Equine cheek tooth repulsion using small diameter repulsion pins: 20 cases

Melissa Kamps | Safia Barakzai

Department of Veterinary Medicine, University of Cambridge, Cambridge, UK
Equine Surgical Referral Ltd., Brighton, UK

Correspondence
Safia Barakzai, Equine Surgical Referral Ltd., Brighton, UK.
Email: safia@equinesurgicalreferrals.com

Abstract

**Background:** Reported complication rates after dental repulsion for equine exodontia are high (up to 80%), but repulsion methods have changed notably in the last 20 years.

**Objectives:** Describe the outcome for 20 cases after dental repulsion using small diameter repulsion pins.

**Study design:** Retrospective case series.

**Methods:** Records of horses that underwent cheek tooth repulsion were reviewed (2014–2023). Inclusion criteria included: mandibular or maxillary cheek tooth extraction where oral extraction failed and repulsion was used to complete extraction, and where clinical follow up information was available. Repulsions were carried out under sedation with a regional nerve block or under a short general anaesthetic, using a small diameter repulsion pin (3–5 mm). Intra-operative radiographs facilitated instrument placement. The alveolus was packed with polymethyl methacrylate post-extraction. Horses were re-examined at 4–6 weeks post-operatively.

**Results:** Twenty cases were included. Patients had a mean age of 10.3 years old (range 5–16 years). The majority (75%) of teeth had pre-existing dental fractures. Maxillary \( n = 15 \) and mandibular cheek teeth \( n = 5 \) were all successfully repulsed, with 16 cases performed with the horse standing and 4 with the horse under general anaesthesia. Intra-operative complications included damage to the mandibular bone \( n = 1 \). Short-term complications \( n = 2 \) included superficial surgical site infection, and dehiscence of one sinus flap. Long-term complications included the recurrence of sinusitis \( n = 1 \) and small intra-alveolar fragments causing persistent bitting problems in another patient.

**Main limitations:** Retrospective study design, small number of cases.

**Conclusions:** When oral extraction fails, cheek tooth repulsion using small diameter repulsion pins is an effective extraction technique. The total intra- and post-operative complication rate was 25%, which is comparable to previously published complication rates for repulsion using Steinmann pins and also those encountered after trans-buccal screw extraction.

**KEYWORDS**

dental repulsion, dental surgery, exodontia, horse, standing surgery
1 | INTRODUCTION

Exodontia is the most common oral surgery in the horse. However, due to the anatomy of equine teeth, extraction can be challenging and carries a risk for intra- and post-operative complications.1–10

Oral extraction is accepted as the preferred surgical technique for equine exodontia due to its high success rates and relatively low complication rate.1,4–6 However, when the clinical crown is brittle, fractured or if it cannot be properly grasped by dental extraction forceps, oral extraction can be complicated. Occasionally, a protuberant dental crown, abnormal apical morphology or drifting of adjacent teeth can prevent vertical elevation of an already loosened tooth at the end of the oral extraction process. In previous studies, oral extraction could not be completed in 20%–29% of cases.1,4,6,11 When this occurs, other methods of extraction need to be employed and include intra-oral segmental, coronectomy, repulsion, lateral buccotomy or ‘minimally invasive’ transbuccal screw extraction.1,2,5–7,9,11,12

Dental repulsion was first described in the 19th century, was originally performed with the horse under general anaesthesia and was reported as a primary method of dental extraction, without pre-loosening of the tooth.5,8 In such cases, a large diameter dental punch was used to exert marked and prolonged forces to repulse the tooth, and the intra- and post-operative complication rates were relatively high (47%–55% for maxillary teeth and 32%–36% for mandibular teeth).5,8 More recently, smaller diameter dental punches or Steinmann pins have been recommended for dental repulsion in standing sedated cases where oral extraction has been previously attempted, thus pre-loosening the periodontal attachments of the tooth.2,3,8,13 However, relatively few cases have been objectively reported in the literature.6

The aim of this case series is to report on the outcomes and complication rates of 20 cases that underwent exodontia by repulsion of pre-loosened cheek teeth using purpose-made narrow diameter repulsion pins, performed by a single board-certified (ECVS) surgeon.

