



Research Article

RADIOGRAPHIC STUDY ON PRENATAL DEVELOPMENT OF DECIDUOUS INCISOR TEETH IN GOAT (*Capra hircus*)

JOSHI N.H.^{1*}, PATEL K.B.², DESAI M.C.³, RAVAL S.H.⁴, PARMAR R.S.⁵ AND CHUDASAMA M.M.⁶

^{1,2,3,6}Department of Veterinary Anatomy, College of Veterinary Science and A.H., Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, 385506

^{4,5}Department of Pathology, College of Veterinary Science and A.H., Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, 385506, Gujarat, India

*Corresponding Author: Email - niravvety1993@gmail.com

Received: May 11, 2018; Revised: May 20, 2018; Accepted: May 21, 2018; Published: May 30, 2018

Abstract: A total of 42 representative goat fetuses from 10th week of gestation to full term (CR length 12.0 cm to 41.2 cm) were utilized for the present investigation. Incisor blocks and hemisections of head were radiographed in dorso-ventral and latero-medial projection, respectively. The sequential progression of development of deciduous incisors was found as D₁, D₂, D₃, D₄. The beginning of crown formation was detected at 12th, 13th, 14th, 15th week for D₁, D₂, D₃ and D₄ in goat fetuses, respectively. The complete crown formation and beginning of root formation was detected at 18th, 19th, 20th, 21st week for D₁, D₂, D₃ and D₄, respectively. At full term, roots of all deciduous incisor teeth were at various levels of development but none had completely formed. The present investigation revealed bilateral symmetry in deciduous incisor teeth development in goat fetuses. There was no any radiographic indication for development of upper deciduous incisors as well as permanent incisor teeth in upper and lower jaw. The scientific baseline data generated from the present study on various radiographic developmental stages of deciduous incisor teeth could be utilized as guideline to estimate age in goat fetuses from 12th week to full term.

Keywords: Goat, Fetus, Teeth, Development, Radiography

Citation: Joshi N.H., et al., (2018) Radiographic Study on Prenatal Development of Deciduous Incisor Teeth in Goat (*Capra hircus*). International Journal of Agriculture Sciences, ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 10, Issue 10, pp.- 6053-6057.

Copyright: Joshi N.H., et al., This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution and reproduction in any medium, provided the original author and source are credited.

Academic Editor / Reviewer: Dr Nischay K Patel, Dr Pardeep Sharma

Introduction

The mammals, in general, the dentition of particular groups is highly characteristic having peculiarity in shape, arrangement and numbers in individual species; and is, therefore, an important criterion for identification and classification. The mammalian dentition is classified as heterodont dentition because the teeth develop differently in each region of the mouth according to their use and are grouped into incisors, canines, premolars, and molars. The dentition of ruminants is highly specialized because of the absence of upper incisors. In place of that they are having dental pad. The lower canines are transformed into incisors and adopted the incisive form [1]. Teeth continue to change from very early intra-uterine life until they are lost or the animal dies. Therefore, teeth can be utilized as a permanent biological kymograph of an individual [2]. The developing teeth are used most reliably in age estimation. Teeth are the indestructible part of the body and exhibit the least turnover of natural structure. They, therefore, remain relatively unchanged thereafter for many thousands of years [3]. The radiographic observations on prenatal teeth development were documented in cattle [4], horse [5], buffalo [6] and camel [7]. From available literature, it seems that no attempts have been made on radiological teeth development in goat fetuses. Hence, to generate scientific baseline data on prenatal development of teeth in goat, the present investigation was planned.

Materials and Methods

A total of 42 representative goat fetuses at weekly interval from 10th week of gestation to full term (CR length 12.0 cm to 41.2 cm) were utilized from the collection of Department of Veterinary Anatomy and Histology, College Veterinary Science and Animal Husbandry, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar.

