

# ANATOMIC-RADIOGRAPHIC DESCRIPTION OF *CEBUS APELLA* (LINNAEUS, 1758) SKULL

## Descrição da anatomia radiográfica do crânio do *Cebus Apella* (Linnaeus, 1758)

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### ABSTRACT

**Introduction:** *the phylogenetic similarities between non-human primates and humans stimulate studies of their stomatognathic system, aiming their use in research.* **Objective:** *the objective of this study was to describe the anatomical structures of the maxilla and mandible of Cebus apella comparing to human characteristics.* **Material and Method:** *two adult animals were used. After removing the organic tissue, the skulls and jaws were x-rayed and photographed, being analyzed with the magnifying glass.* **Results:** *the results showed that the anatomical structures of the maxilla and the mandible had similar characteristics to the human being, but with some peculiarities, such as: the presence of the third premolar; prominent canine prominences in both arches; the mental setting of*

*the majestic; width of ascending branch of maxilla; the presence of the mandibular foramen; V shape of the jaw; incisor foramen size; presence of the incisive suture. With respect to the radiographic interpretation of the pulp chamber and root canal of this species, the maxillary and mandibular maxillary teeth, maxillary and mandibular maxillary teeth are teeth with single, wide, easily accessible ideal for endodontic experiments. Conclusion: thus, the authors conclude that Cebus apella can be used as a study model in endodontic treatment.*

**Keywords:** *Anatomy. Cebus apella. Radiography. Skull.*

## RESUMO

**Introdução:** as semelhanças filogenéticas entre primatas não humanos e seres humanos estimulam estudos de seu sistema estomatognático, visando seu uso em pesquisas. **Objetivo:** descrever as estruturas anatômicas da maxila e da mandíbula do *Cebus apella*, comparando às características humanas. **Material e Método:** foram utilizados dois animais adultos. Após a remoção do tecido orgânico, os crânios e maxilas foram radiografados e fotografados, sendo analisados com a lupa. **Resultado e discussão:** as estruturas anatômicas da maxila e da mandíbula apresentavam características semelhantes ao ser humano, mas com algumas peculiaridades, tais como: a presença do terceiro pré-molar; proeminências caninas evidentes em ambos os arcos; a colocação mental do majestoso; largura do ramo ascendente do maxilar; a presença do forame mandibular; Formato V do maxilar; o tamanho do forame incisivo; presença da sutura incisiva. Com relação à interpretação radiográfica da câmara pulpar e canal radicular desta espécie, os dentes incisivos central e lateral superiores, caninos superiores e inferiores e 1º, 2º, 3º Pré-molares inferiores são dentes com canais únicos, amplos, de fácil acesso e, desse modo, ideais para experimentos endodônticos. **Conclusão:** o *Cebus apella* pode ser usado como modelo de estudo em tratamento endodôntico.

**Palavras-chave:** Anatomia. *Cebus apella*. Radiografia. Crânio.

## INTRODUCTION

*Endodontic techniques that have been developed in relation to human root canal anatomy are commonly used in small animals such as dogs and cats (BARKER; LOCKETT, 1971; ORSINI; HENNET*

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1992; VONGSAVAN et al. 2000). In some cases, however, the use of these animals as an experimental root canal treatment model have been questioned due to the particular anatomy of the apex in these species (HENNET; HARVEY, 1996).

*Anatomical features of the root canal have not been investigated in non-human primates. Several aspects of this system have been reported, like the eruption chronology of deciduous and permanent teeth, dental crown morphology and amelodentinal junction (HERSHKOVITZ, 1977; WHITTAKER, 1978; DARIS, 2002). Thus, the dental anatomy study of Cebus Apella is necessary to enable its use on applied research. Thus, the purpose of this study was to describe the anatomic structures of maxilla and mandible of the Cebus apella comparing with the human features.*

## MATERIALS AND METHOD

*Two skulls of adult animals were examined (one male and one female). Cadavers from the postmortem room of the Institute of Research Evandro Chagas (Pará, Belém, Brazil) were used in this study. The skulls were cleaned from most of the soft tissues, then immersed in a mixture of equal oxygenated water and borax proportions and then put on a hot source for 15 min with the solution in ebullition to dissolve organic tissue. Subsequently, the pieces were kept in saline solution (9%) for bone hydration.*

