Clinical Anatomy of the Mandible of Three Marsupial Species (Koala, Wombat, Wallaby)

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Abstract

Marsupials are an infraclass of mammals living primarily in Australasia and the New World. Well-known marsupials include kangaroos, wallabies, koala, possums, opossums, wombats and the Tasmanian devil. Three species, the koala, wombat and wallaby were chosen for this study. Three Koala (*Phascolarctos cinereus*), two wombat (*Vombatus ursinus*) and three Grey's wallaby (*Macropus greyi*) mandibles, were used for this morphometric study. Twelve measurements were taken for each mandible with the aim of evaluating some morphometric parameters in these three species and its clinical implication during regional anesthesia. The craniometric measurements were taken using a normal caliper. Photographs were taken by a Samsung digital camera WB 700. Nomina Anatomica Veterinaria (2005) was utilized for denominating the anatomical terms in the study. The results were supported by 9 Figures and 2 Tables.

Introduction

Marsupials are an infraclass of mammals living primarily in Australasia and the New World. A distinctive characteristic, common to most species, is that the young are carried in a pouch. Well-known marsupials include kangaroos, wallabies, koala, possums, opossums, wombats and the Tasmanian devil. Less well-known species of marsupials include the numbat, bandicoots, bettongs, the bilby, quolls and the quokka[1].

Close to 70% of the 334 extant species occur in Australia, New Guinea, and nearby islands. Three species, the koala, wombat and wallaby were chosen for this study as they are kept in the wildlife sanctuaries and zoos in Australia as attractions and representative of the Australian marsupials. These marsupials may suffer many infections, injuries and diseases. The Chidlow Marsupial Hospital located in Perth listed some infections of the head region such as the oedema, ear discharge and debris, eye infections and injuries, cracked nostrils, nasal

bleeding and discharge and different mouth infections [2].

It is quite clear that the morphologic and morphometric investigations on the skull/ mandible not only reflect contributions of genetic and environmental components to individual development, but are also foundations of the clinical and surgical practice (Karimi et al., 2011 and Wehausen and Ramey, 2000). Many geometrical measure-ments of the skull bones have been used for species determination in ruminants in particular (Sarma, 2006; Yalçin and Kaya, 2009; Yalçin and Lök 2009; Karimi et al., 2011; Karimi et al., 2012). In addition, applied anatomy is one of the principals of clinical and surgical practice; because it enables the clinician to visualize details of structures relevant to the case at hand (Ommer and Harshan, 1995 & Dyce et al., 2002). Similarly, the distribution of the cranial nerves and their passages from different foramina in the skull are of clinical importance in regional anesthesia for surgical purposes (Dyce et al., 2002 & Hall et al., 2000).

Since there is no information about the applied anatomy of these marsupial species in the available literatures, the aim of this work is to evaluate some morphometric parameters of the mandible in these three species and its clinical implication during regional anesthesia.

Keywords: Koala (*Phascolarctos cinereus*), Wallaby (*Macropus greyi*), Wombat (*Vombatus ursinus*), clinical anatomy, mental foramen, mandibular foramen, morphometery.

Material and Methods

Three Koala (*Phascolarctos cinereus*), three Grey's wallaby (*Macropus greyi*) and two wombat (*Vombatus ursinus*) skulls including the mandibles, kept in the Discipline of Anatomy and Pathology, School of Veterinary and Biomedical Sciences, James Cook University, Townsville, Australia, were used in this study. The measurements taken for the mandibles included:

1. Mandibular length (distance between the level of the rostral part of the alveolar root of the incisor to the level of the caudal border of the mandible).
2. Mandibular weight.
3. Distance between caudal mental foramen and caudal mandibular border.
4. Distance between caudal mental foramen and rostral mental foramen.
5. Distance between rostral mental foramen and incisor root.
6. Distance between mandibular foramen and caudal border of the mandible.

7. Distance between mandibular foramen and angle of the mandible.
8. Maximum mandibular height (distance between the basal point of the mandible to the highest level of the coronoid process)
9. Condyloid process to the caudal border (base) of the mandible.
10. Maximum height of coronoid process (condyloid fossa to height of mandible).
11. Mandibular foramen to base of the mandible.
12. Diastema length: distance from the lateral alveolar incisor root to first cheek tooth (P).

