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Comparative study on ground structure and wear pattern of dentition in domestic animals

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Abstract
The comparative study of dentition was carried out to investigate the difference in ground section and wear pattern of teeth in domestic animals using matured cattle, pig and dog as the representative of herbivores, omnivores and carnivores. For this study teeth of matured male animals were used and 6 set of teeth for each species. Ground structure of teeth was observed without using any histological stain. The section revealed the enamel covering the external surface of crown in all teeth of dog, pig and incisor of cattle while cementum covered the enamel in cheek teeth of cattle. The difference in cementoenamel junction between different species was also observed. Edge to edge pattern in dog and incisor of cattle, overlapping junction in pig and cementum forming the outermost layer in cheek teeth of cattle which is continuous with the roots. The section also revealed demineralized enamel, which is the stage of tooth decay. Tooth wear pattern was studied using Smith and Knight tooth wear index (TWI). The differences in wear pattern and score between different species were observed due to the difference in their food pattern as well as age of the animals. The study was conducted in fully matured male animals which may attribute to the high score in the wear index.

Keywords: Dentition, domestic animals, ground structure, microscopic structure, wear pattern

Introduction
An animal's diet is one of the most important aspects of its biology, and it helps in shaping the behavior, evolution, physiology and anatomy of the species. The development and arrangement of teeth in animal reflects how the skull evolves and develop to suit their diets. In general, carnivores have teeth for tearing and skulls capable of biting with great force, while the plant-eating herbivores have teeth and skulls equipped to grind tough vegetation. Omnivores which eat both plants and meat have skulls and dentition suitable for a wide range of foods [1]. Ruminants such as cattle, sheep and goats are herbivores with a unique digestive anatomy. A prominent feature of ruminant dental anatomy is that they lack upper incisors which are replaced by dental pad. To a first approximation the dental anatomy of all ruminants is similar [2].

Teeth are among the best source of evidence for both identification and studies of demography, biological relationships and health. The specimen may be a cast that a dentist has taken from a living mouth or actual teeth from an archaeological site or forensic case [3]. This text introduces the complex biology of teeth and provides a practical guide to all essential aspects of dental anthropology including excavation, identification, microscopic study and tooth age determination. Dental anthropology is a concise yet to comprehensive resource designed for students and researchers in anthropology and archaeology [4]. Different methods for the determination of age have been used. One of the oldest methods is to determine the age of the animal depending on the amount of wear and tear of the teeth. In case of ungulates the age is determined on the basis of replacement of the milk teeth by the permanent teeth and by studying the rate of wear of the permanent teeth. In some of the methodology the ratio of the length of the root to the crown is used in age determination. The relative breadth of the tooth canal has also been used in determining age in some species of animals [5].

The principal tooth materials were enamel and dentin. Enamel was the hardest substance in the body forms a thin layer over the surface of the tooth. The bulk of tooth was formed by dentin which was similar in composition to bone but differed structurally. A softer substance cementum resembled dentin and bone grossly which covers only the roots in simple teeth but in others it may extended over the crown [6].

The aim of the study was to carried out and investigate the difference in ground section and wear pattern of teeth in domestic animals using matured cattle, pig and dog as the representative of herbivores, omnivores and carnivores.

Materials and Methods

Ground section

Ground sections were the section prepared without using any chemical. The teeth were first soaked in 20% formaldehyde for 24 hours, washed in water, then sectioned were made.

For making ground section, hand grinding method was used. Hand grinding was done manually with the use of lathe stone fitted on the motor. The tooth was kept along the lateral surface of lathe and the tooth is grinded till it is 4 to 5 mm thick. A constant spray of water was required to be sprayed on grinding surface while grinding. Then further grinding was done at slow speed of lathe till the section of 3 to 4 mm thickness was obtained. After grinding was done a lathe stone was used. This stone has two rough surfaces one course and one slightly smooth. Tooth was first grinded on course surface and water is constantly poured on this stone while grinding. Tooth was grinded on this surface till the thickness is 1 mm. After that grinding was further done by using finely rugged surface of the stone till the section become 0.25-mm thickness was left. The section was rinsed with alcohol and xylene. Finally cleaned and dried section were mounted on slide using DPX and viewed under microscope for observation of hard tissue of teeth of cattle, pigs and dogs [7] (Robbins *et al*. 2004).