*The skull and jaw were radiographed and photographed with teeth and bone intact. The occlusal and panoramic radiographs were taken by a radiographic equipment using occlusal (Dabi Atlante, Ribeirão Preto – SP, Brazil) and panoramic films (Kodak, Brazil). The photographs were taken using digital camera (Coolpix 995, Nikon, Japan). The anatomic descriptions of skull and jaw were based on visual exam, observed directly through the loupe.*

## RESULTS

*The results of the investigation are shown in Tables 1 and 2. In general the results showed that the anatomic accidents of the jaws of this species are similar to the ones found in human beings, however, some typical particularities were observed in this species.*

**Table 1 - Radiographic analysis of maxillary teeth**

Mesiodistal	Buccolingual
<p>Maxillary Central Incisor - MD                      Pulp chamber – wider with diverticulum.                      Root canal – single, conic and wider.                      Apical root canal – the root canal tapers evenly along with the root toward its apex.</p>	<p>Maxillary Central Incisor - BL                      Pulp chamber – the diverticulum is bigger mesially.                      Root canal – Single, conic and wider.                      Apical root canal – the root canal tapers evenly along with the root toward its apex.</p>
<p>Maxillary Lateral Incisor - MD                      Pulp chamber – strait with diverticulum.                      Root canal – single, conic and strait.                      Apical root canal – tapered.</p>	<p>Maxillary Lateral Incisor - BL                      The description of anatomical features of the maxillary lateral incisor is identical to that of the maxillary central incisor.</p>
<p>Maxillary Canine - MD                      Pulp chamber – strait, long and following crown dimensions.                      Root canal – single, conic, long and wider.                      Apical root canal – wider.</p>	<p>Maxillary Canine -BL                      Pulp chamber – strait, long and following crown dimensions.                      Root canal – single, conic and wider. In male it is wider until its reach near 2mm of constriction. In female, the root canal tapers evenly along with the root toward its apex.</p>
<p>Maxillary First Premolar - MD                      Pulp chamber – strait with diverticulum.                      Root canal – conic, tapered and strait.</p>	<p>Maxillary First Premolar - BL                      Pulp chamber – it's has two diverticulum, one in each root. The diverticulum is bigger buccally. The pulp chamber floor and roof of the chamber were viewing.                      Root canal – it's has two pulp canals, one buccal and one lingual. The Buccal root canal tends to be larger in cervical third of the root and then it narrows gradually until it reaches apical third of the root.                      The Lingual root canal – strait, conic and single following root shape.</p>
<p>Maxillary Second Premolar - MD                      The description of anatomical features of the maxillary second premolar is identical to that of the maxillary first premolar.</p>	<p>Maxillary Second Premolar - BL                      The description of anatomical features of the maxillary second premolar is identical to that of the maxillary first premolar.</p>
<p>Maxillary Third Premolar - MD                      The maxillary first, second and third premolars are similar.</p>	<p>Maxillary Third Premolar - BL                      The maxillary first, second and third premolars are similar.</p>

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Maxillary First Molar - MD Pulp chamber – strait. Root canal – Mesiobuccal root and Disto- buccal were strait.	Maxillary First Molar - BL Pulp chamber – strait in cervical third Root canal – The DistoBuccal root canal is single, conic. In cervical third tends to be larger and then it narrows gradually until it reaches apical third of the root. The Lingual root canal – single and conic. The Mesiobuccal – similar the description of the distobuccal root canal.
Maxillary Second Molar -MD Pulp chamber – strait. Root canal – strait.	Maxillary Second Molar - BL Pulp chamber – strait in cervical third Root canal – The DistoBuccal, Lingual and Mesiobuccal root canals are single, conic and wider.
Maxillary Third Molar -MD Pulp chamber – strait. Root canal – single, conic and wider.	Maxillary Third Molar - BL Pulp chamber – wider. Root canal – single, conic and wider.