2 | MATERIALS AND METHODS

2.1 | Study population

Horses referred to a single board-certified equine surgeon (S.B.), that underwent maxillary or mandibular cheek tooth extraction by dental repulsion, between 2014 and 2023 were included in this case series. In all cases, oral extraction methods had been attempted but failed and repulsion was performed. Horses were included in the study if they had full follow-up information available (minimum 6 months post-operatively). Owner consent was obtained, and owners were contacted to give additional long-term follow up data where necessary. Data collected included breed, sex, age, clinical signs, findings during dental examination, radiographic or computed tomography (CT) findings, plus all relevant intra- and post-operative clinical information.

2.2 | Extraction methods/surgical technique

Oral extraction as described by Dixon et al. (2005, n=19) or oral extraction plus longitudinal sectioning of the tooth and attempted trans-buccal screw extraction (n = 1) had been previously attempted by either the referring veterinarian or by one of the authors (S.B.).

Depending on the duration of the sedation for the attempted oral extraction, repulsions were either performed on the same day or 1–2 days later. Horses received procaine penicillin (25 mg/kg IM [Depocillin, MSD Animal Health]) and flunixin-meglumine (1.1 mg/kg IV [Finadyne, MSD Animal Health or Allevinix, CEVA]) prior to the procedure. Repulsion was either performed standing under sedation (detomidine hydrochloride, 0.1–0.15 mg/kg IV [Detcionerv, Animal-care]) in combination with either butorphanol (0.01–0.04 mg/kg IV [Torbugesic, Zoetis]) or morphine (0.1 mg/kg IV [Morphine sulphate 60 mg, Wockhardt]), with maxillary or inferior alveolar nerve blocks (n = 16), or, for four cases at the beginning of this case series, under a short general anaesthesia.

Repulsions were performed through a trephine hole (for horses that did not present with concurrent sinusitis) or a small maxillary sinus flap (for horses that presented with concurrent dental sinusitis). For all cases, the skin above the dental apex was aseptically prepared and infiltrated with 2–3 mL of local anaesthetic using either mepivacaine hydrochloride [Intra-Epicaïne, Dechra] or lidocaine hydrochloride monohydrate [1% w/v Lidocaine injection, Braun]. A crosshatch of skin staples was applied widely over the skin overlying the presumed area of the dental apex, with staples orientated both vertically and horizontally (Figure 1) in order to precisely guide the location of the surgical incision. The dorso-ventral location of the incision was assessed from a straight lateral radiograph. Slightly dorso-ventrally angulated (10°–15°) oblique lateral radiographic views were then used in some cases to confirm the rostro-caudal position of the surgical site, because this view prevents superimposition of the left and right dental apices (Figure 1). Occasionally, the optimal surgical site for approaching the apex had to be adjusted to avoid damage to the infra-orbital foramen or nerve, or the salivary ducts.

Small maxillary sinus flaps were used to access the dental apex in most cases where co-existing sinusitis was present, as they allowed for full surgical access to the sinus interior which often contained inspissated pus. Maxillary sinus flaps were made in a standard fashion with an oscillating bone saw or with osteotomes and a surgical mallet as per Dixon et al. (2012). Trephine holes were used to access dental apices that lay outside the paranasal sinuses (including for mandibular cheek teeth)—these were made in the maxillary bone or hemi-mandible using a series of modified masonry drill bits which had been welded onto a T-piece handle (Figure 2) to allow manual creation of a drill hole in the bone as per Dixon et al. (2000), starting with a 5 mm diameter bit, then enlarging to 7 and 9 mm in succession if required.

For horses where repulsion was performed under general anaesthesia, all preparation for the repulsion including staple placement, pre-operative radiographs and creation of the trephine hole was performed with the horse standing and sedated, prior to induction, to
reduce the duration of general anaesthesia. For these cases, after creation of the trephine hole, diazepam (0.05 mg/kg, Diazepam, CP Pharmaceuticals) was administered and general anaesthesia was induced with intravenous ketamine (2.2 mg/kg IV, Vetalar, Parke-Davis) and maintained with 1–2 further doses of ketamine (1.1 mg/kg IV) if a longer duration of anaesthesia was required.