Ground section of all the teeth of right maxillary and mandibular teeth were prepared. The ground sectioned were observed under microscope to interpret any difference among the three species i.e. cattle, dog and pig. Ground sections were prepared without using any chemical and thus maintaining normal anatomy and constituent.

Tooth wear pattern

The assessment of tooth wear types was done based on previous studies conducted. They were examined for frequency and severity of tooth wear using the Smith and Knight Tooth wear index (TWI) [8]. Scores from 0-4 were given according to the severity of wear.

Results and discussion

Ground section

Enamel covers the external surface of crown in teeth of dog and pig as well as incisors of cattle. Long, slender rods, enamel prisms held together by interrod enamel were observed in the histological slide. There was presence of enamel tufts in almost all the ground section. The enamel tufts showed diverse thickness and structures [9]. Ground section of teeth were shown in Plate No. 1, 2, 3 and 4 in cattle, 5, 6, 7 and 8 in pig, 9, 10, 11 and 12 in dog.

Demineralized enamel was frequently observed on the section which indicates exposure of the tooth enamel to acids that produced within accumulations of bacterial plaque. Enamel demineralization represented a superficial dissolving of the surface enamel the glassy outer shell of the tooth which was the earliest stage of tooth decay. Attrition, a type of tooth wear was seen in almost all the sectioned teeth. It was caused by tooth-to-tooth contact, resulting in lost of tooth tissue, started at the incisal or occlusal surfaces. Tooth wear was a physiological process and was commonly seen as a normal part of aging. In bovine enamel, interprisms were nearly perpendicular to prisms in the inner enamel and at a small angle to prisms in the outer enamel [10].

Cementum was of two types Acellular and cellular cementum. Acellular cementum was composed of lamellae oriented parallel to the surface of the tooth. Cellular cementum has cementocytes and cementoblasts at the junction of cementum and periodontal ligament. Cementum covered the outside surface of ruminant cheek teeth both above and below the gingiva. Hypercementocytes was commonly seen in apical third of pig teeth which might be physiological or pathological condition. Plate No 1, 3, and 12 showed the ground sectioned of roots where cementum resemble bone, cellular cementum has cementocytes which occupy lacunae and canaliculi similar to bones [11].

Dentine constituted the major part of tooth. The thickness of dentin decreases towards the apex. Dead tracts were seen in some section which was characterized by degenerated odontoblastic processes that might result from injury caused by caries, attrition, erosion or cavity preparation. They were found experimentally to be shut off from the pulp in such a way that fluids could not enter it as shown in Plate No 11. It thus lacks the necessary body fluids to support the tissue [12]. Incremental lines were observed in dentin as well as enamel shown in Plate No 12.

The dentinocemental junction where dentine contained dentinal tubules, stratum granulosum of root and cementum with lacunae were shown in plate no 7 which was in agreement with the findings of Frandson [13]

Dental pulp occupied the pulp cavity of the tooth [11] which could be demonstrated in Plate No 6. Pulp cavity of pig teeth was comparatively wider than other species.

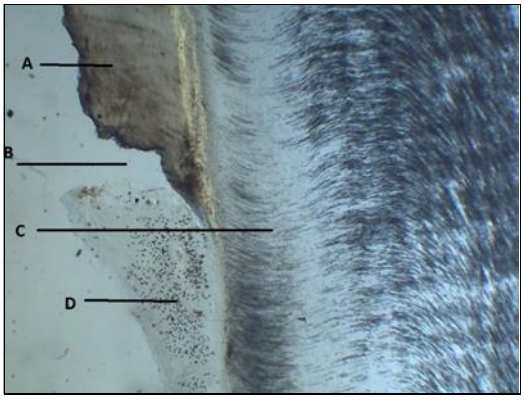

Plate 1: Ground section of cattle incisor showing different layers in tooth.