Font: authorship

**Table 2 - Radiographic analysis of mandibular teeth**

Mesiodistal	Buccolingual
Mandibular Central Incisor - MD Pulp chamber – strait with one diverticulum. Root canal – conic and strait.	Mandibular Central Incisor -BL Pulp chamber – straight with diverticulum. Root canal – conic and strait with bifurcation in cervical third or apical third of the root.
Mandibular Lateral Incisor - MD The description of anatomical features of the mandibular lateral incisor is identical to that of the mandibular central incisor.	Mandibular Lateral Incisor -BL The description of anatomical features of the mandibular lateral incisor is identical to that of the mandibular central incisor.
Mandibular Canine - MD Anatomical features are identical to that of the Maxillary Canine.	Mandibular Canine -BL Anatomical features are identical to that of the Maxillary Canine.
Mandibular First Premolar -MD Pulp chamber – strait with one diverticulum. Root canal – wider, conic and single follow- ing root shape.	Mandibular First Premolar -BL Pulp chamber – it's has two diverticulum. The roof of the chamber was viewing. Is not having pulp chamber floor. Root canal – single, conic and wider in cervi- cal third of the root and then it tapered grad- ually until it reaches apical third of the root.

Mandibular Second Premolar -MD The description is similar to that of the mandibular first premolar.	Mandibular Second Premolar -BL The description is similar to that of the mandibular first premolar.
Mandibular Third Premolar -MD The mandibular first, second and third premolars are similar.	Mandibular Third Premolar -BL The mandibular first, second and third premolars are similar.
Mandibular First Molar -MD Pulp chamber – it's has two diverticulum. The diverticulum is bigger Mesially. Strait in cervical third and following crown shape. Root canal – The Mesiobuccal – strait, conic and following root shape. The Mesiolingual – Similar the description of the mesiobuccal root canal. The Distal – strait, conic with apical third of the root tapered.	Mandibular First Molar -BL Pulp chamber – following crown shape. It's has two diverticulum. The pulp chamber floor and roof of the chamber were viewing. Root canal – following root shape.
Mandibular Second Molar -MD Pulp chamber – The cervical-occlusal diameter is bigger. Root canal – The Mesiobuccal and Mesiolingual are atresic. The Distal – single, conic and wider with apical third of the root tapered.	Mandibular Second Molar -BL Identical to that of the Mandibular First Molar.
Mandibular Third Molar -MD Pulp chamber – wider with two diverticulum Root canal – single, conic and wider with apical third of the root tapered.	Mandibular Third Molar -BL Pulp chamber – wider with two diverticulum Root canal – single, conic and wider. Following root shape and apical third of the root tapered.

Font: authorship

## Maxilla and Mandible Anatomy

### Anatomic repairs of maxilla and mandible - anterior view

*Skull (Fig. 1) - In maxilla, it is noted that frontal process of maxilla articulates with frontal bone and forms the medial portion of the orbit (Fig.1A). The lower orbital cleft separates the maxilla from the sphenoid bone. On the orbit floor, the infraorbital groove is found, which communicates to the infraorbital canal and finishes with the infraorbital foramen. On the studied skulls, it was observed the existence of two or more accessory foramens. Below the infraorbital*

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*foramen (Fig.1B), there is the canine fossa (Fig.1C) and on the canine region, the canine eminence (Fig.1D) passes the height of infraorbital foramen, which does not happen with man. The maxilla is the main responsible for the formation of infraorbital margin due to the maxillary zygomatic suture be located more laterally than in man, reducing the space of zygomatic bone (Fig.1E) responsible for the formation of infraorbital margin. On the studied skulls, it was not observed the existence of anterior nasal spine.*

*On the mandible, ventral to the lower incisor roots, the mental fossa can be seen (Fig.1F) which is delimited on the lower part by the mental protuberance, and on the lateral part by two eminencies caused by lower canines roots. On human beings, these eminencies are only noted in the maxilla, where they are called canine eminencies. A little closer to the caudal part, the mental foramen (Fig.1G) is located between the roots of first and second pre molar, next to the mandible base, which differs from the location in man, which can be found in a half distance from the mandible base and the free border of alveolar process.*

