and prophylactic dental procedures. Such procedures are often poorly tolerated by the horse and may result in potentially violent avoidance behaviour, preventing safe completion of the procedure. In addition, due to the high cost of general anaesthesia, and its reported risks of morbidity and mortality, and due to the high demands on time and personnel, the ability to perform many investigative, surgical and dental procedures safely in the conscious, sedated horse is attractive.

Regional and local nerve blocks are commonly used to enhance the analgesia achieved under general anaesthesia, for oral surgical procedures in other species, including dogs (Beckman and Legende 2002; Lantz 2003) and man (Reiter 1980; Johnson 1982; Lefevre 1991), and for surgical procedures on the distal limbs in horses.

Traditionally, restraint of horses for procedures on the head has been achieved with the assistance of an experienced handler, nose twitches and administration of sedatives, especially α-2 agonist drugs. The α-2 agonists produce a satisfactory level of sedation and analgesia, particularly when used in combination with opiates including butorphanol (Torbugesic)[1], methadone (Physeptone)[2] and morphine (Morphine Sulphate)[3]. Although adequate, chemically-assisted restraint can be achieved using these techniques in many horses and for many minor procedures, the horse undoubtedly still experiences considerable pain, which is both noxious and undesirable. Therefore, from a welfare perspective, with respect to the horse, and from an efficacy and safety perspective with respect to the veterinarian, it is highly desirable to achieve a greater degree of regional analgesia and muscle relaxation than is possible using sedatives alone, particularly when doing invasive procedures requiring a high degree of precision. The use of regional or local anaesthetic techniques produces superior analgesia resulting in better compliance, safer restraint, reduced doses of sedative drugs and greater duration of sedation, and consequently facilitates shorter operating times. In addition, head-shy behaviour, which can be learned as a consequence of noxious veterinary procedures on the head, is less likely to be reinforced.

Indications for regional analgesia

Such procedures for which local anaesthetic techniques are commonly used by the author include ocular examination and conjunctival or eyelid surgery, keratectomy, *membrana nictitans* biopsy, facial wound repairs, dental extractions and repulsions (**Figs 1** and **2**), periodontal treatments, incisive bone or rostral mandibular fracture repairs, sinus trephinations and bone-flap osteotomies (**Fig 3**). In addition, the author routinely uses regional analgesia to desensitise areas of the head when performing painful procedures on the head in anaesthetised patients, including dental removals via buccotomy, alar fold resection, orbital enucleation, and in some cases sinus surgery.

Regional innervation

The horse is sensitive to stimulation of the head from movement, sound, light and touch, and its natural instinct is rapidly to take avoidance action from any perceived noxious stimuli from any of these sources. In addition to the sensory information processed by the special senses of sight, smell and hearing, the cranial nerves supply additional sensory information from all parts of the head (**Figs 4** and **5**). Detailed descriptions of the cranial nerve innervation to the equine head are described elsewhere (Kainer 1993; Budras *et al.* 1994) and should be reviewed to select the appropriate nerve block.

Action of local anaesthetic drugs

The first local anaesthetic was cocaine derived from the alkaloid producing plant *Erythroxylon coca*, the leaves of which were chewed historically as a herb by the Inca, to reduce altitude sickness, to suppress appetite and fatigue, and to induce a feeling of well being. Cocaine was isolated in 1860 and, in 1884, Koeller reported desensitisation of the cornea (Heavner 1996). Reports of other peripheral nerve blocks and spinal

