

TREATMENT OF FRACTURED TEETH IN A RHESUS MONKEY

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Key words: veterinary dentistry; fractures of teeth; Rhesus monkey, (*Macaca mulatta*)

The case report describes treatment of fractured teeth in a 10-year old male Rhesus monkey (*Macaca mulatta*) weighing 9.5 kg presented to the Small Animal Clinic of the Veterinary faculty in Brno after the animal was kicked in the face by a horse. The monkey suffered the following injuries: fractures of the crowns of all four canine teeth (104, 204, 304, 404), fractured roots of the mandibular right first and the left second incisors (401, 302), avulsion and loss of the mandibular right second incisor (402), minor lacerations and bruising of the facial and oral soft tissues. The dental anatomy of the Rhesus monkey is similar to that of humans and dogs so endodontic treatment was performed to save those damaged teeth where there was sufficient remaining crown. The technique and materials used were those described for other species. Following treatment, by partial pulpectomy or conventional root canal therapy as appropriate, restoration using metallic or cosmetic metal-coated crowns was considered, however, this was declined by the owner.

ZDRAVLJENJE POŠKODOVANIH ZOB PRI OPICI REZUS

Ključne besede: veterinarska stomatologija; fraktura podočnika; opica Rezus, (*Macaca mulatta*)

Članek opisuje zdravljenje poškodb ustne votline in zob pri deset let stari opici Rezus moškega spola, teži 9,5 kg. Lastnik jo je pripeljal na univerzitetno kliniko v Brnu iz cirkusa, kjer jo je med čakanjem na nastop udaril poni s kopitom. Dobila je naslednje poškodbe: frakture kron vseh podočnikov, frakture korenin prvih desnih I₁ in drugih levih 2I spodnjih sekalcev, avulzijo drugega spodnjega desnega I₂ sekalca ter manjše razrtganine mehkih tkiv v ustni votlini.

Denticija in zobni lok sta po morfologiji podobna človeškemu. Podočniki pa so veliki in vsidrani v kosti kot pri mesojedih.

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Poškodovani zobje so bili konvencionalno endodontsko obdelani z materiali, ki jih uporabljamo v vsakodnevni praksi. S predlagano nadomestitvijo zobnih kron s kovinskimi prevlekami, ki bi predstavljale optimalno rešitev ohranitve normalnega zobnega loka, se lastnik živali ni strinjal.

Introduction

The Rhesus monkey (*Macaca mulatta*) inhabits central and south-eastern Asia from eastern Afghanistan to northern Thailand. It is popular in zoos, circuses and is also kept by private individuals, also being used as an experimental animal. Its hair-coat is of medium length and brown to grey in colour. The skin around the anus and genitals is cornified and hairless, being red in colour in adults. The body weight is between 9 and 10 kg in adults. The body length is around 50 cm, with the tail being in the region of 25 cm (i.e. 75 cm total length). Rhesus monkeys can live up to 30 years. Their dental formula is $2 \times I \frac{2}{2} C \frac{1}{1}, P \frac{2}{2}, M \frac{3}{3}$. The dental anatomy and tooth morphology is largely similar to that of humans, however the canine teeth are huge and resemble those of a carnivore. The similarity the dentition with that of man and the dog allows the direct application of recognised clinical techniques to treatment of monkey teeth.

Fresh complicated crown fractures, in which the pulp has not yet been irreversibly damaged, may be treated by direct pulp capping or by partial vital pulpectomy (vital amputation), and sealing of the pulp exposure site with a restorative material (1). A disadvantage of this approach is the likelihood of continued bleeding from the stump of the pulp, this sometimes being hard to control (2, 3). In this situation total pulpectomy and a conventional root filling are probably the best option, but apical haemorrhage can still be a problem (4). In this case application of a temporary dressing can be considered, the exposed pulp stump being dressed with calcium hydroxide or a more aggressive devitalising substance to induce necrosis of the residual pulp so that it can be removed easily at a later stage without further haemorrhage (i.e. a mortal amputation procedure) (5, 6, 7). After an appropriate period, depending on the product used, the pulp canal can be thoroughly cleaned and the root canal treatment completed. The main disadvantage of this method is the need of the second anaesthesia, especially in an animal that requires special handling (2, 3).

Failure to treat complicated crown fractures results in infection and inflammation of the exposed pulp with development of periapical pathology (8, 9). This may remain localised for a variable period before extending to involve adjacent structures. Apical abscessation and fistulation, either within the mouth or through the facial skin, are common sequelae, with bacteraemia and septicaemia also being possibilities.

Case report

Presentation

A 10-year-old male Rhesus monkey weighing 9.5 kg, kept by an entertainer for use in variety shows, was presented to the Small Animal Clinic of the Veterinary Faculty in Brno. The animal was injured during rehearsals for a show when the animal tried to bite a horse. definitive examination having to be performed after sedation. The monkey appeared to be in good general health and was difficult to handle. Limited conscious examination of the oral cavity was possible with the help of the owner. The following injuries were noted: fractures of the crowns of all four canine teeth (104, 204, 304, 404 - modified Triadan notation (9), fractures of the roots of the mandibular first right (401) and the second left (302) incisors, avulsion and loss of the second right lower (402) incisor, plus minor lacerations and bruising to the facial and oral soft tissues (Figure 1). In addition to the above-mentioned injuries, there was a longstanding complicated crown fracture of the maxillary right first incisor (101), the pulp already being necrotic.