The craniometric measurements were taken using a normal caliper, and a digital scale was used for weighing. Photographs were taken by a Samsung digital camera WB 700. Nomina Anatomica Veterinaria (2005) was utilized for denominating the anatomical terms in the study.

Results

The mandible comprises two rami firmly fused together at the mandibular symphysis. This fusion is remarkably very rigid in koala, less in wombat and weak in wallaby. The masseteric fossa is deep in koala and is bounded by prominent rostral and caudal borders. Only koala has two mental foramina, the rostral one lies in front of the premolar (P), while the caudal one lies under M_2. In wombat and wallaby, the mental foramen lies at the level in front of the premolar (P) (Figs 1-4). Moreover, the wombat has an extra mental foramen on each side, situated on the ventral surface of the body of the mandible about 1.5 cm from the root of the incisor. In one right mandible, many ventral mental foramina were detected (Fig 3/B).

In the present study, the mandible length in koala, wombat and wallaby was 9.8±5.66, 12.7±8.89 and 9.9±5.72 cm and the mandible height was 6.8±3.93, 8.03±5.69 and 4.1±2.37 cm respectively. The mandibular weight was 26±15.01, 137±96.87 and 35±24.75 gm. respectively. Furthermore, the distance between (caudal) mental foramen and caudal mandibular border and between the (rostral) mental foramen and incisor root was 5.8±3.18, 9.75±6.31 and 8.2±4.73 cm and 1.3±0.75, 2.2±1.56 and 1.7±o.98 cm in the koala, wombat and wallaby respectively. Only the koala posses two mental foramina, rostral and caudal; with a distance of 2.4 cm between them (Table 1, Fig 2)

The distance between the condyloid process to the base of the mandible and the maximum height of coronoid process in koala, wombat and wallaby was 5.7±3.29, 6.75±4.78 and 4.2± 2.42 cm& 1.13±0.65, 1.3±0.92 and 2.1±1.21 cm respectively. While, the

distance between the mandibular foramen to base of the mandible was 2.6±1.84, 2.25±1.50 and 0.8±0.57 cm and between the mandibular foramen and caudal border (base) of the mandible was 1.3±0.75, 2.1±1.48 and 2.7±1.56 cm and between the mandibular foramen and angle of the mandible was 2.3±1.63, 3.05±2.16 and 1.2±0.69 cm in koala, wombat and wallaby respectively (Table 1, Fig 5).

Discussion

Beddard (1958) mentioned that the mandible in marsupials is inflected; this familiar charachteristic of the marsupials goes back to the earliest representatives of the order in Mesozoic times; but it is not absolutely universal, being absent from the much weakened skull of *Tarsipes* (honey possum).

According to Lieberman and Crompton (2000), animals that have unfused mandibles like the goat (and wallabies of this study to some extent) not only have a ratio of working to balancing side adductor muscle force of 1:1 but they also have their mandibles rotate independently during occlusion.

The mandibular length and height measured for koala, wombat and wallaby of this study were 9.8±5.66, 12.7±8.89, 9.9±5.72 cm & 6.8±3.93, 8.05±5.69, 4.1±2.37 cm respectively. Barroso et al. (2009) mentioned 51.47 ±4.02 mm as length of non defined cat breed's mandible, Samul et al. (2013) mentioned in goats 13.61± 1.73 and 8.5±0.53 cm for the length and height of the mandible respectively, while Monfared (2013i) gave 8.3±1.03 and 3.7±0.59 cm as length and height for the Persian cat's mandible.

The distance between the lateral alveolar root to mental foramen was 1.3±0.75, 2.2±1.56 and 1.7±0.98 cm in the Koala, wombat and wallaby respectively. This parameter is a vital guide that will allow detection of the location of the mental nerve for the regional nerve block in these animals; especially for lower lip anesthesia. The injection of the local anesthetic agents can be made in the rostral aspect of the mandibular canal through the mental foramen to mandibular nerve block in the mental zone. This will ensure the loss of sensation of the lower incisors, premolar and lower lip on the same side (Hall et al. 2000) during lower lip trauma, dental extraction and treatment of the tooth injuries. Extra mental foramen found in wombat of this study was also described in dog by Popesko (1977) and Evans and De Lahunta (2010), in one-humped camel by Monfared (2013c) as well as in man by Balcioglu and Kocaelli (2009).