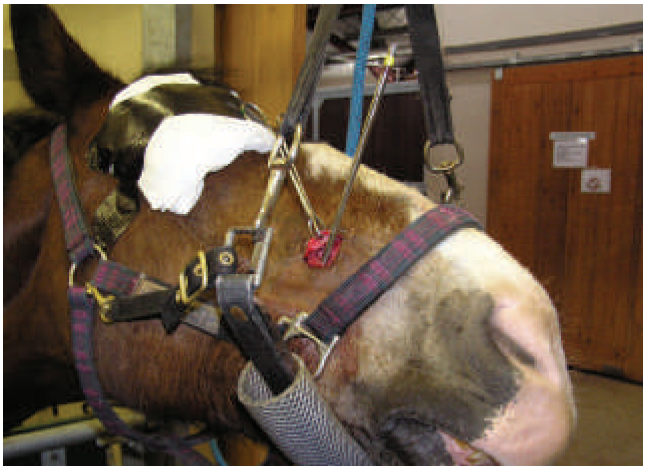


***Fig 1:** Maxillary cheek tooth repulsion in a conscious, sedated horse with satisfactory analgesia achieved by using both a perineural maxillary nerve block and subgingival infiltration.*

***Fig 2:** A mandibular tooth is being extracted, assisted by desensitisation of the tooth using an inferior alveolar nerve block.*

***Fig 3:** A nasofrontal bone-flap osteotomy being performed under standing chemical restraint and local regional analgesia by subcutaneous infiltration of local anaesthetic solution. This technique will desensitise the skin and periosteum, but the sinus mucosa is not desensitised. Care must be taken to avoid damage to the infraorbital canal during such procedures.*

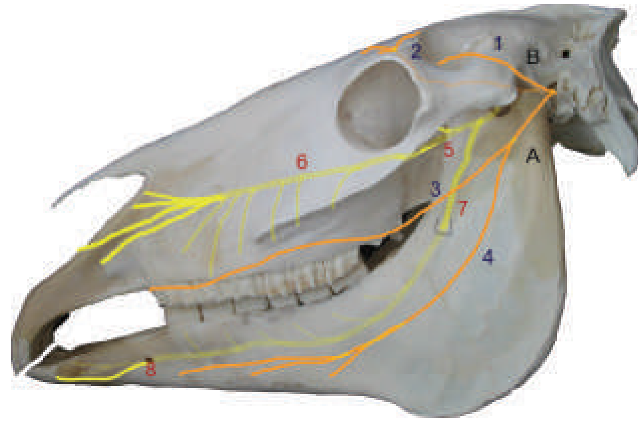


***Fig 4:** Peripheral cranial nerves of the equine head, showing branches of the facial (A) and trigeminal (B) nerves: 1) auriculopalpabral, 2) supraorbital, 3) dorsal and 4) ventral buccal nerves. The maxillary nerve (5) enters the maxillary foramen as the infraorbital nerve (6), which sends branches to the maxillary dental alveoli before emerging from the infraorbital foramen. The mandibular branch of the trigeminal nerve enters the mandibular foramen as the inferior alveolar nerve (7) and supplies the mandible and lower dental alveoli before branches emerge from the mental foramen (8) as the mental nerve.*

***Fig 5:** Cutaneous innervation of the equine head showing autonomous zones innervated by the: 1) supraorbital, 2) infratrochlear, 3) zygomatic, 4) lacrimal, 5) infraorbital, and 6) transverse facial nerves.*

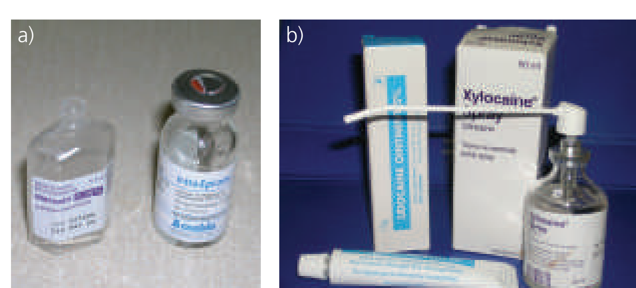


***Fig 6:** a) Commonly used agents for regional analgesia 1) bupivicaine, which has a relatively long time to peak effect and a long duration of action, 2) mepivicaine which is a commonly used drug for peripheral limb nerve blocks in horses. b) shows 2 topical local anaesthetic preparations that can be used for desensitisation of oral and pharyngeal mucosa.*

Fig 7: Subgingival infiltration of the oral mucosa using 4% lidocaine, to facilitate gingival elevation prior to extraction of a maxillary cheek tooth 208.