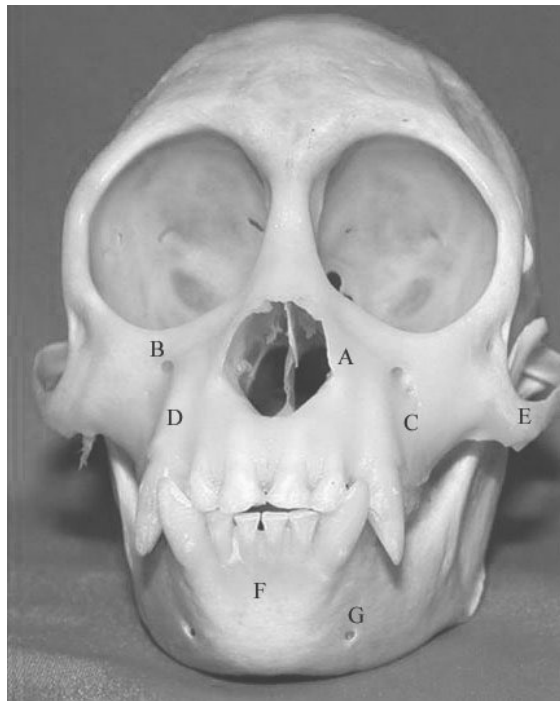


Figure 1 - Skull view of the anterior anatomic repairs of maxilla and mandible: (A) medial portion of orbit; (B) infraorbital groove; (C) canine fossa; (D) canine eminence; (E) zygomatic bone; (F) mental fossa; (G) mental foramen.



## Anatomic repairs of maxilla and mandible - lateral view

*In the maxilla was observed the zygomatic bone and the zygomatic process, the maxillary tuberosity and alveolar foramina (Fig.2A). It can be seen: the mandible ascending ramus (Fig.2B), a flat and rough bony lamina which is similar to a rectangle, this anatomic repair shows a bigger width than human beings. On the rostro-dorsal border of the ramus the coronoid process (Fig.2C) can be observed, but in humans it appears on its medial face. The temporal crista was not observed in examined skulls. The anterior border of the ramus continues with the oblique line. On the caudal-dorsal border, the condylar process (Fig 2D) is found, this structure is formed by the mandible head which is divided in medial pole and lateral pole. Below the mandible head, there is the neck of mandible (Fig.2E). The caudal and the ventral border of mandible form the mandible angle (Fig.2F), where there are some rugae named masseteric tuberosity.*

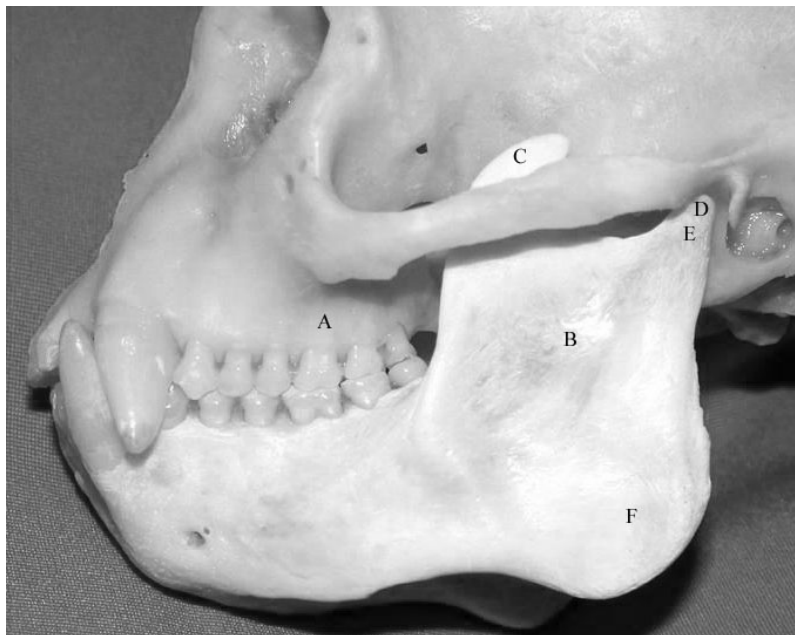


Figure 2 - Left lateral view of the anatomic repairs of maxilla and mandible: (A) maxillary tuberosity; (B) mandible ascendant ramus; (C) coronoid process; (D) condylar process; (E) neck of mandible; (F) mandible angle.