Sedation and Anaesthesia

A combination of medetomidine (10 µg/kg: Domitor ® Orion Co., Turku, Finland) and ketamine (5 mg/kg: Narkamon 5% ® Spofa Praha, Czech Republic) was mixed in one syringe and administered intramuscularly into the biceps femoris muscle. Ataxia was noted within 3 minutes and lateral recumbence occurred after a further 5 minutes. However it took another 7 minutes before the animal was safe to handle and the oral examination could be completed (Figure 2). At this stage the monkey was deeply sedated, the palpebral reflex was absent but the corneal reflex remained and the animal responded to painful stimulae and the swallowing reflex was preserved. An intravenous catheter was placed in the cephalic vein and general



Figure 1: Damaged incisors and lateral border of the tongue



Figure 2: Anaesthetised patient in lateral recumbence prior to intubation

anaesthesia was induced using intravenous injection of propofol to effect (2.5 mg/kg: Propofol ® Abbott, UK) and a 6mm internal diameter endotracheal tube placed to protect the airway. Vital functions were by pulse oxymetry, capnography and manually and the following parameters noted: heart rate (HR), respiratory rate (RR), peripheral pulse rate (PR), oxygen saturation (SpO₂) and the end tidal CO₂ concentration (ETCO₂). The animal breathed atmospheric air (21% O₂) spontaneously throughout the procedure, SpO₂ varying between 90 and 100%. The heart rate dropped from 130 and stabilised at between 90 and 100 beats per minute. The respiratory rate rose to 40 breaths per minute initially and then stabilised at 20 to 25 breaths per minute. Anaesthesia was maintained using incremental doses of propofol at a dose rate of 6 mg/kg/hour. At the end of the procedure atipamezole (25 µg/kg :



Figure 3: Open pulp cavity visible on the fractured surface of the canine tooth

ANTISEDAN ® Orion Co., Turku, Finland) was administered intramuscularly to reverse any residual effects of the medetomidine used during induction. The animal regained consciousness within 5 minutes but remained ataxic for a further 30 minutes.

Treatment

Before starting treatment the oral cavity was radiographed focusing on the damaged and adjacent teeth (101-104, 201-204, 301-304, 401-404). The canine teeth were treated with the patient in lateral recumbence, with its mouth propped open (Figure 3). The mandibular right first and the left second incisors (401, 302) were irrecoverably damaged so the fractured root remnants were extracted.

The fractured surfaces of the other damaged teeth were irregular and the enamel was cracked. The damaged crowns were smoothed using a cylindrical diamond bur in a turbine unit creating a surface slanting to the distal portion of the tooth at an angle of about 30° to the neck of the tooth.

Partial pulpectomy and direct pulp capping of the fractured canine teeth

The pulp was subsequently removed from the pulp chambers of the canine teeth (104, 204, 304, 404) to a depth of about 4 mm using a sharp excavator. Using a sterile round bur in the turbine unit, the pulp canal was then enlarged to one third of the tooth diameter creating a cavity, the bottom of which joined the pulp canal containing the vital pulp. Circumferential retentive grooves were then formed in the inner walls of the cavity using an inverted cone bur.

Bleeding from the stump of the pulp was controlled by application of cotton pellets dipped in 3% H₂O₂ and put directly over the pulp. These were left in place for about 15 minutes (whilst preparing other teeth). When haemorrhage was fully controlled the pulp was directly covered with Ca(OH)₂ paste, (Calxyd, Spofa dental Czech Republic) over which a layer of glass-ionomer cement (Kavitan, Spofa dental Czech Republic) was placed to provide a coronal seal. Once it had cured, excess cement was removed, further retentive undercuts established in the cavity walls and amalgam surface restorations placed.

Conventional root canal treatment maxillary right first incisor

The necrotic pulp was removed from the root canal of the fractured incisor tooth (101), the empty canal shaped and disinfected using endodontic files with repeated flushing using a 5.25% solution of sodium hypochlorite (Chlordent, C.S.C. Praha, Cz).

The coronal portion of the pulp canal was then prepared using a round diamond bur to create a suitable cavity form with an undercut to provide retention of the restoration.