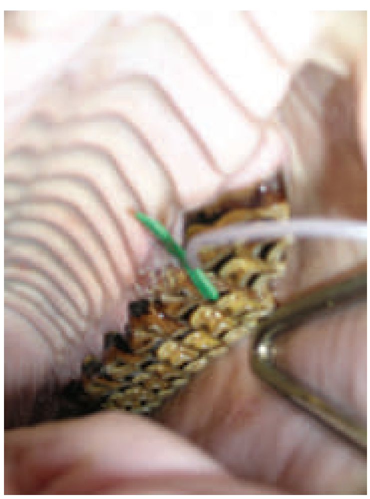


Fig 8: Subgingival infiltration of local anaesthetic using an extension tubing and a butterfly catheter, taking care to avoid inadvertent injection into the greater palatine artery.

Fig 9: Supraorbital and auriculopalpebral nerve blocks are used to provide desensitisation and motor paralysis to the upper eyelid. Additional topical analgesia of the eye can be achieved using topical ophthalmic preparations containing amethocaine or proparacaine.

a)

b)

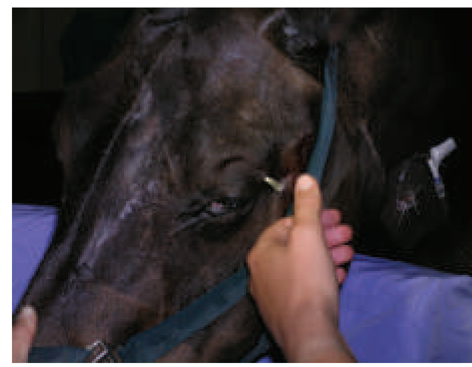
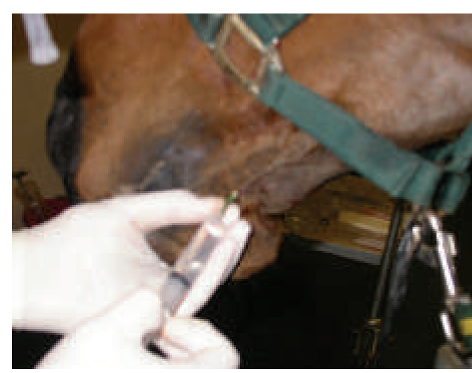


Fig 10: Desensitisation of the medial (a) and lateral (b) structures within the orbit using a retrobulbar infiltration technique prior to performing an enucleation procedure.

a)



b)

Fig 11: A mental nerve block being performed (a). Analgesia of the nerve branch will as it emerges from the foramen will desensitise and paralyse the lower lip and gingiva. The fine 23 gauge needle must be advanced into the mental foramen (b) in order to desensitise any branches supplying the lower canine and incisor teeth.

TABLE 1: Pharmacological properties of some commonly used local anaesthetics (Heavner 1996)

Drug	Lipid solubility	Relative potency	Onset of action	Duration (min)	Plasma binding
Lignocaine/ lidocaine[3]	3.6	2	Fast	90–200	65
Prilocaine (Citanest)[3]	1	2	Fast	120–240	55
Mepivicaine 2% (Intraepicaine[4] carbocaine)	2	2	Fast	120–240	75
Bupivicaine 0.5% (Marcaine)[3]	30	8	Intermediate	180–600	95

anaesthesia followed in swift succession. In 1905 Keinhorn produced procaine, which was less addictive and toxic than cocaine, and in 1943, Lofgren developed lidocaine (lignocaine). The pharmacological properties of a local anaesthetic drug depend on its molecular structure and different drugs are utilised for different procedures.

Local anaesthetic agents

Currently lignocaine (Xylocaine)[3], prilocaine (Citanest)[4] and mepivicaine (Intra-epicaine)[5] (**Fig 6**) are licensed for use in the UK. Other agents, licensed for use in other species and human use, which have different pharmacological properties, may also be used in some situations when no licensed product is available.

