

A retrospective study of 109 dogs with mandibular fractures

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Summary

Objective: To determine patient factors and fracture morphology of dogs presented with mandibular fractures to a small animal referral centre in South Africa.

Methods: Patient data on age, sex, breed and aetiology of dogs with mandibular fractures were recorded. The fractures were classified according to the anatomical location, displacement, fracture type, fracture line direction, periodontal pathology, and whether there were teeth in the fracture line or not by evaluation of preoperative radiographs. Clinical observations indicated whether these fractures were open or closed.

Results: In total, 109 dogs with 135 mandibular fractures were included in the study.

Small breed dogs and dogs less than eight months of age predominated (102/109). Dog fights were the most common aetiology in this study (68/109). The molar region was the most commonly affected region (56/135). Evaluation of the radiographs revealed that transverse (73/135), relatively unstable (116/135), and displaced (112/135) fractures were the most common. The majority of fractures involved teeth in the fracture line (100/135), with the first molar frequently involved (54/135). The majority of fractures were open (104/135).

Clinical significance: The results obtained from this study may be used to guide patient and fracture morphology selection in bio-mechanical studies of mandibular fracture repair techniques. Screening of this patient population may inspire the search for new treatment options for mandibular fracture repair in South Africa.

Keywords

Mandibular, fracture, classification, molar, open fracture, small breed.

Introduction

The bones' ability to absorb forces will depend on the inherent characteristics of the bone such as mineral content, and presence of pathology, as well as the species type, age, and sex of the animal (1, 2). Inorganic structural materials provide compressive strength and are responsible for the stiffness whereas organic components determine the tensile properties (1). If bone cannot resist the forces applied to it, it will fracture (1, 3). Fractures can either be a complete or incomplete break in the continuity of the bone (1, 3).

Fracture morphology depends on the aetiology and patient factors. In humans, patient factors depend mainly on anatomical characteristics like the relative strength of certain regions of the bone, size and shape of the bone, and muscle attachments (4). Fracture morphology also depends on the characteristics of the force such as direction, rate, amount and nature, as well as the spatial relationship of the bone to the force (4).

Mandibular fractures are reported to have a high incidence in male dogs less than twelve months of age (5, 6). The mandibular body is most commonly involved in mandibular fractures (5, 6).

Anatomical location and conformation of these fractures can play an important role in the selection of treatment methods and can aid in prognostication of fractures (7, 8).

Although previous retrospective studies of oral fractures in dogs exist, none of these describe the fracture morphology in detail (5, 6). In the present study, dogs with mandibular fractures presented to a South African referral clinic were studied.

Materials and methods

The case records and radiographs of dogs with mandibular fractures that were presented to the Dentistry and Maxillofacial Surgery Clinic at the Onderstepoort Veterinary Academic Hospital in South Africa between January 2001 and December 2009 were reviewed retrospectively.

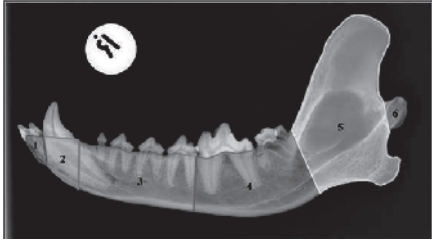


Figure 1 Anatomical regions used to classify the mandibular fracture locations: 1) Incisive region; 2) Canine region; 3) Premolar region; 4) Molar region; 5) Ramus region; and 6) Condylar process.

Data recorded from the patient files included sex (entire or neutered), age (months), weight, and breed. The information recorded in the patient files was also used to determine whether the fractures were open or closed. Aetiological factors were classified as dog fights, road traffic accidents, idiopathic, pathologic or other. All preoperative radiographs were evaluated by the first author (AK). The data recorded from the radiographic re-evaluation included anatomical location (►Figure 1), fracture conformation, unilateral or bilateral involvement, the presence of tooth roots in the fracture line, displacement, fracture stability, and radiographic evidence of pathology (►Appendix Table 1 - available online at www.vcot-online.com). Patients with incomplete patient records were excluded from the study.