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## Anatomic repair of maxilla- palatine view

*Palatine view of maxilla- signed anatomic accidents, according to the text. There is the median palatine suture (Fig.3A) which begins more anterior than incisive foramen (Fig.3B), which occupies a larger space than in man. Also, before the incisive foramen, there is the incisive suture that in man is usually seen in children. More posterior, the transversal palatine suture is observed separating the maxilla from the palatine bone. The presence of major (Fig.3C) and minor (Fig.3D) palatine foramens in palatine bone, similar to the man, but in one skull, the major palatine foramen was located in the molar region of the maxilla on the left side and in the premolar region on the right side. Also, the alveolar processes and the teeth can be noted.*

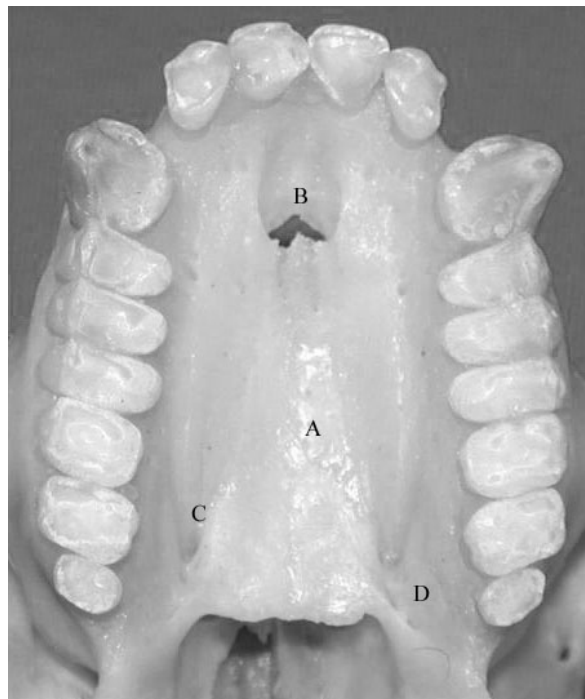


Figure 3 - Palatine view of the anatomic repairs of maxilla:  
(A) median palatine suture; (B) incisive foramen; (C) major palatine foramen;  
(D) minor palatine foramen.

## Anatomic repairs of mandible lingual view

*On the angle of mandible (Fig.4A), the pterigoidea tuberosity (Fig.4B) is very notable. In human beings is situated anterior to the mandibular foramen (Fig.4C). The mental spines are next to*

*the base of mandible, which differs from the human anatomy where these repairs are located at a superior position. On the anterior part of the lingual face mandibular can be observed the “V” shape and the formation of a horizontal plane in the mandible base, below the incisors roots. On this horizontal plane, there is a depression that can correspond with digastric fossa (Fig.4D) which in human is visualized by an internal norm. By the internal norm, there is a large depression in height of roots of lower incisors that it is not noted in human beings (Fig.4E). Also was observed the teeth, the condyle (Fig.4F) and the alveolar processes.*

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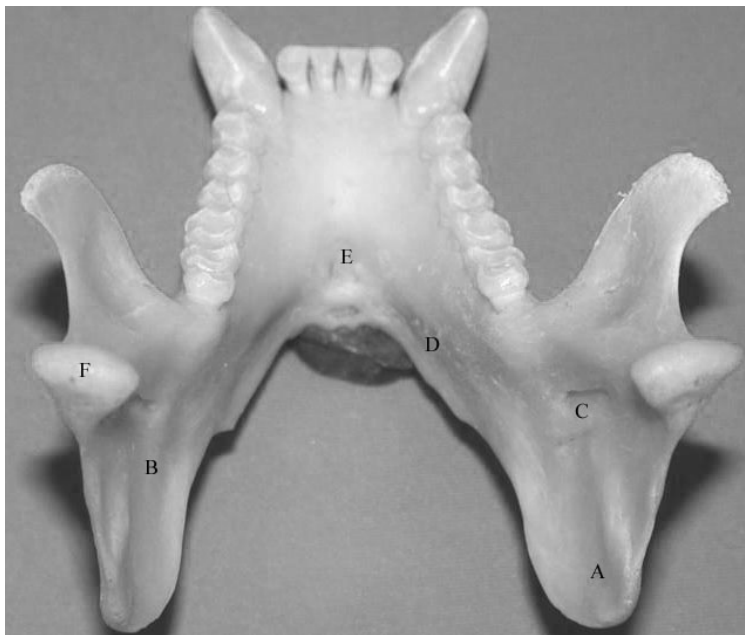


Figure 4 – Anatomic repairs of mandible lingual view: (A) angle of mandible; (B) pterigoidea tuberosity; (C) mandibular foramen; (D) digastric fossa; (E) depression in height of roots of lower incisors; (F) condyle.