The pharmacology of local anaesthetic drugs is described in detail elsewhere (Heavner 1996). Some examples of those used in the horse are summarised in **Table 1**. The lipid solubility of different agents imparts potency, and degree of protein binding affects the duration of action of the drugs. The speed of onset is determined by the acid dissociation constant of the particular molecule. The mechanism of action of the drugs is by inhibiting the rapid influx of sodium across axonal membranes, which is responsible for depolarisation. It has been suggested that the local anaesthetic prevents influx of sodium ions into the channels by a combination of physical blocking and by indirect interference with sodium channel function. Biotransformation of the drugs occurs in the liver and excretion follows in the urine or bile.

Adverse reactions are commonly reported anecdotally following subcutaneous injection of lignocaine in horses. High doses of bupivicaine (Heavner 1986) have been reported to induce toxic signs in laboratory species but at the doses used for local anaesthetic techniques described here, this does not appear to be relevant.

Regional analgesia

Local or regional analgesia can be achieved by several techniques including: local anaesthetic infiltration, application of topical local analgesia (**Fig 6**), perineural analgesia of a cranial nerve branch, and intra-articular analgesia. Due to the potential irritation of local anaesthetic drugs and potentially serious side effects resulting from inoculation of infection, aseptic preparation of the site should be performed before performing transcutaneous nerve blocks of the head.

Local infiltration

The tissues of the head are well vascularised and diffusion of local anaesthetic injected intradermally or transcutaneously can be effective for desensitising small areas of skin or gingival mucosa. Fine needles should be used to avoid discomfort, and skin is injected at least 1 cm from the site of intended pain. Local infiltration is used for eyelid desensitisation for correction of entropion, desensitisation of skin and periosteum to create paranasal sinus trephine osteotomies (**Fig 3**), removal of small skin lesions such as melanomas and sarcoids, and the fixation of indwelling ocular or paranasal sinus lavage systems. Small volumes (1–2 ml of mepivicaine or prilocaine) are injected in each site to avoid creation of pockets in fascial planes, which can be created by the injection of large volumes at a single site. Subgingival infiltration can be useful for removal of deciduous incisors or wolf teeth, and to assist with desensitising premolars and molars (**Figs 7** and **8**). Infiltration of entrapped subepiglottic mucosa is used to enable axial division of the tissue for correction of epiglottic entrapment in the conscious horse.

Topical local anaesthetic

The application of gel containing Lidocaine[1] 5% (**Fig 6**) can desensitise small areas of gingival tissue, prior to gingival injection, or for wolf tooth removal. A spray containing lidocaine is commonly used to desensitise the pharynx prior to endotracheal intubation in dogs and cats. The efficacy of such topical sprays has not been convincingly demonstrated for use in equine practice, and anecdotal reports suggest that their efficacy in equine tissue is limited due to incomplete tissue penetration in thick equine skin and gingiva.

Regional perineural nerve blocks

Eyelids

Complete desensitisation of the eyelids involves desensitisation of 4 sensory branches of the trigeminal nerve: the frontal, lacrimal, zygomatic and infratrochlear branches. Akinesis of the eyelids can be achieved by blockade of the dorsal and ventral branches of the palpebral nerve (Facial VII) (Skarda 1996).

Upper eyelid

The supraorbital nerve is desensitised as it emerges from the supraorbital foramen, which is easily palpated 1 cm caudal to the upper orbital rim, 5–7 cm dorsal to the medial canthus. By using a 23–25 gauge needle, 1–3 ml can be injected subcutaneously and into the foramen. This will desensitise the forehead and the middle two-thirds of the upper eyelid (**Fig 9**).