After gaining access to the dental apex, the smallest (3 mm diameter, 19 cm length shaft) of a set of custom-made dental pins [Minimally invasive repulsion kit, Equine Blades Direct] was positioned onto the dental apex under radiographic guidance, ensuring that the pin was oriented along the long axis (eruption pathway) of the tooth (Figures 3 and 4). The mouth was held open with a Hausmann gag and the tooth was repulsed into the oral cavity using a slotted mallet [Minimally invasive repulsion kit, Equine Blades Direct] acting on the wide ‘head’ end of the pin. An assistant held their hand in the horse’s mouth with fingers over the occlusal aspect of the tooth that was

**FIGURE 1** Pre-operative lateral (left) and 15° ventro-dorsal lateral oblique radiographs of the same case showing crosshatch staple placement to facilitate accurate positioning of trephine hole below of the affected 309. Note how both the dorso-ventral and rostro-caudal positioning of the trephine hole (red circle) is more accurate in the straight lateral view as there is significant dorso-ventral and a small amount of rostro-caudal distortion in the oblique view. The trephine hole would be positioned at the area of the red circle, around 2 cm ventral to the ventral border of the 309 which has quite blunted roots (309 apex outlined in red in the lateral view). N.B. The radiograph on the left is not a true lateral projection—a few degrees of dorso-ventral angulation exists as the ventral mandibular cortices are not fully aligned.

**FIGURE 2** Equipment used for repulsion. (A) Minimally invasive repulsion kit with slotted mallet and 3 and 5 mm repulsion pins. (B) Textured end of a repulsion pin designed to give better contact on tooth. (C) Modified drill bits with T-piece used to make trephine holes (5–9 mm diameter).
being repulsed to check that vibrations from the mallet/punch were being directly transferred onto the correct tooth, and to indicate to the surgeon once there was any small movement of the tooth. If no movement of the tooth could be elicited using the 3 mm diameter pin, a 5 mm diameter pin was then used.

Once repulsed, the tooth was carefully examined to ensure that all roots were present. If the reserve crown or roots of the tooth were fractured by the repulsion process, remaining fragments were removed either with dental picks by mouth or by re-positioning of the 3 mm repulsion pin. An oblique radiograph was obtained to confirm complete removal of the tooth. The alveolar bone was curetted if needed, from the apical aspect and then the surgical site and dental alveolus were flushed with Hartmanns solution [Vetivex 11, Dechra]. After drying with swabs, the dental alveolus was packed with polymethyl methacrylate (PMMA) plug [Simplex HV Antibiotic Bone Cement with Gentamicin, Stryker]. The minimal amount of PMMA necessary to fill only the oral 2–3 cm of the empty alveolus was used, sometimes using the repulsion pin placed via the trephine hole to push the PMMA up/down towards the oral cavity before it set, ensuring that it did not fill the entire alveolus. This empty space left in the more apical portion of the alveolus is important because it allows this area to fill with granulation tissue and encourages the iatrogenically created fistula to seal.

If a maxillary bone flap had been made, the bone was replaced as long as it had retained its soft tissue attachments, and the soft tissues were closed in two layers using polyglactin 910 suture [Vicryl 2-0, Ethicon] in a simple continuous pattern in the subcutaneous tissues and staples in the skin. If a trephination site had been made, the skin was left open to heal by secondary intention and allow for post-
operative drainage from the contaminated surgical site. For cases that had concurrent active sinusitis, a mare uterine lavage catheter was sutured into a frontal trephine hole to allow post-operative sinus lavage.