The distance between the mandibular foramen to caudal border of the mandible was 1.3±0.75, 2.1±1.48 and

2.7±1.56 cm in koala, wombat and wallaby respectively. In addition, the distance between mandibular foramen and angle of the mandible and the ventral border (base) of the mandible was 2.3±1.63, 3,05±2.16 and 1.2±0.69 cm & 2.6± 1.84, 2.25±1.50 and 0.87±0.57 respectively. Comparative lengths of both distances in different animals species studied were given in table (2). Accordingly, the anesthetic agent must be injected on the medial side of the mandible for blocking the mandibular nerve and achieving the regional anesthesia of the lower jaw with its teeth and the mandibular lip and this also in agreement with Flecknell (1980) and Hall et al., (2000). This view agrees with that of Monfared (2013a-k) in Caspian Miniature horse, Iranian native cattle, one-humped camel, Native sheep, Native horse, Iranian buffalo, dog, rabbits, Golden jackal, Persian cat and native donkey; Olopade et al., (2005) in West African Dwarf Goat; and Olopade et al., (2010) in Red Sokoto and Sahel goats.

In conclusion, the morphometric values of the mandibles and the clinical anatomy of the three marsupials; koala, wombat and wallaby mandibles provide an important baseline for further research in the comparative anatomy. Furthermore, the results obtained could be a useful tool that will aid the regional anesthesia of the cranial nerves around the head especially during treating head injury and dental extraction and approach of these species.

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Table (1): Mean and Standard deviation (SD) of the mandible measurements of the kola, wombat and wallaby.

No	Parameters /cm	Koala/ mean	Koala/ SD	Wombat / mean	Wombat/ SD	Wallaby / mean	Wallaby/ SD
1	Mand.Length	9.8	5.66	12.7	8.89	9.9	5.72
2	Mand.Weight (gm)	26	15.01	137	96.87	35	24.75
3	C Ment. For – C Mand. B	5.8	3.18	9.75	6.31	8.2	4.73
4	C Ment. For – R Ment.For.	2.4	1.39	-	-	-	-
5	R Ment. For – Incis. Root	1.3	0.75	2.2	1.56	1.7	0.98
6	Mand. For – C B Mand.	1.3	0.75	2.1	1.48	2.7	1.56
7	Mand F – Mand. Ang.	2.3	1.63	3.05	2.16	1.2	0.69
8	Mand. Height	6.8	3.93	8.05	5.69	4.1	2.37
9	Condyl.Pr -Ven.Bor.Mand.	5.7	3.29	6.75	4.78	4.2	2.42
10	Max.Height Corono. Pros.	1.13	0.65	1.3	0.92	2.1	1.21
11	Mand.For. -Ven.Bor.Mand.	2.6	1.84	2.25	1.50	0.8	0.57
12	Diastema Length	1.7	0.98	2.57	1.94	2.0	1.15

Table (2): Measurements between the mandibular foramen (Mand. For.) and caudal border of the mandible and betweem mandibular foramen and ventral border (base) of the mandible in some animal species.

Animals	Authors	Mand. For. To caudal border of mandible (cm)	Mand. For, to ventral border of mandible (cm)
Caspian Miniature horse	Monfared (2013a)	4.4±0.03	5.79±0.57
Iranian native cattle	Monfared (2013b)	2.9±0.72	5.2±0.37
One-humped camel	Monfared (2013c)	3.7±0.11	3.88±0.37
Native sheep	Monfared (2013d)	0.86±0.03	2.99±0.03
Native horse	Monfared (2013e)	4.8±0.62	6.3±1.34
Iranian buffalo	Monfared (2013f)	2.97±0.26	5.5±0.31
Dog	Monfared (2013g)	1.1±0.09	0.96±0.57
rabbit	Monfared (2013h)	1.51±0.23	0.87±0.09
Golden jackal	Monfared (2013i)	1.05±0.02	1.2±0.04
Persian cat	Monfared (2013j)	0.65±0.36	0.8±0.66
Native donkey	Monfared (2013k)	3.5±0.02	4.7±1.22
West African dwarf goat	Olopade et al. (2005)	1.57±0.44	-
pig	Olopade and Okandeji (2010)	2.83±0.34	9.34±0.95
Black Bengal goat	Uddin et al., (2009)	0.9±0.15	3.64±0.23
goat	Samuel et al., (2013)	2.54±0.56	4.17±1.03
Koala	Saber (2014) this study	1.3±0.75	2.6±1.84
Wombat	Saber (2014) this study	2.1±1.48	2.25±1.50
Wallay	Saber (2014) this study	2.7±1.56	0.87±0.57