The pulp cavity was dried with sterile paper points and then filled using a non-setting calcium hydroxide containing root canal sealer (Apexit Vivadent, Lux) and laterally condensed gutta-percha points (Figure 4). A heated modelling instrument was then used to remove the excess gutta-percha. The cavity was then closed and sealed with glass-ionomer cement. After this had set, excess cement was



Figure 4: The incisor tooth filled with endodontic cement and gutta-percha points



Figure 5: The finally restored incisor

removed from the borders of the cavity and a composite (Evicrol molar, Spofa dental, Czech Republic) surface restoration placed following the manufacturer's instructions. (Figure 5)

Post-operative care

Antibiotic cover was provided using amoxycillin clavulanate (Augmentin sir., Beecham Pharmaceutical, UK) at a dose of 30 mg/kg daily for 5 days. The owner was instructed to observe the animal closely and return after 21 days for re-examination.

Discussion

Facial trauma commonly results in damage to the teeth (10). As in man, the treatment options for veterinary patients depend upon the nature of the injury, the need to retain teeth, the ability of the patient to withstand treatment and the abilities of those performing the treatment. Further factors include the wishes of the owner, their ability and willingness to pay for the treatment. This case involved a Rhesus monkey, an infrequently seen exotic species with special handling requirements. It therefore presented a challenge.

The vital endodontic treatment performed in this case provide sufficient residual functionality of the affected canine teeth with a relatively reliable single stage procedure (11, 12, 13) at an acceptable expense. The main pitfall of leaving remaining vital pulp in a canal is the possibility of progressive pulpitis and pulp necrosis, which can, without proper treatment, result in formation of a periapical granuloma, cyst or abscess with the risk of loosening of the tooth (12, 13). Complete devitalisation (conventional root canal treatment) would have decrease that risk, but left the tooth less resistant to mechanical damage (14, 15). The owner is aware of the need for ongoing monitoring and maintenance of an effective coronal seal, and that should there be complications, further intervention may be needed in the future. It is hoped that regular radiological examinations will be possible, however, the costs involved and the need for anaesthesia may prove to be hurdles.

Dental filling materials are formulated and designed for use in man. The basic composition of monkey teeth is the same in man but there are structural variations and the stresses to which the teeth are subjected are different. The restorative materials selected in this case possess all the appropriate properties to maintain the toughness and functionality of the treated teeth (16). Amalgam was chosen for the surface restoration of the canines as it is very strong and durable. As it does not bind directly to the dentin, either physically, nor chemically, it required anchorage by mechanical means, i.e. the undercuts created within the prepared cavities. In man the cosmetic appearance of the teeth is important. this could also be a factor in a performing animal as in this case. The option of fitting either metallic or cosmetic crowns onto the damaged teeth was declined by the owner. Another option would have been to perform a composite build up, but the long term results would be questionable in view of the stresses imposed on the teeth by the behaviour of the animal. The incisor teeth are not subjected to the same degree of stresses as the canine teeth and it was considered appropriate to use a composite restorative to provide a surface restoration in this case. Combined enamel and dentine bonding provided a large surface area for firm attachment of the restorative with the composite providing an acceptable cosmetic appearance.

Unfortunately the owner did not return for the scheduled follow-up examination of the patient so longevity of the restorations has not been checked and radiological assessment of the root treatments has not yet been possible. Follow-up is very important after endodontic treatment to evaluate the alveolar tissues and compare them with the situation prior to therapy. We recommend radiographic follow-up within 6 months of initial treatment, then at six to twelve month intervals. In this way

treatment failure can be dealt with before periapical granulomas, cysts or abscesses have progressed too far (15, 16, 17).

Large primates, may be dangerous to humans during restraint. Proper physical restraint, sedation and appropriate methods for induction of anaesthesia help. A rapidly acting sedative is advisable as this minimises the duration stress for both the animal and clinicians. Ketamine and xylazine or medetomidine are suitable drugs for this purpose, being safe for use in primates. Use of such drug combinations can be preferable, reducing potential side effects and enhancing the quality of analgesia and muscle relaxation (18, 19). The combination of ketamine and medetomidine is definitely superior to using just ketamine alone. Dosage can be varied to provide anything from just sufficient immobilisation for routine clinical examination, obtaining blood samples and simple non-painful procedures, to full surgical anaesthesia, and use of incremental dosing is safe to provide gradual deepening of the anaesthetic plane. Once anaesthesia has been induced the airway requires protection with an endotracheal tube, permitting administration of oxygen should this be required. The combination of ketamine and medetomidine results in a rapid onset of good quality anaesthesia which lasts for as long as 60-90 minutes (20). When additional anaesthesia is required it can be maintained by further doses of the induction combination or other agents, by injection or inhalation (19, 21). However, the cardiovascular depressive effects of halothane in primates are more profound than in the dog, primates having narrower safety limits compare to other species (22).

During long procedures it is necessary to prevent hypothermia and it is recommended to use heat pads or incubators kept at 35 °C, for small primates, in particular.

Conclusion

Endodontic treatment of the Rhesus Monkey is possible using the technique and materials used to treat humans and dogs, particularly as many of the currently used dental materials and instruments have been tested on the primates (12, 14, 16). Although the teeth are shaped differently from the commonly treated animal species (dogs and cats), the mechanical properties of the tooth tissue are the same. Problems of the treatment are more likely to relate to handling and anaesthetising an animal not so commonly seen in clinical practice.

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