## Radiographic Findings

*The radiographic findings are compatible with radiographic aspects found in human species, detaching the repairs which are not visible clinically such as: mandibular canal, maxillary sinus and lower and upper canines' roots with bigger length than in human. There is an ample maxillary sinus presenting osseous septum inside, which is located from the third molar region to canine region. The incisive foramen appears on occlusal radiography as a radiolucent image with a heart shape, located between upper central incisors roots, occupying a space between the lateral incisors. Still on*

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*the occlusal radiography, was observed the presence of median palatine suture between the upper central incisors and the presence of palatine and zygomatic extension of maxillary sinus. The root apexes of upper canines are next to the orbit floor. On radiographs, was observed the presence of the mandibular canal in the mandible connecting the mandibular foramen to the mental foramen. The mandibular canal has a radiolucent image delimited by two radiopaque lines, an upper line and a lower one, which are only visible on the of mandible ramus region, losing the image according to its proximity to the mental foramen. The mental foramens have a circled radiolucent image located below the roots of first and second premolars. On the lower premolars and molars region, was observed a diffuse radiolucent image which is compatible to the submandibular fovea. The oblique line crosses the lower molars roots on their medium thirds. The lower canines root apexes are next to the mandibular base. It was not possible to observe on radiographs the mental spines, the lingual foramina, mental protuberance and mental fossettes (Figs. 5, 6, 7).*

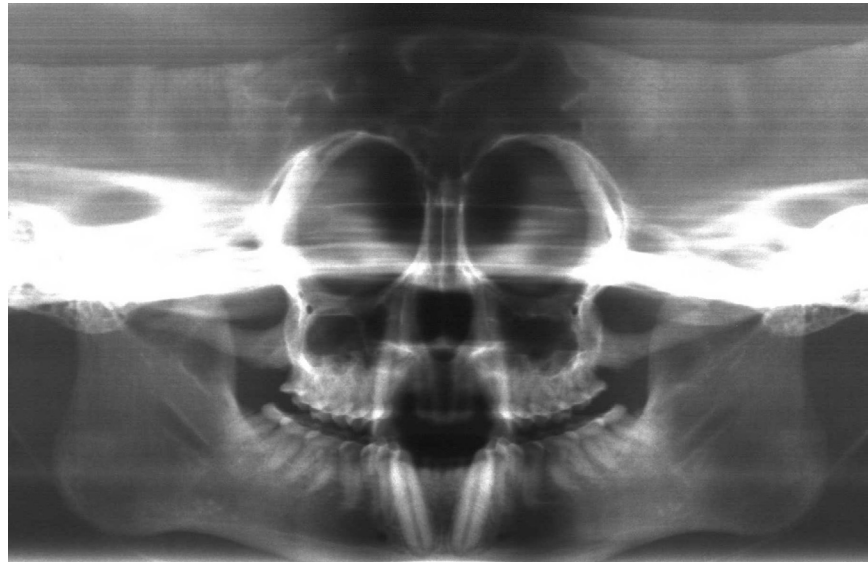


Figure 5 – Panoramic radiograph of the maxilla and mandible in a male *Cebus apella* (Linnaeus, 1758).



Figure 6 – Intraoral ventrodorsal radiograph of the maxilla in a male *Cebus apella* (Linnaeus, 1758).



Figure 7 – Normal intraoral dorsoventral radiograph of the mandible in a male *Cebus apella* (Linnaeus, 1758).