The lateral canthus and lateral upper eyelid are desensitised by injecting 1–3 ml of local anaesthetic adjacent to the lacrimal nerve. This is located by directing a needle medially along the dorsal orbital rim just medial to the lateral canthus. Medial canthal analgesia is achieved by injecting 1–3 ml of local anaesthetic deeply and rostral to the notch on the dorsal rim of the orbit around the infratrochlear nerve, and this will also desensitise the *membrana nictitans* and conjunctiva. The lower eyelid can be desensitised by injection of local anaesthetic around the zygomatic branch of the trigeminal nerve, which can be located by introducing a needle on the lateral aspect of the orbit, just dorsal to the margin of the zygomatic arch (Manning and St Clair 1976) (**Fig 9**).

Motor paralysis of the auriculo-palpabral nerve (VII) is achieved by perineural local anaesthesia of this nerve at the most dorsal point of the zygomatic arch or just caudal to the vertical ramus of the mandible, just ventral to the zygomatic arch.

Cornea

The cornea and sclera are desensitised most effectively using topical application of 1% solution of amethocaine (Minims)[6], a potent long acting ophthalmic preparation or 0.5% proparacaine. Some desensitisation of the conjunctiva will also be produced. More concentrated solutions, e.g. 4% lignocaine, may be toxic to corneal epithelial cells and are therefore less suitable (Durham *et al.* 1992).

Retrobulbar block

Surgical procedures on the globe, such as enucleation can be safely performed in conscious sedated or anaesthetised horses with improved analgesia using regional local analgesia. The retrobulbar block may be achieved using a 19 gauge 80 mm long spinal needle passed over the zygomatic arch in a ventro-medial direction until the medial wall of the bony orbit is encountered (Fletcher 2004). Infiltration with approximately 15 ml of mepivicaine will desensitise the extraocular muscles and the optic nerve. This block may be combined with an auriculopalpebral block to paralyse the eyelids and subpalpebral infiltration to desensitise the eyelids. Side effects can be observed with this block; prolapse of the globe may occur after relaxation of the extraocular muscles as a result of this block and therefore this technique should be reserved for enucleation to avoid damage to sensitive structures of the eye. Misplacement of the needle too ventrally can result in puncture of the maxillary artery or veins, resulting in a large haematoma formation. Other complications include orbital oedema and cellulitis. Caudally directed placement of the needle can result in desensitisation of the maxillary branches of the trigeminal nerve and possible epidural subarachnoid infiltration of local anaesthetic into the optic nerve meninges, resulting in CNS signs.

Retrobulbar infiltration (**Fig 10**) of local anaesthetic can be used as an alternative method of periocular analgesia and ocular muscle paralysis for orbital enucleation procedures. Mepivicaine is used routinely, but bupivicaine is preferred for procedures of duration >90 min.

Mental nerve

Deposition of local anaesthetic, adjacent to the mental nerve (the rostral continuation of the inferior alveolar branch of the mandibular branch of the trigeminal nerve) just prior to its emergence from the mental foramen, on the lateral aspect of the mandible below the interdental space (**Fig 11**), is a commonly used and easily performed block, which will result in desensitisation of the lower lip, labial gingiva and part of the interdental space. Desensitisation of the branches supplying the premolars and incisors will only be achieved if the needle is advanced caudally up into the foramen and 3–5 ml of local anaesthetic is injected proximally up the canal under pressure. A 23 gauge needle is angled acutely to the skin in a caudal direction and can be advanced carefully into the foramen, which is palpable after displacing the *depressor labii inferioris* muscle dorsally.