2.3 | Post-operative care

After surgery, horses received 5 to 7 days of oral non-steroidal anti-inflammatory drugs (phenylbutazone 2.2 mg/kg every 12 h PO [Equipalazone, Dechra] and trimethoprim sulfadiazine (30 mg/kg every 12 h PO [Trimediazine Plain, Vetoquinol]) or doxycycline (10 mg/kg every 12 h PO [Doxycycline paste, BOVA]). Horses were fed as normal after they had recovered from the sedation and the majority were discharged from the hospital/clinic the same day. Only those that underwent ongoing sinus lavage were hospitalised for the duration of the sinus lavage (3–5 days). Ridden work was paused for 2–3 weeks to allow for healing of the skin incisions. Follow-up appointments were recommended at 14 days post-surgery to remove skin staples and check the PMMA plug. If the PMMA was still firmly in place, a further examination 4–6 weeks post-surgery was planned for removal of the PMMA plug and inspection of the alveolus—in particular to examine the granulation bed, ensure no oro-antral or oro-cutaneous fistula remained and check that no alveolar seques-trae were present (and remove them if so). If in any case the PMMA plug was lost prior to 4–6 weeks post-surgery, it was replaced if an oro-antral or oro-cutaneous fistula was still present.

2.4 | Post-operative complications

Follow-up data regarding surgical complications were obtained from the surgeon’s clinical records, hospital records, the referring veterinarian and telephone follow-up with owners if necessary.

3 | RESULTS

Nineteen horses were included in this case series, with a total of 20 cheek teeth repulsed. One horse underwent two extractions of fractured and apically infected teeth (309 and 409), 13 months apart. The mean age was 10.3 years old (range 5–16 years). Other information on signalment is provided in Table 1. Cases included 15 maxillary cheek teeth and 5 mandibular cheek teeth. Triadan position of extracted teeth and types of pre-existing dental fractures are shown in Table 2. Mean follow up period was 29 months (range 6–48 months).

3.1 | Extraction

Oral extraction with the horse standing and sedated was attempted in all cases either by the referring vet (n = 2), or by one of the authors (n = 17). In one case, initial oral extraction was attempted by a dental specialist who also sectioned the tooth longitudinally and attempted trans-buccal screw extraction, but this was unsuccessful. During the study period, 199 teeth were successfully orally extracted by the senior author; therefore, the failure rate of oral extraction for cases operated on exclusively by this surgeon was 7.8% (17/216). Oral extraction was abandoned due to fracture (or additional fracture) of the clinical crown in 13 cases meaning that extractors could no longer grasp the tooth. Additionally, these teeth could not be loosened or elevated further using dental picks. A wide area of apical hypercementosis prevented oral extraction in two cases. In three cases, vertical elevation at the end stage of oral extraction was not possible, despite the tooth being loose and with marked force being exerted on the fulcrum. A dilacerated root in two of these cases prevented elevation and a bulbous apical region was present in the other. The reason for oral extraction failure was not recorded in two cases. Dental repulsion was performed in the standing sedated horse in 16 cases, and with the horse under general anaesthesia in four cases which were operated in the early part of this case series. Repulsion was performed via a trephine site in 13 cases and via a small maxillary bone flap in seven cases. Post-operative sinus lavage via a frontal trephine hole was performed in 5/7 cases after maxillary bone flap surgery—in the other two cases the sinuses were lavaged intra-operatively but none or only minimal amounts of purulent material were present thus post-operative lavage was not deemed necessary.

In all cases, the tooth and any apical hypercementosis were extracted successfully by repulsion. In 11/20 cases, the tooth was repulsed in one piece (includes teeth that were loosely joined at the apex by soft tissue in cases of complete midline sagittal fractures); in 7 cases, the remaining tooth was repulsed in two pieces; in 1 case, the tooth came out in 3 pieces or more; and in 1 case, it was not recorded. A PMMA plug was placed in all cases.

3.2 | Intra-operative complications

An intra-operative complication occurred in one case (5%), when repulsing a mandibular cheek tooth (309) in a standing sedated horse.
The lateral aspect of the mandibular alveolar crest immediately adjacent to the affected tooth was damaged by misdirection of the punch during the repulsion process. This horse experienced slowly increasing focal mandibular swelling from around 3 weeks post-operatively and at 3 months post-surgery, small crestal bone fragments became loose and were removed orally. After that the mandibular swelling subsided and healing was uneventful.