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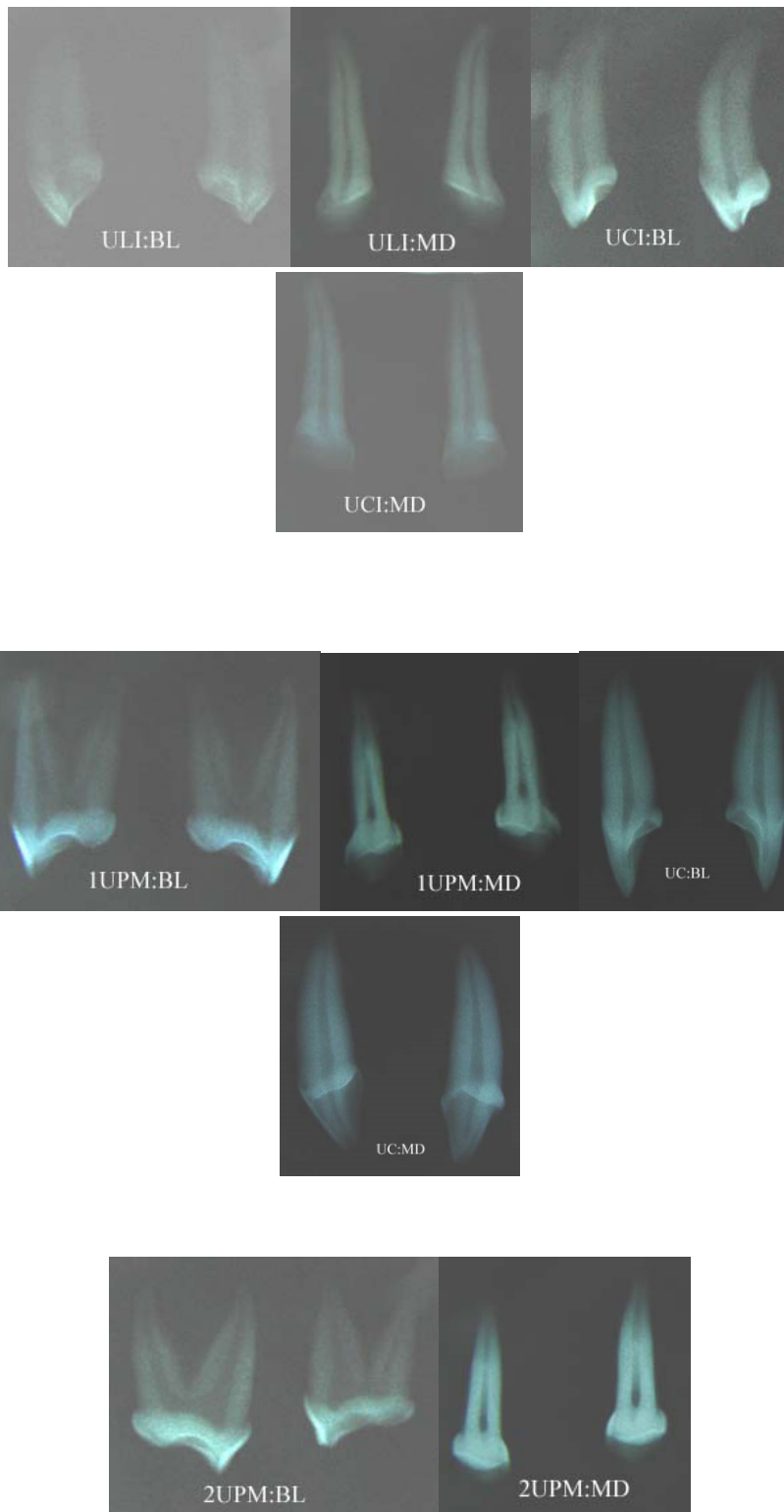


Figure 8 - Periapical radiograph of maxillary teeth (*Linnaeus, 1758*).