Inferior alveolar nerve

The inferior alveolar nerve enters the mandible via the mandibular foramen on the medial aspect of the mandible 1 cm caudal to the rostral edge of the vertical ramus, and approximately 12–14 cm from the ventral border of the horizontal ramus (**Figs 12–15**). The nerve gives off several branches that innervate the mandibular teeth and a branch that emerges from the mental foramen (mental nerve), with the terminal branch continuing within the mandible to innervate the rostral mandible and incisors. Desensitisation of the inferior alveolar nerve can be achieved by advancing a 12.5 cm spinal needle, entering the skin on the medial aspect of the mandible at the level of the rostral insertion of the masseter, and directing it dorsally aiming towards the medial canthus. The needle is advanced approximately 75–100 mm, while maintaining it in close proximity to the medial mandibular periostium, underneath the medial pterygoid muscle, until the convexity of the dorsal margin of the foramen is contacted. Approximately 10 ml of local anaesthetic may be used. Mepivicaine is used for most short procedures but is combined with bupivicaine if the procedure is anticipated to last >90 min. The use of excessive volumes can result in paralysis of the muscles of mastication, which may be undesirable. The exact site can be difficult to appreciate and it can be imagined using an intersection of 2 imaginary lines: firstly a horizontal one along the buccal aspects of the mandibular cheek teeth, and secondly a vertical line 1 cm caudal to the rostral border of the mandible. A caudal approach has also been previously described (Fletcher 2004).

Infraorbital nerve block (Figs 16 and 17)

The branches of the maxillary nerve, which emerge from the infraorbital foramen, fan out and supply sensory and motor innervation to the skin on the side of the face, the nostrils and the upper lip. A branch supplying the rostral premolars branches off approximately 1 cm caudal to the foramen. The

Fig 12: The inferior alveolar nerve is derived from the mandibular branch of the trigeminal nerve which contains sensory and motor fibres and enters the mandible via the mandibular foramen. The deposition of local anaesthetic at this site will desensitise the branches supplying all of the mandibular teeth on this side and parts of the gingival mucosa.

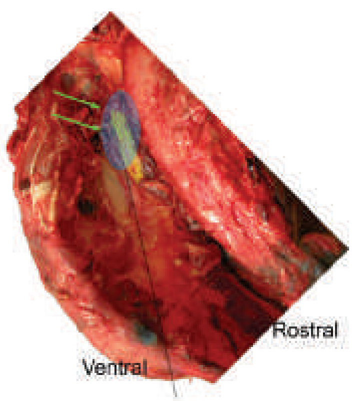


Fig 13: This specimen shows the medial aspect of the left mandible with the mandibular branch of the trigeminal nerve entering the mandibular foramen to become the inferior alveolar nerve (arrows) and showing the approximate area for deposition of local anaesthetic (shaded area), and the direction of passage of the needle (black line).

Fig 14: The inferior alveolar nerve block is being performed to assist with the removal of a mandibular cheek tooth via a lateral alveolar buccotomy in an anaesthetised horse.

Fig 15: This image shows the intersection of 2 imaginary lines which locates a point opposite the mandibular foramen. The horizontal line runs along the buccal aspect of the maxillary cheek teeth. The vertical line runs parallel with and 1 cm caudal to, the rostral aspect of the vertical mandibular ramus.

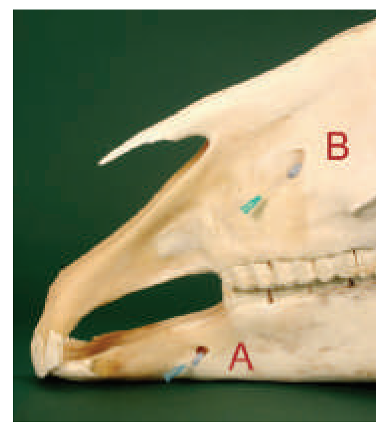


Fig 16: The mental (A) and infraorbital (B) nerve blocks can be used to desensitise the lips and rostral facial skin, and to paralyse the lips and nostrils.