Categorical data were evaluated using Pearson's Chi-squared test and continuous data using the paired t-test. The age groups in this study were compared to studies done by Umphlet et al. and Lopes et al. by calculating

the coefficient of determination (R^2) (5, 6). The breeds of the dogs that were presented to the hospital for mandibular fractures were compared to the entire patient population for the same time period, and test statistics were performed to evaluate whether certain breeds were presented more than expected. All calculations were done using a commercial spreadsheet program^a. Statistical significance was set at $p \leq 0.05$.

Results

The case records of 119 dogs that were presented between January 2001 and December 2009 were identified and reviewed. Due to incomplete records 10 patients were excluded. A total of 135 mandibular fractures were present in the 109 dogs included in this study.

Fifty-seven percent of the dogs were under the age of twelve months at the time of fracture management (►Figure 2). In this age group, males ($n = 32$) and females ($n = 29$) were almost equally represented (Chi-squared test: $\chi^2 = 0.067$; $p = 0.80$). In the patients older than twelve months, a male: female ratio of 1.9:1 was observed although the difference was not statistically significant (Chi-squared test: $\chi^2 = 3.000$; $p = 0.08$). In this group of patients, 69% of the males and 6.25% of the females were entire. The age distribution in the current study compared more closely to the findings of the study done by Umphlet et al. (R^2

$= 0.92$) than to the one done by Lopes et al. ($R^2 = 0.34$) (5, 6).

A high incidence of mandibular fractures was noted in small breed dogs (77/109; 70.6%). The mean body weight of patients in this study was 6.46 kg (standard deviation ± 5.4 kg) and the median was 5.2 kg. Of the total dog population that was presented to the hospital during the same time period, 1023/2321 (44.1%) were small breeds. The five breeds that had the highest incidence of mandibular fractures were: Yorkshire Terriers (16%), Dachshunds (14%), Jack Russell Terriers (11%), Maltese (10%) and Pekingese (6%). These breeds made up 15%, 24%, 11%, 21% and 2% respectively of the total patient population. Test statistics revealed that only Pekingese dogs were presented more often than expected ($p = 0.001$).

Large breed dogs older than eight months of age only made up six percent of the study population.

Dog fights were the most common aetiology (68/109) of mandibular fractures in this study (►Figure 3).

The patients with aetiologies that did not fit into any of the groups were classified as 'other'. In this group, mandibular fractures due to gunshot ($n = 3$), pig bite ($n = 1$), kick from a horse ($n = 1$), hit with a metal pole ($n = 1$), run over by a wheelbarrow ($n = 1$), and chewing on a hard object in the absence of pathology ($n = 1$), were included. Only one mandibular fracture was caused iatrogenically during extraction of teeth. This fracture was subsequently classified as pathologic due to the radiographic presence of alveolar bone lysis. Pathologic fractures also occurred in three other dogs.

^a Excel 2010: Microsoft, Redmond, Washington, United States

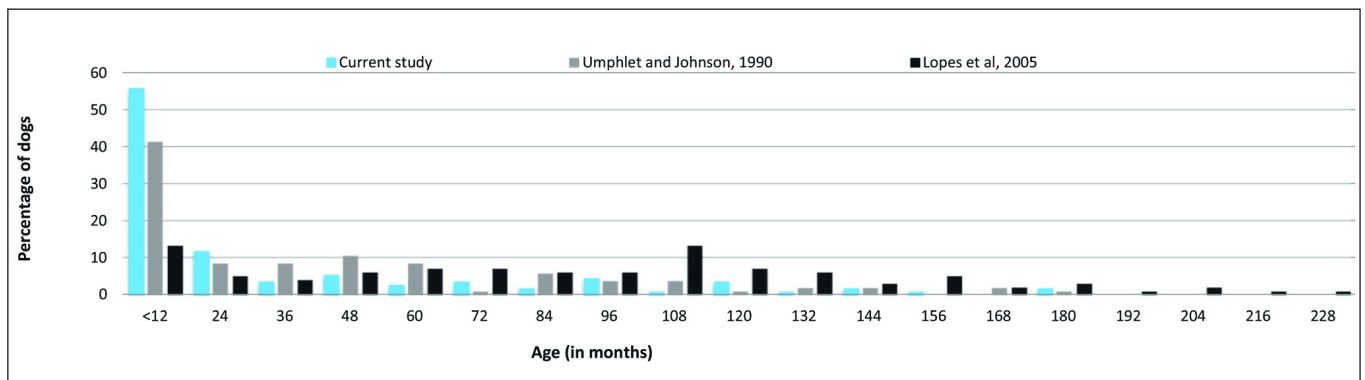


Figure 2 The age distribution of the 109 patients presented to the Dentistry and Maxillofacial Surgery Clinic. Age distributions extracted from Umphlet et al. and Lopes et al. are provided (5, 6).