Heads of goat fetuses were frozen in deep fridge for overnight before preparation of the incisor blocks and the hemi sections of heads for radiography. The incisor blocks of upper and lower jaws were prepared for 30 specimens from 10 to 21 weeks. For preparation of the incisor block, incisive portion of both jaws were cut just behind the commissure of lips. The hemi sections of whole head were prepared for 12 specimens from 10 to 21 weeks. A longitudinal cut section of the head was made along the median plane for preparation of the hemisections of heads. The incisor blocks and the hemisections of head were radiographed on Gevipro radiography machine (Model No.Dx5251R) with capacity 70 kVp and 20 mAs. The incisor blocks and the hemi sections of head were directly placed on thin plastic sheet on X-ray cassette by keeping the Object Film Distance (OFD) at minimum. The Focal Film Distance (FFD) was kept 90 cm constant. The incisor blocks of lower jaw were placed in dorso-ventral (DV) projection and that of upper jaw in ventro-dorsal (VD) projection. The hemi sections of heads were placed in latero-medial (LM) projection. The exposure values ranged from 26 kVp and 9 mAs to 43 kVp and 12 mAs according to the size of specimen and the degree of calcification. Radiographic images were first examined in the descending order of fetal age to ascertain location of various incisor teeth. After identifying the earliest appearance of radiodense (white) areas as calcification for particular incisor, the radiographic images were examined in ascending order of fetal age for progressive development of that particular tooth. This procedure was followed for all deciduous incisor teeth. Various radiographic stages of deciduous incisor teeth development were observed as earlier reports in cattle [4] and buffalo [6]

Results and Discussion

The latero-medial (L/M) and dorso-ventral (D/V) radiographs of incisive portion of heads of 42 goat fetuses were examined for development of deciduous incisor teeth at weekly interval from 10 weeks to full term gestation. The findings on chronology of prenatal radiographic development of deciduous incisor teeth are given in [Table-1].

Table-1 Chronology of radiographic developmental stages for deciduous incisor teeth in goat fetuses

SN	Radiographic developmental stage	Age of goat fetuses (week)			
		First deciduous incisor	Second deciduous incisor	Third deciduous incisor	Fourth deciduous incisor
1	Beginning of crown formation	12	13	14	15
2	Complete crown formation & beginning of root formation	18	19	20	21
3	Complete root formation	-	-	-	-

First deciduous incisor (D₁₁): Up to the age of 11th week goat fetus, there was no evidence of radiographic indication of mineralization for any deciduous incisor teeth. The beginning of crown formation for D₁₁ was detected at 12th week of goat fetus as wanning moon shaped in D/V projection [Fig-1] and in cone shaped radiodense outline in L/M radiograph [Fig-2]. From 13th to 17th week of goat fetuses, the crown of D₁₁ was progressively mineralized and increased in size [Fig-3-11]. In D/V and L/M projections, the complete crown formation and beginning of root formation was detected at 18th week of foetal age [Fig-12, 13]. At 18th week of goat fetal age, pulp cavity of D₁₁ was seen in the form of reverse trapezoidal radiolucent area. The very small and narrow developing root canal indicated beginning of root formation at this age. From 18th week onward, root of D₁₁ was progressively lengthened. The developing root canal was seen in form of radiolucent regular tubular outline. The root of first deciduous incisor was not completely formed till full term (21st week) of goat fetus.

Second deciduous incisor (D₁₂): In D/V and L/M radiographic view, the second

deciduous incisor followed a similar pattern of radiographic development to that of D₁₁. Radiographically, the beginning of crown formation of second deciduous incisor D₁₂ was found at 13th week of goat fetal age [Fig-3, 4]. Crown of D₁₂ was progressively developed from 14th to 18th week age goat fetuses [Fig- 5-13]. The complete crown formation and beginning of root formation of D₁₂ was detected at 19th week of goat fetus. The above mentioned radiographic developmental stages for D₁₂ were observed one week later than those for D₁₁. Till the full term, root formation of D₁₂ was not complete.