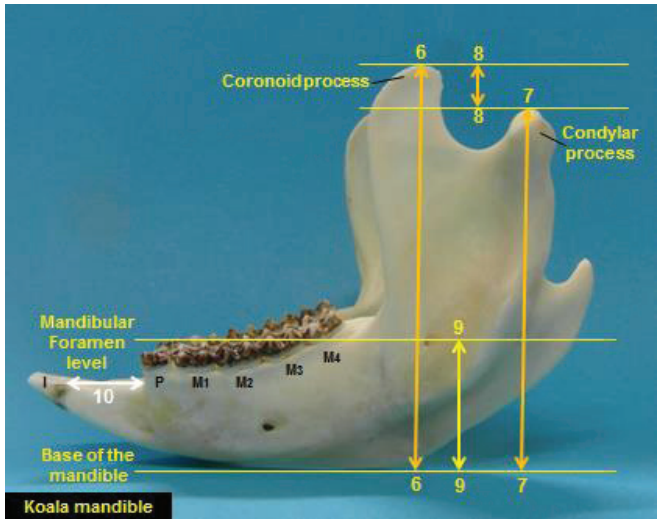

Fig (1): Lateral view of the koala mandible showing: 6-6 Maximum height of the mandible, 7-7 Condyloid process to the base of the mandible, 8-8 condyloid process to coronoid process (Condyloid fossa to hight of mandiblr), 9-9 Mandibular foramen to ventral border (base) of the mandible 10 diastema length between alveolus of the incisor and that of the premolar.

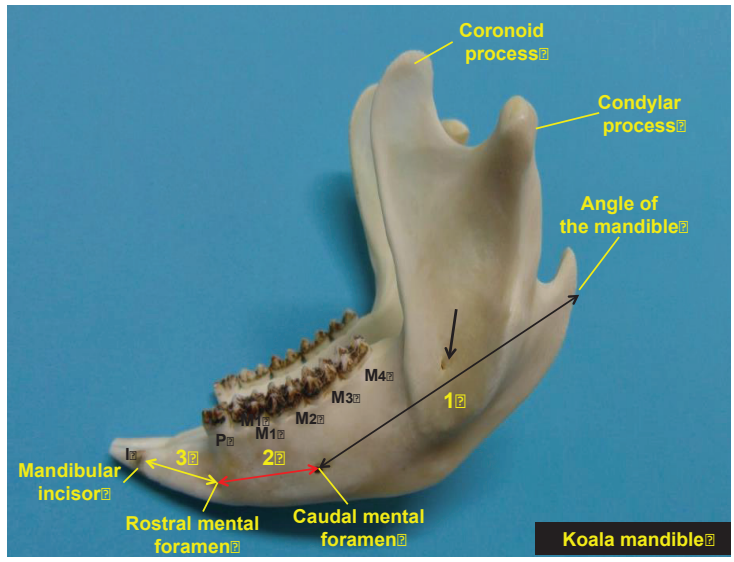

Fig (2): Lateral view of the koala mandible showing: 1 distance between the caudal mental foramen and angle of the mandible, 2 distance between the caudal and rostral mental foramina, 3 distance between rostral mental foramen and the incisor. Arrow indicates extra foramen in the masseteric fossa.

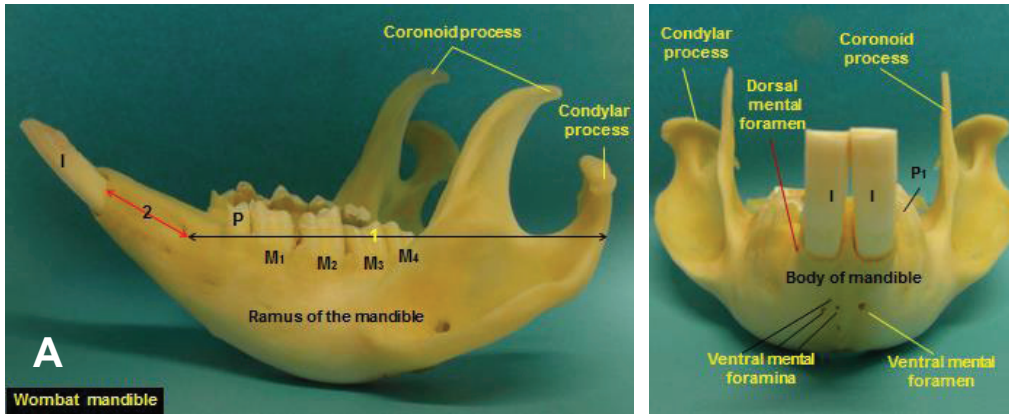

Fig (3): (A) Lateral view of the wombat mandible showing: 1 distance between mental foramen and angle of the mandible, 2 distance between mental foramen and the incisor,

(B) Rostral view of the mandible of wombat showing the ventral mental foramen which is found ventral to the incisors and may be more than one in the same animal.