The incidence of mandibular fractures was highest in the molar region (► Figure 4). Anatomical distribution of mandibular fractures were similar to that noted in two other studies (5, 6).

Of the 135 fractures, 104 were open (► Figure 5). There was a high incidence of open fractures in the dentulous portion of the mandible (87/104).

The fracture type was transverse in 73, short oblique in 48, oblique in one, comminuted in 11, and incomplete in two of the cases. The fractures were relatively unstable in 116/135 and displaced in 112/135. Almost three quarters of the fractures extended through the alveolus of one or more teeth. A total of 124 teeth were involved in the fracture line with the first molar predominating (► Figure 6).

In small breed dogs, fractures of the molar, premolar and symphyseal regions predominated compared to large breed dogs where fractures of the ramus, incisive, canine, and condylar process regions were more common (Chi-squared test: $\chi^2 = 23.73$; $p = 0.02$).

Contingency tables also showed that aetiology was associated with fracture type (Chi-squared test: $\chi^2 = 30.27$; $p = 0.02$) and anatomical location (Chi squared test: $\chi^2 = 36.36$; $p = 0.05$). Higher than expected incidences of short oblique fractures in the canine and premolar regions, incomplete fractures of the ramus region, and transverse fractures of the condylar process were noted when the fractures occurred as a result of road traffic accident.

Multiple mandibular fractures were present in 24 of the patients. The multiple fractures included fractures involving both mandibles ($n = 14$), multiple fractures with non-communicating fracture lines of one mandible ($n = 3$), and mandibular fracture together with symphyseal separation ($n = 7$). Two-thirds of these patients were presented after a dog fight.

Discussion

Previous studies found that mandibular fractures accounted for 1.6% to six percent of all fractures in dogs that were presented to veterinary hospitals (11, 12). In other studies, the main aetiologies for mandibu-

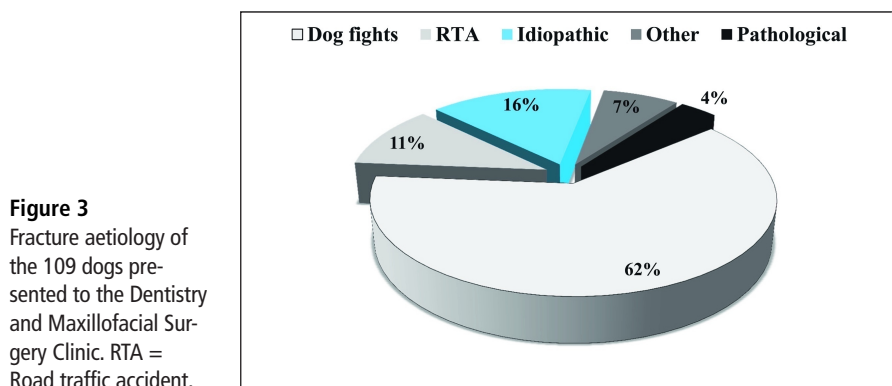


Figure 3 Fracture aetiology of the 109 dogs presented to the Dentistry and Maxillofacial Surgery Clinic. RTA = Road traffic accident.