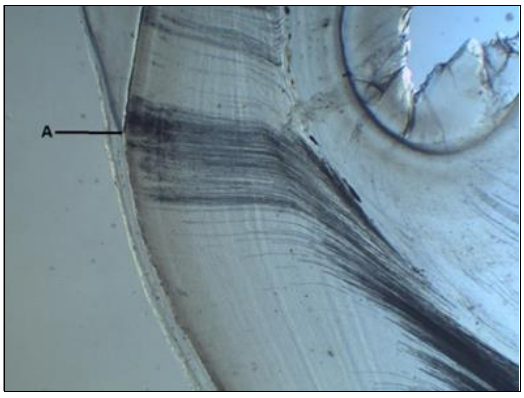

Plate 2: Ground section of cattle molar showing the junction between crown and root. Enamel, B – Cement enamel junction A – Junction between crown.

Plate 3: Ground section of cattle molar showing the root. A – Cementocytes, B – Cementum, C – Dentine.

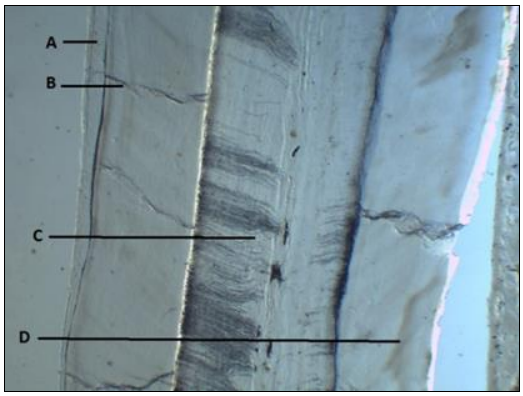

Plate 4: Ground section of cattle premolar showing different layers in tooth A - Cementum, B and D – Enamel, C – Dentine

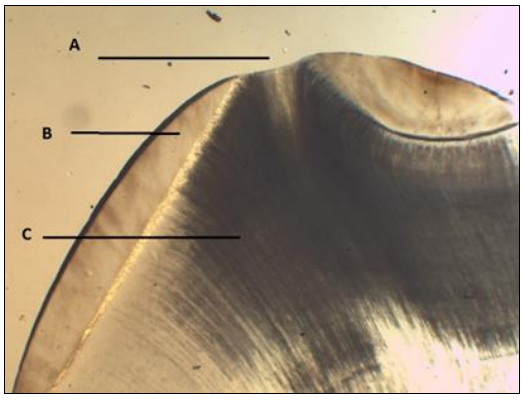

Plate 5: Ground section of pig molar showing the crownA – Attrited occlusal surface, B – Enamel, C – Dentine.

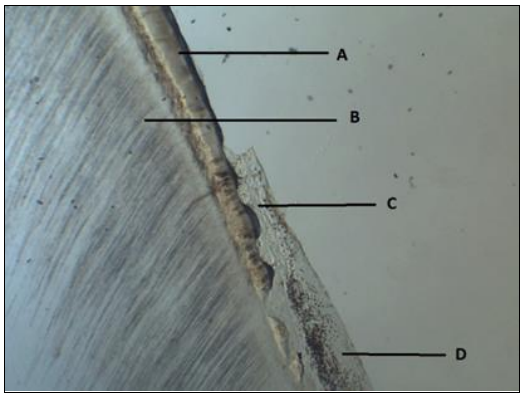

Plate 6: Ground section of pig incisor showing the overlapping junction A – Enamel, B – Dentine, C – Cementoenamel junction, D – Cementum

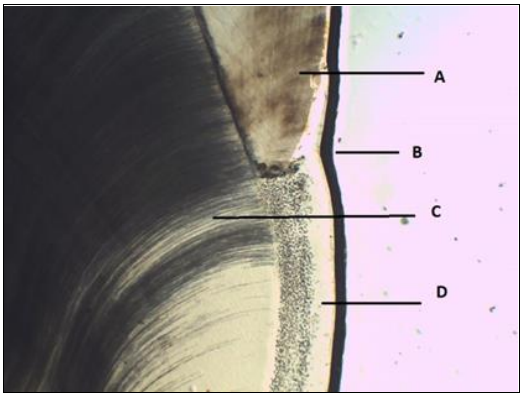

Plate 7: Ground section of pig premolar showing different layers in and overlapping junction. A- Enamel, B – Cementoenamel junction, C – Dentine, D – Cementum.