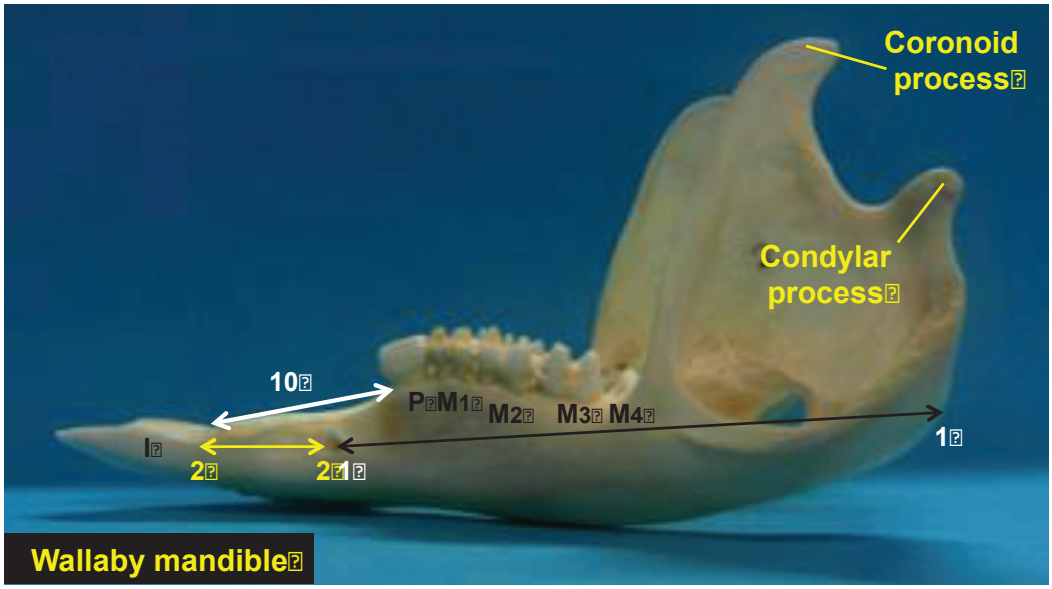

Fig (4): (A) Lateral view of the wallaby mandible showing: 1-1 distance between mental foramen and angle of the mandible, 2-2 distance between mental foramen and the incisor, 10 diastema length

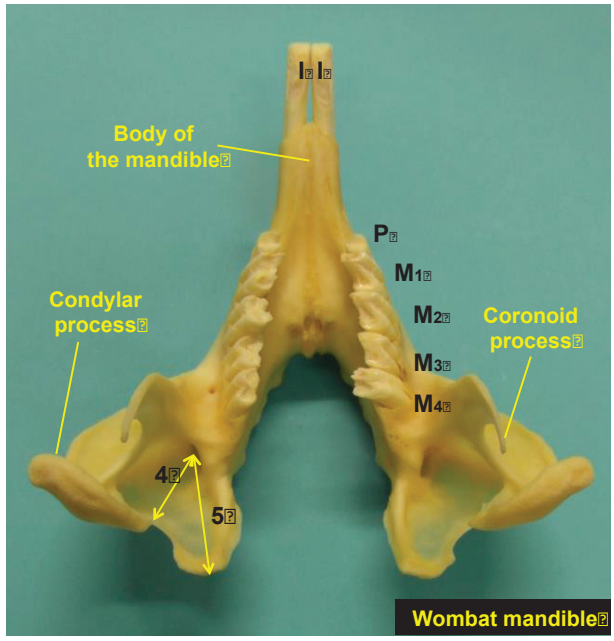

Fig (5): Caudal view of the wombat mandible showing the mandibular foramen. 4 distance between mandibular foramen and caudal border of the mandible, 5 distance between mandibular foramen and angle of the mandible.