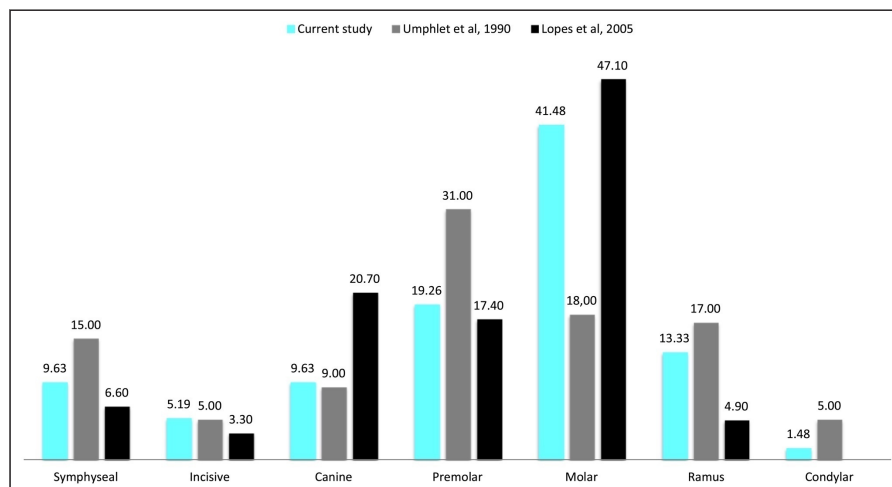


Figure 4 A comparative presentation of fracture frequencies in the various anatomical locations of the mandible. The comparison takes into consideration this current study as well as those done by Umphlet et al. and Lopes et al. (5, 6).

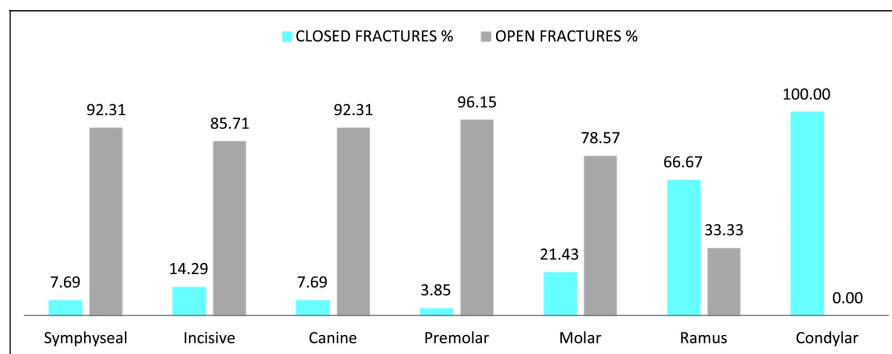


Figure 5 The incidence of open or closed fractures based on the anatomical locations involved.

lar fractures were road traffic accidents, falls from a height, projectile injuries, unknown trauma, and dog fights (5, 6, 11). In our study, dog fights were more frequently the cause of mandibular fractures (62%) than has been previously reported (19% – 43%) (5, 6).

During dog fights, the head and neck are frequently targeted areas (13). The relative sizes of the victim and the attacker play a significant role in the severity of bite wounds (13). As the size of the animal increases so does its biting forces (14). This makes smaller dogs more prone to fractur-

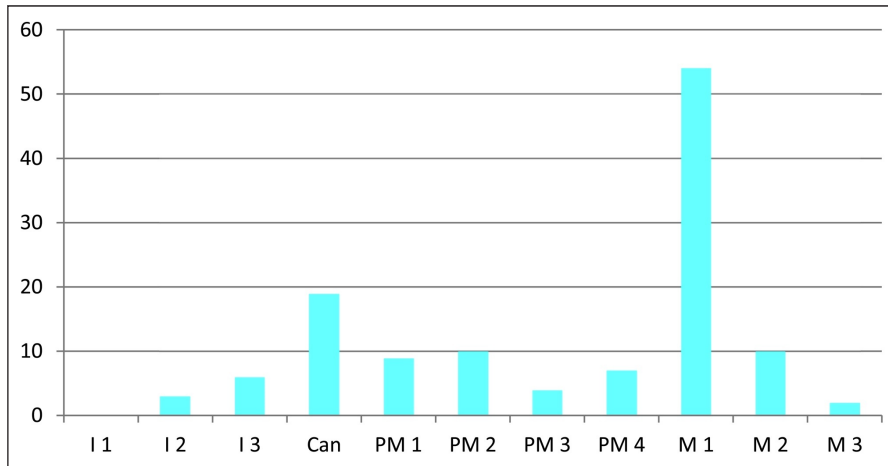


Figure 6 Regional distribution of the 124 teeth in the fracture line of 109 dogs with 135 mandibular fractures. I = incisor, Can = canine, PM = premolar, M = molar.

ing their mandibles if bitten by larger dogs compared to when larger dogs are bitten by smaller dogs. The popularity of large breed dogs like Boerboels and multi-dog households (especially mixed large and small breed) in the Onderstepoort area are factors that might explain the higher incidence of mandibular fractures caused by dog bites in this study. It is the authors' opinion that owners in the Onderstepoort region prefer to keep larger guard dogs on their properties together with smaller pets.