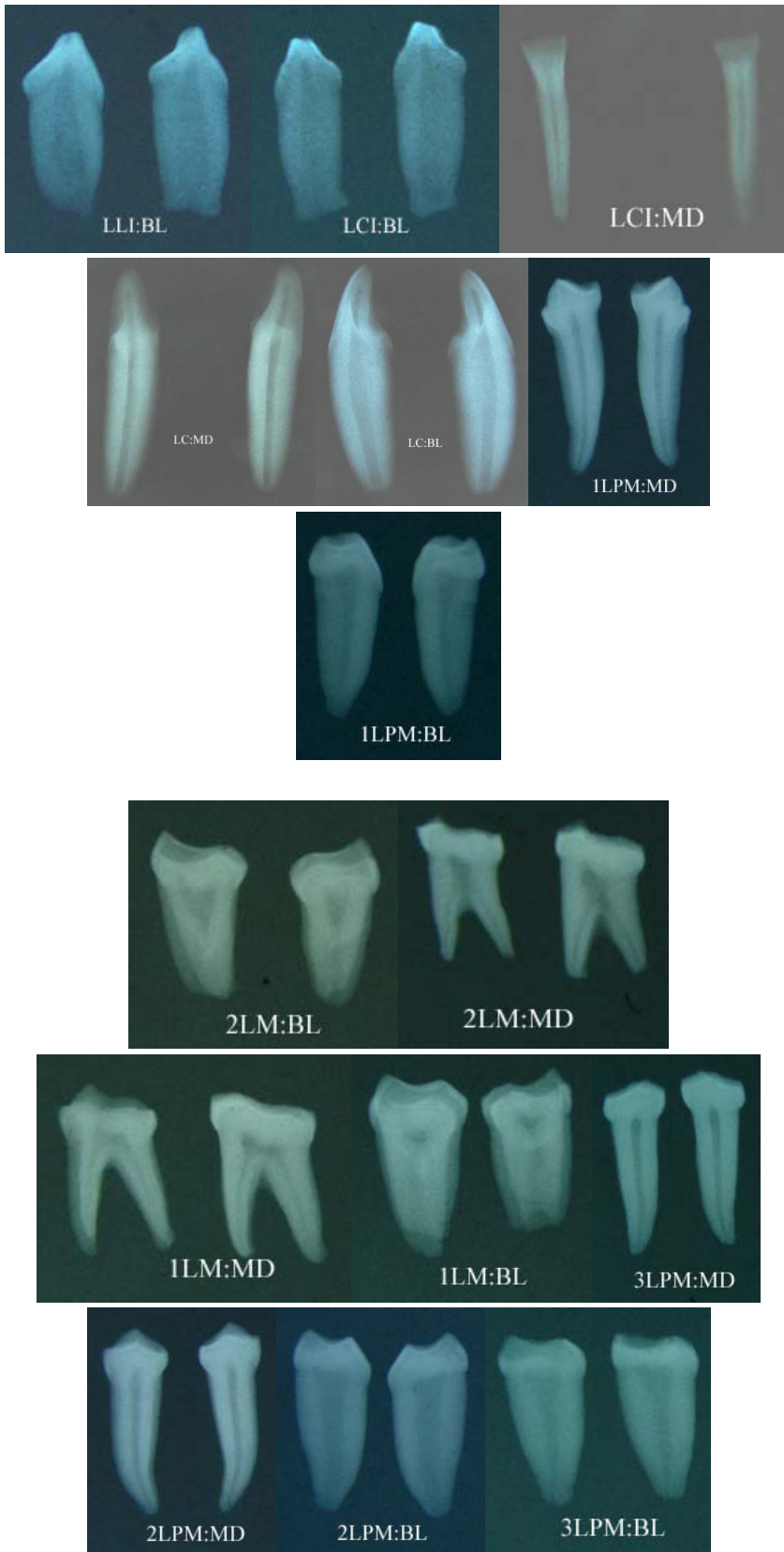


Figure 9 - Periapical radiographic of mandible teeth (*Linnaeus, 1758*).

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## DISCUSSION AND CONCLUSION

*The correlation between the development structure and the function has been brought contribution for the clinical applications in dentistry, emphasizing the position of oral anatomy and histology. The aim of the present study was to describe the anatomic and the radiographic features of stomatognathic system (skull and jaw) of non-human primate *Cebus apella*. Having a parallel with man, we believe that this model, with regard to its phylogenetic relation presents many similarities with the human specie (CLEATON & AUSTIN, 1978; FEJERSKOV, 1979; MARKS & SCHROEDER, 1996). The results showed that the anatomic repairs of the maxilla and mandible have extreme similarity to human structures, except some particularities: the evident presence of canine eminence on both arches, mental foramen location, mandible ascending ramus width, location of mandibular foramen, V shape of mandible, incisive foramen size, presence of incisive suture, that differ from human species in shape, size and location.*

*The internal anatomy observation of the *Cebus apella* teeth in the present study is in agreement with previous findings, due to its phylogenetic proximity with man (CLEATON; AUSTIN, 1978; FEJERSKOV, 1979; BRIGHAM, 1985). It was confirmed in order to radiographic interpretation that the anatomy of pulp chamber and root canal present similar features with human beings. Maxillary central incisor, maxillary lateral incisor, maxillary and mandibular canine and mandibular first, second and third premolars are single root canal and wider to permit instrumentation in endodontics research. The radiographs confirmed the anatomic findings. New studies have been realized to complement the anatomic findings in order to amplify our knowledge about morphophysiology of stomatognathic of this animal.*

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