Third deciduous incisor (D₁₃): The third deciduous incisor (D₁₃) radiographically also developed on similar pattern as D₁₁ and D₁₂. The beginning of crown formation of third deciduous incisor D₁₃ was first depicted at 14th week of goat fetal age [Fig- 5, 6]. The development of crown of D₁₃ was progressed from 15th to 19th week age goat fetuses [Fig-7-15]. At 20th week of goat fetus, complete crown formation and beginning of root formation of D₁₃ was detected in L/M and D/V radiographs [Fig- 14, 15]. The beginning of crown formation and the beginning of root formation for D₁₃ were started two week later than those for D₁₁. The root formation of D₁₃ was not found completed till full term (21 week) goat fetus.

Fourth deciduous incisor (D₁₄): Among all deciduous incisors, the fourth deciduous incisor (D₁₄) was found last to begin developing. In L/M radiograph, beginning of crown formation of fourth deciduous incisor was started at 15th week [Fig-7]. The development of crown of D₁₄ was progressed from 16th to 20th week age goat fetuses [Fig-8-15]. The complete crown formation and beginning of root formation for D₁₄ was seen at 21st week of goat fetal age [Fig-16, 17]. In the present radiographic investigation, no any difference was observed between the right and left deciduous incisor teeth as regards to their morphological development or their sequence of calcification [Fig-1-17]. This indicated bilateral symmetry in deciduous incisor teeth development. There was no any radiographic indication of beginning of deciduous incisor teeth development detected in upper jaw of goat fetuses in present work [Fig-1-17]. The present radiographic study revealed that individual deciduous incisor took 6 weeks to develop complete crown. There was no any radiographic indication detected for development of upper deciduous incisors as well as permanent incisor teeth in upper and lower jaw. The comparative chronology of radiographic sequences of deciduous incisor teeth development in the present investigation and earlier published reports in other ruminants are given in [Table-2].

Table-2 The comparative chronology of appearance of radiographic developmental stages for deciduous incisor teeth in goat fetuses in the present study and earlier reports in other domestic animals

Teeth	Beginning of crown formation			Complete crown formation and Beginning of root formation		
	Goat fetuses Present study (Week)	Cattle foetuses (Soana et al., 1997)(Week)	Buffalo fetuses (Patel, 1996) (Week)	Goat fetuses Present study(Week)	Cattle foetuses (Soana et al., 1997) (Week)	Buffalo fetuses (Patel, 1996) (Week)
D ₁₁	12	17	23	18	-	Full term
D ₁₂	13	19	23	19	-	Full term
D ₁₃	14	20	23	20	-	Full term
D ₁₄	15	22	33	21	-	Full term

In the present prenatal radiographic study on goat fetuses, the beginning of crown formation and the complete crown formation and beginning of root formation for D₁₁, D₁₂, D₁₃, D₁₄ was detected at 12th, 13th, 14th, 15th week and 18th, 19th, 20th, 21st week of fetal age, respectively [Table-1, 3]. However, the beginning of crown formation for D₁₁, D₁₂, D₁₃, and D₁₄ reported at much later fetal ages in cattle [4] and buffalo [6] [Table-2]. The beginning of root formation for D₁₁, D₁₂, D₁₃, and D₁₄ was found at early ages in goat fetuses, though it was reported at full term in buffalo fetuses [6] [Table-2]. However, beginning of root formation could not be detected before birth in bovine fetuses [4] [Table- 2]. At full term goat fetuses, roots of all deciduous incisor teeth were at various levels of development but none had completely formed [Fig-16,17] [Table-1]. Similar observation was documented for buffalo fetuses [6]. In the present work, all the developing deciduous incisors in goat fetuses were seen overlapped in form of tiles of roof in D/V projections and stacks of playing card in L/M projections. This overlapping arrangement happened to accommodate simultaneously developing deciduous incisor teeth in relatively smaller size of developing mandible in goat fetuses. Similar findings were also reported for fetuses of cattle [4] and buffalo [6]. In the present study, the sequential progression of development of deciduous incisors was found as D₁₁,

D₁₂, D₁₃, D₁₄ which was in agreement with reports for fetuses of cattle [4] and buffalo [6].