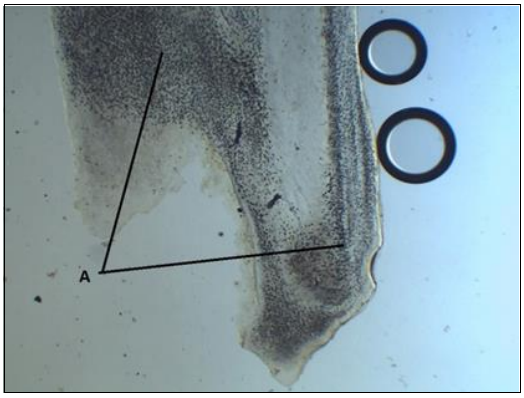

Plate 8: Ground section of pig premolar showing the root. A – Hypercementocytes

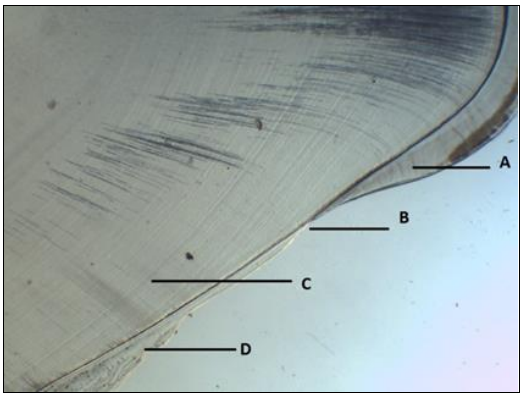

Plate 9: Ground section of dog premolar showing different layers of tooth. A- Enamel, B – Cementoenamel junction, C – Dentin, D – Cementum.

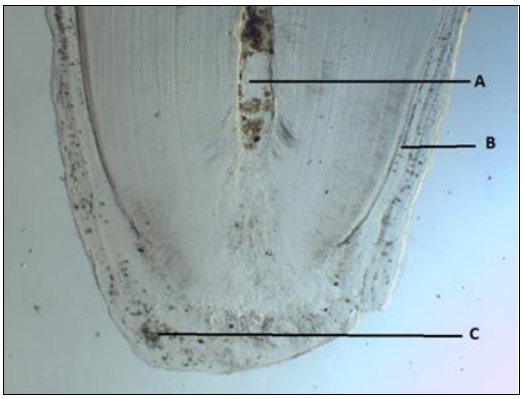

Plate 10: Ground section of dog incisor showing the root. A – Pulp cavity, B – Cementum, C – Cementocytes.

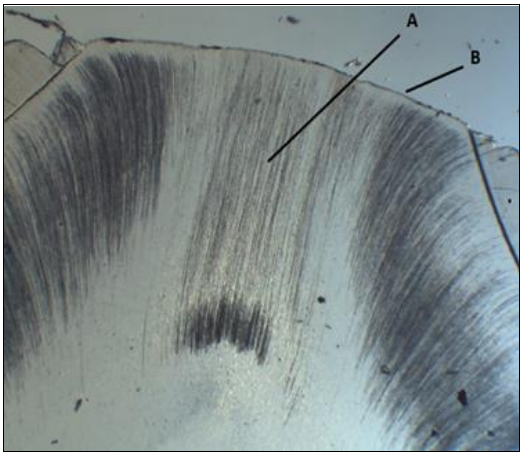

Plate 11: Ground section of dog premolar showing the wear of tooth. A – Dead tract, B – Attrited occlusal surface.

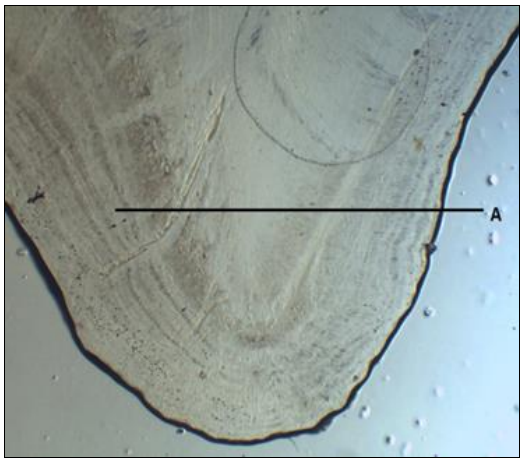

Plate 12: Ground section of dog premolar showing the root. A – Incremental lines.