### 3.3 Short-term complications (≤4 months)

Three patients had bony alveolar sequestra identified and removed after removal of the PMMA plug at the 4–6-week post-operative re-examination, but no clinical signs were associated with these fragments and thus these cases were not counted as having complications.

Two cases (10%) experienced short-term post-operative complications that warranted further medical treatment. Both were after maxillary cheek teeth repulsion, through a sinus flap in one patient and via a trephination site in the other. One patient developed a superficial surgical site infection at the trephine hole, which resolved with a 2-week course of trimethoprim sulfadiazine (30 mg/kg every 12 h PO [Trimediazine Plain, Vetoquinol]). In the other case, where the bony part of the maxillary flap was not retained because it became separated from the overlying periosteum during surgery, there was partial necrosis of the skin flap, leaving a temporary sino-cutaneous fistula (Figure 5). Systemic antibiotics (2 weeks of doxycycline) (10 mg/kg PO every 12 h [Doxycycline paste, BOVA]) and basic wound care were instituted and the fistula healed in 2.5 months without further surgical intervention.

### 3.4 Long-term complications (>4 months)

Two patients (10%) experienced complications in the longer-term. One patient developed unilateral nasal discharge 4 months after initial repulsion of 209 via a maxillary flap plus post-operative sinus lavage for 5 days. Radiographic findings were consistent with recurrence of sinusitis. A frontal trephination hole was created and inspissated pus was removed under sinoscopic guidance. The sinus was lavaged for 5 days and the pony was administered doxycycline (10 mg/kg PO every 12 h [Doxycycline paste, BOVA]) and phenylbutazone (2.2 mg/kg every 12 h PO [Equipalazone, Dechra]) for 7 days. The sinusitis resolved after this treatment. One horse was re-presented to the referring vet 9 months after dental repulsion of 109 due to

### Table 2

<table>
<thead>
<tr>
<th>Tooth position</th>
<th>Number of teeth</th>
<th>No fracture</th>
<th>Midline sagittal fracture</th>
<th>Slab fracture</th>
<th>Other fracture configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maxillary 07</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1 (diagonal) 1 (horizontal-traumatic)</td>
</tr>
<tr>
<td>Maxillary 08</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Maxillary 09</td>
<td>9</td>
<td>2</td>
<td>5</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Maxillary 10</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mandibular 07</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mandibular 08</td>
<td>2</td>
<td>0</td>
<td>-</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Mandibular 09</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>0</td>
<td>1 (diagonal)</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>5</td>
<td>7</td>
<td>6</td>
<td>3</td>
</tr>
</tbody>
</table>

Note: One maxillary 09 tooth had both a midline sagittal and a slab fracture present (hence 10 fractures in 9 teeth).
persistent biting problems when ridden. A CT scan was performed which revealed one small (circa 8 mm) hyperdense circular fragment within the granulated dental alveolus approximately 1 cm from the apical area. This bone fragment was removed with the horse sedated via an oral approach with dental picks, the alveolus granulated fully again, biting problems resolved and no further complications occurred.

4 | DISCUSSION

Several dental extraction techniques are available to remove diseased equine cheek teeth and extraction methods continue to evolve. Due to the anatomy of equine teeth, extraction can sometimes be challenging and all techniques carry some risk for intra- and postoperative complications. It should be noted that ‘complication rates’ are not always directly comparable between different publications, with authors’ definitions of what constitutes a complication varying noticeably.

There has only been one study objectively reporting results of ‘minimally invasive’ repulsion of cheek teeth using a Steinmann pin after attempted oral extraction (n = 41, 24% complication rate). Coomer et al. (2011) used both narrow (5 mm) and wider (9 mm) dental punches in their 20 repulsion cases performed with the horse standing and sedated, but did not detail specifically which of these instruments was used in cases when reporting complications. In this case series of 20 cheek teeth, we report the results of dental repulsion using narrow (3 and 5 mm) purpose-made dental repulsion pins, performed after failed oral extraction, predominantly in standing sedated horses.