Fig 17: The infraorbital foramen is approximately midway between the rostral facial crest (yellow dot) and the nasoincisive notch (green dot). Reflection of the levator nasolabialis *dorsally allows palpation of the foramen and introduction of a needle into it to with infusion of local anaesthetic to desensitise the rostral maxillary teeth and upper lip.*

foramen is palpable under the *levator nasolabialis* muscle, halfway along an imaginary line between the nasoincisive notch and rostral limit of the facial crest. Deposition of local anaesthetic around the emergent branches can be used to sensitise the skin of the muzzle and nostrils. By advancing a 21 gauge needle into the foramen and forcing local anaesthetic along the canal, branches supplying the cheek teeth can be affected. This nerve is extremely sensitive and stimulation of the nerve can provoke an extreme reaction, such as a sudden head jerk or rearing. Consequently this procedure should only be formed when the horse is heavily sedated or anaesthetised.

a)

b)

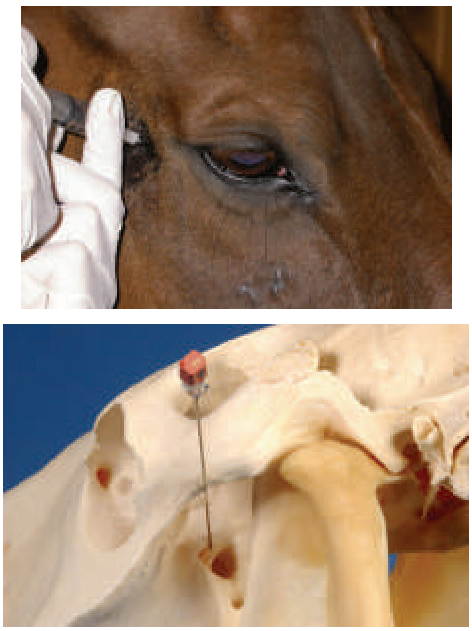


Fig 18: The maxillary nerve supplies the apices of all maxillary cheek teeth and desensitisation of this nerve before it enters the maxillary foramen facilitates with maxillary tooth removal. This nerve does not supply sensory innervation to all of the frontal sinus mucosa, which is partly derived from branches of the ethmoidal and nasociliary nerves. The needle shows the caudolateral approach.

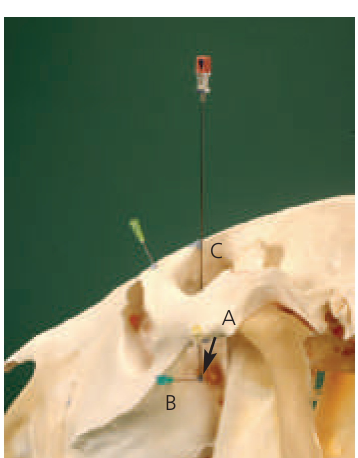


Fig 19: Several different approaches to desensitise the maxillary nerve are described including the caudolateral approach favoured by the author (A), a lateral approach (B) and (C) the supraorbital approach. The latter approach involves advancing the needle axial to the extraocular muscles, which can be inadvertently paralysed.

Fig 20: Ultrasonogram showing the temporomandibular articulation. Identification of the synovial space between the disc and the bony surfaces ultrasonographically assists with intra-articular analgesia.

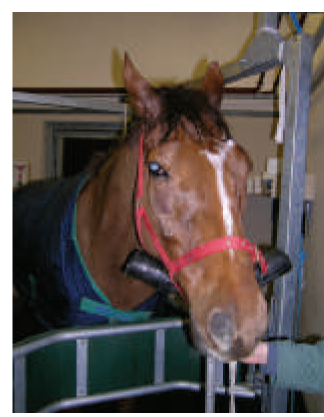


Fig 21: Undesirable side effects can be experienced after deep nerve blocks. This horse is showing facial sweating consistent with Horner's syndrome after a maxillary nerve block.

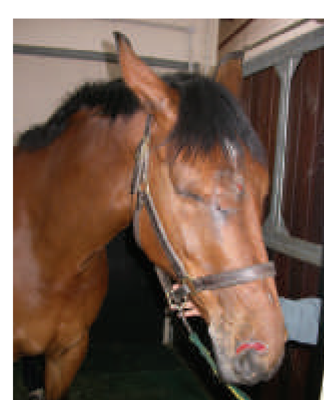


Fig 22: This horse exhibited suspected infraorbital neuropraxia after maxillary sinus surgery, resulting in self trauma to the nostril.

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