Cementoenamel junction

Three types of mineralized tissues were present in cementoenamel junction viz. enamel, dentin and cementum. The CEJ was not a uniform line with a mild and regular contour, but a complex line with linear and regular trajectory. In the odontogenesis of primary and permanent teeth all three types of relationships between enamel and cementum at the cervical region might be led, which were described as follows by other worker [14].

1. Pattern I

The cementum overlaped the enamel for a short distance. This type of overlapping occurs when the enamel epithelium degenerated at the cervical region allowing the cementoblasts to contact the enamel directly. The cementoblasts produced a type of cementum called afibrillar cementum which appeared as dense laminated and does not contain collagen fibers with 64 nm periodicity.

2. Pattern II

An end-to-end approximating cementoenamel junction where cementum and enamel meet at a butt joint.

3. Pattern III

There was the absence of contact between enamel and cementum and hence that the dentin was an external part of the surface of the root. This occurs when enamel epithelium in the cervical portion of the root was delayed in its separation from dentine. In this situation, the CEJ was absent.

In cattle incisors pattern I type of CEJ were found, molars and premolars had no CEJ as enamel was covered by cementum and was in agreement with the findings of other worker [11] which was shown in Plate No 4.

In pig teeth pattern I type of CEJ were found and shown in Plate No 6 and 7. Pattern I and pattern II type of CEJ were found in dog, shown in Plate No 9

Wear pattern

Tooth wear was the loss of tooth tissue and structures which occur in a normal physiological process. It could be occured in various forms either attrition, abrasion, erosion, non caries cervical lesion (NCCL) or a combination of two or more forms [15]. This cross-sectional study involved 6 male adults of representative species with tooth wear which was visually assessed. Wear pattern of a teeth of 6 cattle, 6 pigs and 6 dogs were identified and were given a score by using Smith and Knight Tooth Wear Index (TWI) and presented in the table.

The difference in wear pattern and score between different species was due to the difference in their food pattern as well as age of the animals. Wear and score increased with the increase of age of the animal.

Heavily pitted/wear molar surface generally suggested a diet consisting of harder, more brittle food items such as nuts or bones, a heavily scratched shearing facet on a molar tooth indicated that tooth was used to shear tough food items such as leaves or meat. Intermediate patterns indicated mix diets, or diets with intermediate food properties. The grinding motion used by cattle resulted in heavy wear of the cheek teeth. The present observations were in agreement with the findings of other workers [15] [16]

Since the teeth were collected from matured male animal, the rate of wear i.e. attrition, abrasion and erosion were considerably high in the entire collected sample.

Conclusion

From the comparative study among the species of cattle, pig and dog, it could be concluded that the difference in cementoenamel junction, could be identified through ground section. Attrition of teeth was extensive in the entire teeth sample regardless of the species. Hypercementocytes was observed in some section which was considered to be pathological condition in human, but was unknown in domestic animals whether it was pathological or physiological condition. Wear pattern was applicable for identifying the food pattern in different species.

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Conflict of interest

There is no conflict of interest

Table 1: Tooth wear index scoring

Score	Surface	Criteria
0	B/L/O/I	No loss of enamel surface characteristics
	C	No change in contour
1	B/L/O/I	Loss of enamel characteristics
	C	Minimal loss of contour
2	B/L/O	Loss of enamel exposing dentine for less than 1/3 of the surface
	I	Loss of enamel just exposing dentine
	C	Defect less than 1mm deep
3	B/L/O	Loss of enamel exposing dentine for more than 1/3 of the surface
	I	Loss of enamel and substantial loss of dentine but not exposing the pulp or secondary dentine
	C	Defect 1 - 2mm deep
4	B/L/O	Complete loss of enamel or pulp exposure of secondary dentine
	I	Pulp exposure or exposure of secondary dentine
	C	Defect more than 2mm deep or pulp exposure or exposure of secondary dentine

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