4.1 | Indications for repulsion

Oral extraction is now widely accepted as the preferred surgical technique for equine exodontia, due to its high success rates and relatively low complication rate (14%–29%). Complications that occur after oral extraction are usually minor and easily managed. However, in a minority of cases, when the clinical crown is brittle, fractured or if it cannot be properly grasped by dental extraction forceps, oral extraction can become challenging. Anatomic variances in morphology, such as dilacerated roots, dental dysplasia, ‘protuberant’ dental crown morphology, neoplasia, or other apical masses such as hypercementosis can prevent elevation of the tooth vertically from the alveolus at the end of oral extraction and require other methods to complete the surgery. Previous studies have documented that oral extraction could not be completed in 11%–29% of cases. We reported a similarly low rate for failure of oral extraction (17/216 cases performed exclusively by one surgeon, 7.8%). The majority (75%) of failed cases of oral extraction in this series had pre-existing dental fractures. Two cases had no fracture but had advanced dental pathology which affected the overall integrity and strength of remaining dental tissues, evidenced by marked radiolucency of the entire affected tooth on radiographs (Figure 4), friable dental tissues and subsequent early fracture of the clinical crown during the oral extraction process. In five cases, the tooth was loosened significantly using separators and cheek tooth forceps, but could not be elevated vertically from the alveolus using a fulcrum, due to having dilacerated roots (n = 2) or a wider structure apically than orally (‘protuberant’ apical morphology or hypercementosis, n = 3). In such cases, we believe that a method that uses force applied directly onto the tooth (e.g., repulsion or transbuccal screw extraction methods) which might result in breakage of the tooth root or apical hypercementosis is safer than leveraging with massive force against the premaxilla or rostral mandible with a fulcrum and intra-oral forceps, thus risking iatrogenic fracture of these bones.

4.2 | Options after failed oral extraction

When standard oral extraction methods fail, advanced intra-oral methods including intra-oral segmentation/longitudinal sectioning or coronectomy can be employed but these do require considerable skill and also specific equipment to be used safely and effectively, particularly in young horses with long reserve crowns. Alternative surgical methods to facilitate difficult dental extractions are repulsion, lateral buccotomy or transbuccal screw extraction. One 8-year-old horse in this case series had undergone longitudinal sectioning and attempted trans-buccal screw removal of a fractured 308, but these methods were unsuccessful and repulsion was then indicated.

Lateral buccotomy is a relatively invasive procedure that provides access to the clinical and reserve crown by sectioning the lateral alveolar bone plate. It is technically demanding, may require prolonged general anaesthesia, has a reasonably high complication rate (27%–31%) and is not in common use at the current time, with most dental specialists and equine surgeons preferring alternative methods.

The placement of an intra-dental screw via a trans buccal trocar is widely termed ‘minimally invasive’ trans-buccal extraction, but the technique is technically challenging and there is significant risk of complications. These include significant haemorrhage during surgery (up to 13%), temporary facial nerve paralysis (up to 27%), damage to the salivary ducts, infection of the surgical site (up to 7%), non-resolution of or novel development of nasal discharge (up to 35%), oromaxillary fistula (up to 26%) and standard complications related to prolonged sedation or general anaesthesia. Additionally, 3%–19% of teeth cannot be successfully removed using transbuccal screw extraction and these cases required dental repulsion to complete the exodontia procedure. Kennedy et al. (2020) directly compared cases of transbuccal screw extraction to those that underwent Steinmann pin repulsion and found that complication rates were very similar (24% for pin repulsion, 26% for transbuccal screw repulsion). Caramello et al. (2020) also examined cases that underwent lateral buccotomy and dental repulsion, but their repulsion cases included many (56/78) that did not undergo attempted oral extraction first, and in most horses, they used a larger ‘traditional’ dental punch in anaesthetised horses rather than a narrow Steinmann pin.
Earlier reports on dental repulsion in the veterinary literature describe surgery performed with the horse under general anaesthesia, without oral pre-loosening of the affected tooth, using traditional wide (10–15 mm diameter) dental punches. Large diameter punches may be more likely to damage structures adjacent to the tooth and will always result in a wide oro-cutaneous or oro-sinus fistula which then takes much longer to fill in with granulation tissue. In the original reports of this method from Prichard et al. (1992) and Dixon et al. (2000), intra-operative complications occurred in 11%–12% of cases and included alveolar fracture and removal of the wrong tooth. Post-operative complications were frequent (32%–47%) and 19%–21% of cases required an additional surgical procedure. It should be noted that these two studies were performed in the era of film radiography; the use of direct radiography (DR) makes a huge difference to the speed of acquisition of intra-operative radiographic images, and is likely to therefore increase the accuracy of trephine hole and dental punch positioning and of small adjustments to this made during surgery. The use of DR also likely shortens anaesthetic times. With DR available, we believe that the risk of damage to an incorrect adjacent tooth during a dental surgery should be quite minimal.