Table-3 Chronology of radiographic stages for deciduous incisor teeth development in goat foetuses

Age of goat fetuses (week)	Radiographic stages of deciduous incisor teeth development
up to 11	No any radiographic indication of tooth formation
12	Beginning of crown formation for D ₁₁
13	Beginning of crown formation for D ₁₂
14	Beginning of crown formation for D ₁₃
15	Beginning of crown formation for D ₁₄
18	Complete crown formation and beginning of root formation for D ₁₁
19	Complete crown formation and beginning of root formation for D ₁₂
20	Complete crown formation and beginning of root formation for D ₁₃
21	Complete crown formation and beginning of root formation for D ₁₄

However, by histomorphological study, reverse pattern of mineralization for deciduous incisors as D₁₃, D₁₂ and D₁₁ was reported for fetuses of dog [8].



Fig-1 & 2 Radiograph of incisive portion at 12th week of goat fetus showing beginning of crown formation for first deciduous incisor tooth



Fig-3 & 4 Radiograph of incisive portion at 13th week of goat fetus showing beginning of crown formation for second deciduous incisor tooth



Fig- 5 & 6 Radiograph of incisive portion at 14th week of goat fetus showing beginning of crown formation for third deciduous incisor tooth



Fig-7 Radiograph of incisive portion at 15th week of goat fetus showing beginning of crown formation for fourth deciduous incisor tooth



Fig- 8 & 9 Radiograph of incisive portion at 16th week of goat fetus showing progressive development of crown for all deciduous incisor teeth

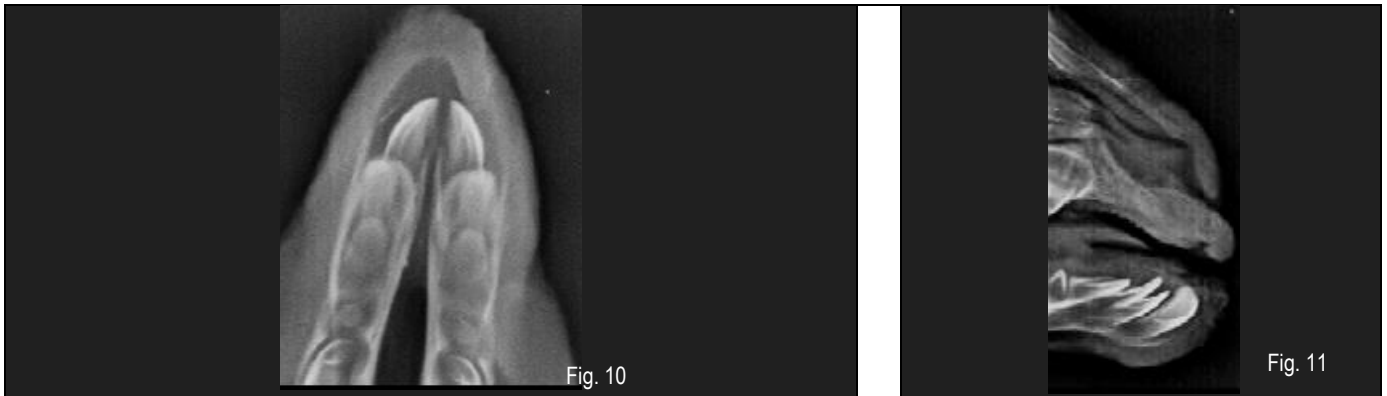


Fig- 10 & 11 Radiograph of incisive portion at 17th week of goat fetus showing progressive development of crown for all deciduous incisor teeth



Fig-12 & 13 Radiograph of incisive portion at 18th week of goat fetus showing complete crown formation and beginning of root formation for first deciduous incisor tooth.