Small breed dogs less than 12 months of age were the most common size and age group affected. As dogs mature the bone mineral content, and thus its density, increases (15). Therefore, young dogs may be over-represented as they have relatively low bone density predisposing the bone to failure (16).

Pekingese dogs were presented more than was expected. It is uncertain whether their particular anatomy, behaviour or personality predisposes them to mandibular fractures and further studies would be needed to clarify this.

Of the patients older than 12 months, entire male dogs were over-represented. When compared to castrated males, entire male dogs are involved in more incidents of aggression and roam more frequently (17, 18). Roaming will increase the opportunity for contact with other dogs and with motor vehicles.

On evaluation of preoperative radiographs, only a few patients had lysis of the

alveolar bone. In the mandible, pathological fractures occur most frequently in the area of the first molar as most of the cases of severe periodontitis and periapical pathology are found in this region (19). This was also seen in this study where all the pathological fractures involved the mandibular first molar. Small breed dogs have more severe periodontal disease (19). Periodontal tissue detachment (5 mm from the furcation apically) potentially causes disruption of 44.6% of the attachment area of the first mandibular molar (20). This can lead to tooth loss and tooth root pathology, potentially predisposing dogs to mandibular fractures even with minor trauma. One patient with periodontal disease experienced a mandibular fracture during tooth extraction prior to referral. Identifying periodontal disease on pre-extraction radiographs might have prevented this fracture.

The roots of the mandibular first molars of small breed dogs are larger in length relative to the height of the mandible and their roots extend further ventral to the mandibular canal when compared with larger breeds of dogs (19, 21). A large mandibular first molar root to mandibular height ratio can act as stress risers, potentially explaining the high incidence of molar region fractures in this study. Of all the fractures that occur in the molar region, the first mandibular molar was involved in nearly all the cases. Fractures through the alveolus of the first mandibu-

lar molar might also be related to early periodontitis that results in weakening of the alveolus and periodontal ligament. This weakening might be the result of periodontal ligament destruction which is a lesion that would not be detectable radiographically.

The nature of the force may have had an influence on the type and location of the fractures in our study.

The low incidence of mandibular fractures through the condylar process was a finding that was similar to another study (5). Research has shown differences in the indentation modulus of the condyles in young and adult dogs (22). It is unknown whether this difference, due to aging, is clinically relevant. During mastication, the shearing action of the carnassial teeth in dogs requires a mild amount of transverse movement of the condyles (23). This minimal movement in the joint and the protective effect of the masticatory muscles might be enough to absorb the forces and thus decrease the incidence of fractures of the condyles. Due to the low number of condylar fractures no significant conclusion could be drawn about the fracture types seen in this region.

The presence of teeth influences the fracture line direction as the fracture line will follow the route of least resistance, resulting in fractures along the tooth roots (24). Likewise the *synchondrosis intermandibularis* is the weakest area in the symphyseal region as it is composed of fibrocartilage (25). A high incidence of transverse fractures through the symphyseal region and short oblique fractures in the canine and premolar regions support this statement.

The protective and supporting effect of the caudal masticatory muscles probably resulted in the high incidence of incomplete and non-displaced fractures in the ramus region.

Mandibular fractures in the dentulous portion of the mandible were mostly open. Only a thin layer of gingiva covers these regions of the mandible orally. Displacement of the fracture fragments and the fragments sharp edges will easily disrupt the gingiva.

Conclusion

Adult large breed dogs were under-represented. The relatively big root of the first molar compared to the mandibular height in small breed dogs might explain the high incidence of molar region fractures.

Conflict of interest

None declared

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