The pre-operative preparation involving mapping out the skin overlying the apical area with a grid-type placement of skin staples and taking both straight lateral and slightly dorso-ventrally (DV) orientated lateral oblique radiographs is critical for optimal placement of the trephine hole (or sinus flap) and also for correct orientation of the dental repulsion pin. The straight lateral radiograph gives the best assessment of where to position the trephine hole in a dorso-ventral plane, and the slightly DV orientated lateral oblique radiograph gives a better view of trephine hole placement in a rostro-caudal direction in some cases where the contralateral tooth can obscure the dental apex of interest. Rostro-caudal angulation of radiographs must be avoided. The most common mistake in our experience was to place the trephine hole too close to the dental apex; it should ideally be placed 1–2 cm dorsal (maxillary teeth) or ventral (mandibular teeth) to the dental apex to allow for optimal angulation of the pin along the long axis of the tooth (Figure 1). For teeth whose apices are within the sinuses, it is possible to damage the bony infra-orbital canal and subsequent infra-orbital neuritis if repulsion is performed via a small trephine hole—we believe that the use of a small maxillary bone flap hugely reduces this risk as the infra-orbital canal can be very clearly identified and avoided.

When oral extraction has already been attempted, the tooth will have had a variable amount of loosening of its periodontal attachments prior to repulsion and thus a smaller diameter dental punch (or Steinmann pin) can be used to perform the repulsion because less force is required to completely detach the remaining periodontal liga-ment attachments. Coomer et al. (2011) used either a 5- or 9-mm dental punch in standing sedated horses after attempted oral extraction but still reported a relatively high (41%) complication rate. Although there are many passing references to ‘minimally invasive’ pin repulsion in the literature, only one previous study has objectively reported complications of repulsion of pre-loosened teeth using a Steinmann pin in 41 standing horses. In Kennedy et al.’s report, the diameter of Steinmann pin used was not specified. They do not specify their technique in detail, but the pin was presumably cut prior to use, because these orthopaedic implants usually are supplied with one or two sharpened ends to allow penetration of bone—whereas two blunt ends are required to abut onto the dental apex (because a pointed end could easily penetrate the tooth causing it to fracture/fragment rather than repulse it into the oral cavity) and also on the end where the surgical mallet is used. These authors reported a complication rate of 24% which was almost identical that found in our smaller case series (25%).

The purpose-made narrow diameter dental repulsion pins used in this study have been available commercially for over a decade. The major advantage of using a narrow pin is that only a small oro-sinus or oro-cutaneous fistula is created, thus fistula healing occurs within weeks. The narrow end of the pin that contacts the tooth has a grooved surface (Figure 2), which is designed to give it better purchase than a smooth cut Steinmann pin. The other end has a large ‘block’ which is easier to hit with force using the mallet than hammering a narrow metal pin. The supplied mallet is slotted, allowing the pin to be removed easily when it is embedded in dense tissues, by retro-grade hammering—removal of the dental punch can be a cause of frustration with a standard dental punch or Steinmann pin. The set comes with a corresponding set of 3- and 5-mm diameter sharp ended pins designed to perform the initial penetration of maxilla/mandible using the mallet, but we preferred to make a slightly larger trephine hole in the overlying maxilla or mandible with a handheld drill bit so that entry through this bone is more controlled and underlying structures are not inadvertently damaged. The slightly larger bony window created also enables wider variation of the pin position/direction intra-operatively. The disadvantage of using a narrow pin is that if the tooth is not adequately loosened, the pin may bend under force from the mallet, rather than the tooth being repulsed into the oral cavity, and this is when the larger diameter pin (5 mm) was used. Repeated puncturing of the alveolar bone plate through inaccurate pin placement is likely to result in a higher complication rate and practitioners should not underestimate the training and experience required to use this technique successfully.