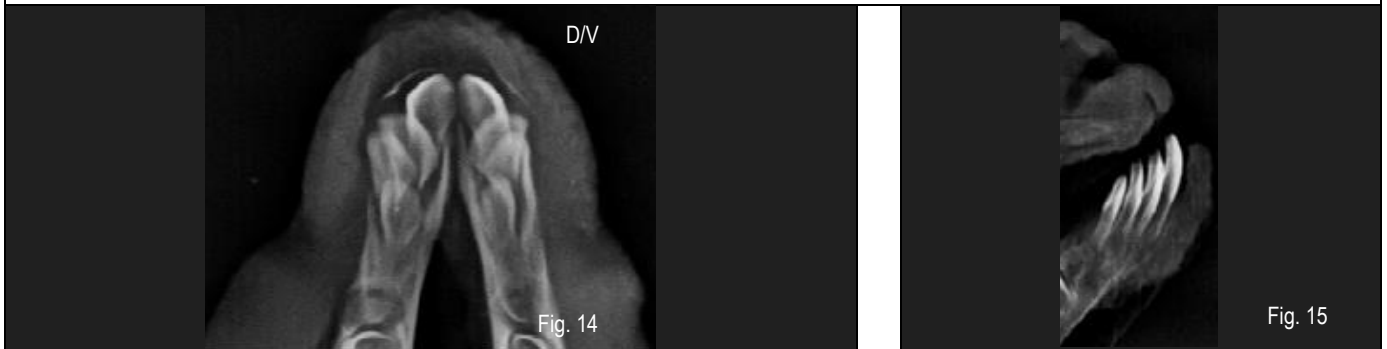


Fig-14 & 15 Radiograph of incisive portion at 20th week of goat fetus showing complete crown formation and beginning of root formation for third deciduous incisor tooth.

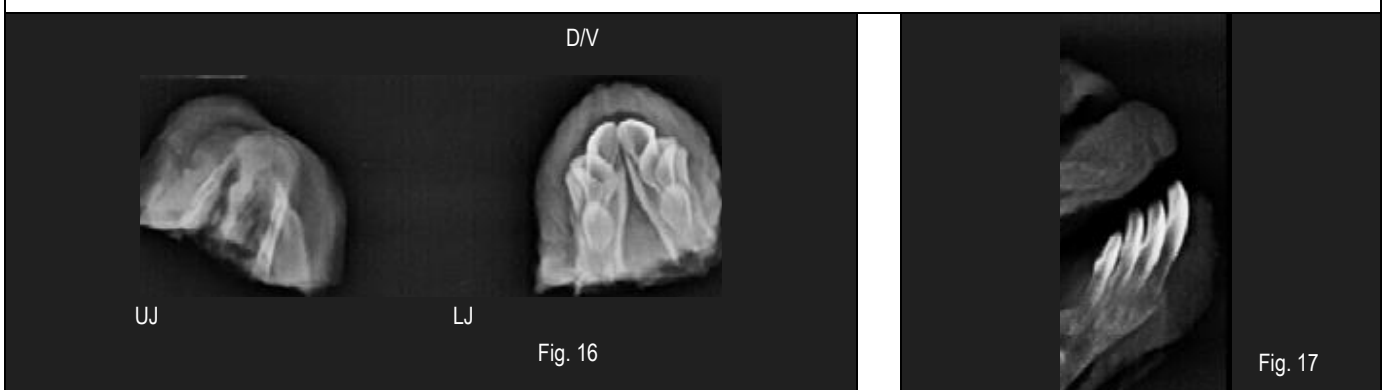


Fig- 16 & 17 Radiograph of incisive portion at 21st week (full term) of goat fetus showing complete crown formation and beginning of root formation for fourth deciduous incisor tooth.