In the current case series, intra-operative damage to the mandible from a misdirected dental punch which emerged on the lateral side of the affected tooth, occurred in one patient. Bone fragments were removed intra-orally as they became loose several months post-operatively and there were no further complications.

Complications occurred in the short (10%) and long term (10%) in our patients—a comparable rate to Kennedy et al. and most complications in our case series were quite straightforward to resolve. Similar to Christiansen et al., bony sequestra found within the alveolus during planned repeat examinations were not regarded as a complication if the horse was not showing any clinical signs. Alveolar sequestra occur commonly as a consequence of the mechanical process of exodontia, regardless of technique used with a reported prevalence of 37.5%–90%. Removal of alveolar sequestra and checking that any oro-cutaneous or oro-sinus fistula has sealed are the principal reasons for the follow-up appointments.
performed at 4–6 weeks and we believe that routine re-examination of the alveolus at this time is very important. PMMA was used to plug the oral aspect of the alveolus in these cases as it is imperative that no food material must enter the fistula in the first few weeks’ post-repulsion whilst the hole is granulating closed. Other forms of watertight dental packing are available.

Dental repulsions have historically been performed with the horse under general anaesthesia and the four horses that underwent general anaesthesia in this series were operated on early in the study period, before the surgeon transitioned fully to performing all repulsions under deep sedation with a regional nerve block in place. There may still be some cases where the horse’s temperament may dictate that repulsion is more safely performed with the horse under general anaesthesia.

The most important limitations of this study are the retrospective design and the low number of cases that did not allow for statistical analysis. Data regarding post-operative complications were gathered retrospectively and a prospective study would likely have been more accurate when recording healing times and incidence of all possible complications.

5 | CONCLUSION

In this case series, extraction via dental repulsion resulted in successful exodontia in 100% of cases. Intra-operative complications occurred in one case (5%), short-term complications occurred in two cases (10%) and two cases experienced complication in the longer term (10%). These complication rates indicate that dental repulsion using small diameter repulsion pins is a useful technique and should be considered after failed oral extraction.

FUNDING INFORMATION

Not applicable.

ACKNOWLEDGEMENTS

The authors thank the participating horse owners and referring veterinarians at Bakewell Equine Clinic, Blackdown Equine Clinic, Cambridge Equine Hospital, Chine House Veterinary Hospital, Lingfield Equine Vets, Priors Farm Equine Vets, Towcester Equine Vets and Tower Equine.

CONFLICT OF INTEREST STATEMENT

The authors declare no competing interests.

AUTHOR CONTRIBUTIONS

Melissa Kamps: Writing – original draft. Safia Barakzai: Conceptualization; writing – review and editing; methodology; supervision.

DATA INTEGRITY STATEMENT

Melissa Kamps and Safia Barakzai had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

ETHICAL ANIMAL RESEARCH

Research ethics committee oversight not required by this journal: retrospective study of clinical records.

INFORMED CONSENT

Owner consent was obtained.

PEER REVIEW

The peer review history for this article is available at https://www.webofscience.com/api/gateway/wos/peer-review/10.1111/evj.14116.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request: Open sharing exemption granted by editor for this retrospective clinical report.

ORCID

Melissa Kamps https://orcid.org/0009-0004-2336-3987  
Safia Barakzai https://orcid.org/0000-0002-1568-8413

REFERENCES


How to cite this article: Kamps M, Barakzai S. Equine cheek tooth repulsion using small diameter repulsion pins: 20 cases. Equine Vet J. 2024. https://doi.org/10.1111/evj.14116