The scientific baseline data generated from the present investigation on the various radiographic developmental stages of deciduous incisor teeth were in sequence with weekly interval from 12th week to full term [Table-3]. The sequence of radiographic dental development is more appropriate for assessment of age as compared to skeletal development; because the dental development and

calcification is controlled more by genes than by environmental factors [3, 9]. In the autolysed fetuses, estimation of age is not possible by routine body measurements and external development of horizons. In such circumstances; findings of the present radiographic study on teeth development can be utilized as guideline to estimate age in goat fetuses from 12th week to full term.

Summary and Conclusion

The sequential progression of radiographic development of deciduous incisors was found as D₁₁, D₁₂, D₁₃ and D₁₄. The beginning of crown formation was detected at 12th, 13th, 14th, 15th week for D₁₁, D₁₂, D₁₃ and D₁₄ in goat fetuses, respectively. The complete crown formation and beginning of root formation was detected at 18th, 19th, 20th, 21st week for D₁₁, D₁₂, D₁₃ and D₁₄, respectively. At full term goat fetuses, roots of all deciduous incisor teeth were at various levels of development but none had completely formed. The present investigation revealed bilateral symmetry in deciduous incisor teeth development in goat fetuses. There was no any radiographic indication for development of upper deciduous incisors as well as permanent incisor teeth in upper and lower jaw.

Future Perspectives: The present investigation can be further continued to study postnatal development of deciduous and permanent incisors in goat.

Application of research: The scientific baseline data generated from the present radiographic study on various developmental stages of deciduous incisor teeth could be utilized as guideline to estimate age in goat fetuses from 12 weeks to full term.

Abbreviations:

CR length- Crown Rump length,
D/V projection- Dorso- ventral projection,
L/M projection- Lateromedial projection
cm- Centimetre
Di- Deciduous incisor

Acknowledgement / Funding: Author thankful to Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, 385506, Gujarat, India. The authors are also hearty thankful to Dr Pinakin Patel, Radiologist and Sonologist, Manglam X- Ray Clinic and Imaging Centre, Palanpur, Banaskantha for radiography.

*Research Guide or Chairperson of research: Dr K. B. Patel

University: Sardarkrushinagar Dantiwada Agricultural University,
Sardarkrushinagar, 385506, Gujarat, India
Research project name: M.V.Sc. Thesis

Author Contributions: All author equally contributed

Author statement: All authors read, reviewed, agree and approved the final manuscript

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.

References

- [1] Koing and Leibich (2009) *Veterinary Anatomy of Domestic Mammals*. 4th ed. Schattauer GmbH, Germany, 310.
- [2] Nickel R., Schurer A. and Seiferle E. (1983) *Anatomy of Domestic Animals*, Verlag Paul parey, Berlin, 2, 65.
- [3] Ciappareli L. (1992) *The chronology of dental development and age assessment*. In: Clar, D. H. (ed.) *Practical forensic odontology*. Oxford: Wright Butterworth – Heinemann Limited, 22 -42.
- [4] Soana S., Bertoni G., Gnudi G. and Botti P. (1997) *Anatomia Histologia Embryologia*, 26,107-113.
- [5] Soana S., Bertoni G., Gnudi G. and Botti P. (1999) *Anatomia Histologia Embryologia*, 28 (5-6), 273-280.
- [6] Patel K.B. (1996) *Prenatal and Postnatal Development of Teeth in Buffalo (Bubalus bubalis)*. Ph.D. Thesis. Submitted to Gujarat Agricultural University, Sardarkrushinagar.
- [7] Saber A.S., Abdel- Monim M.E. and El Din Allam M. A. (1994) *Journal*

of Camel Practice and Research, 1 (1), 34-38.

- [8] Williams R.C. and Evans H.E. (1978) *Anatomia Histologia Embryologia*, 7, 152-163.
- [9] Ardakani F., Bashardoust N. and Sheikhha M. (2007) *Journal of odontostomatology*, 25, 30 – 35.