

FORENSIC VETERINARY ANATOMY- APPLICATIONS IN VETERO-LEGAL CASES

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ABSTRACT

Forensic veterinary anatomy, a newly emerging field therefore, there is a need for collaboration among Anatomist who is interested in forensic education and investigations with other Forensic Scientists. Forensic Veterinary anatomy is not only helpful in various vetero-legal cases but also play important role in identifying sex, breed, age, height, brutal killing as well as in poaching of domestic and wild animals. Forensic Archeologist assists in the identification of dead individuals whose remains are decomposed, burned, mutilated or otherwise unrecognizable.

The fingerprints, footprints, ear prints, and muzzle print also follow the dermal pattern. In Biometric technology the prints are seen, collected, studied, evaluated, and compared with stored data and exact cross-match with the culprit. Pearson (1990) contributed to determining sex by the examination of a single long bone. The sex of animals can be demarcated from the various biometrical parameters of different bones in the body. Animal species identification can be done based on many features including the morphology of animal remains, particularly hair and bone (Bertino and Bertino 2015). Ahmed, *et al.* (2018) mentioned that hair histology act as a tool for forensic identification of some domestic animal species. The DNA can be used as a biometric tool to classify and guide the identification of unknown biological samples such as hair, blood, teeth, saliva, bone fragment, semen etc.

Key Words: Forensic, veterinary anatomy.

INTRODUCTION: The term 'Forensic' is derived from the Latin word forensic, meaning 'of the forum'. Forensic science is a multidisciplinary subject that is drawn principally from Chemistry, Physics, Biology, Geology, Psychology, and even social sciences. Forensic Medicine is defined as the application of medical knowledge to the investigation of crime,

particularly in establishing the causes of injury or death. Both are used for the scientific assessment of DNA, blood samples, bones, and so on. Forensic plays an important role in criminal investigations and it is equally used in Archeology, Anthropology, Astronomy, Biology, Geology and Victimology (Anonymous, 2017). Anatomical sciences are important in medical and forensic education and investigations. Forensic anatomy, a newly emerging field, therefore, there is a need for collaboration among Anatomists who are interested in forensic education and investigations with other Forensic Scientists. It has two major parts: Macroscopic and Microscopic Anatomy. From a molecular point of view, atoms interact to form molecules and the integration of molecules gives rise to organelles seen in the cell. The DNA, a chain of nucleotides and a part of the genetic make-up of an individual can be accessed from any part of the body structure like the hair, blood, bone, etc. This collaboration will create an opportunity for the exchange of ideas required for proper investigations in Forensic as well as an employment opportunity.

History

Role of anatomy in forensic medicine revolves around the identification of sex, species and age in vetero-legal cases, insurance, and soundness certificates etc. The forensic science was recognized early in the 19th century. One of the significant developments in forensic science were the identification of finger prints. The fingerprint evidence was accepted for first time in English court in 1902. In the year 1980, the concept of DNA fingerprinting for species identification came into existence; however, in veterinary science first laboratory in biotechnology was established in 1990 at IVRI, Izatnagar.

Importance of forensic anatomy

Forensic anatomy intends to determine, examine and identify preserved or unpreserved body parts of the animal/human remains, as well as the living consequent upon which the big fours of Forensic Anthropology (i.e. sex, age, race and height) is established. Also examines the cause of death.

Anatomy of an animal crime scene

Without physical evidence including animal bones, animal remains and even financial records, we could not show the link between critical tools in the fight against animal cruelty.

While every crime scene is different, the forensic scientists use the following steps to gather evidence a) Assessment b) Observation c) Documentation d) Search e) Collection f)Packaging and g) Analysis.

Forensic Veterinary Anatomy is a newly emerging field of Veterinary Anatomy. Forensic Veterinary anatomy is not only helpful in various vetero-legal cases but also play important role in identifying sex, breed, age, height, brutal killing as well as in poaching of domestic and wild animals. It also examines the cause of death. Anatomy is the branch of biological science which deals with the form and structure of the organisms (animals). It includes gross anatomy (Osteology, Arthrology, Myology, Splanchnology, Angiology, Neurology and Anesthesiology), microscopic anatomy (Histology, Histochemistry and Ultrastructure) and developmental anatomy (Embryology- prenatal and postnatal). Forensic Veterinary science combines the knowledge of veterinary anatomy with forensic science techniques to determine the identity of animal remains. Forensic experts specialize and have in-depth knowledge of the particular aspect of forensic veterinary anatomy. Forensic science has two subfields viz; forensic archeology and forensic taphonomy.

Forensic Archeologist assists in the identification of dead individuals whose remains are decomposed, burned, mutilated or otherwise unrecognizable. Forensic Taphonomist assists in the study of post-mortem changes of animal/human remains caused by soil, water and interaction with plants, insects, and other animals.

Forensic taphonomy is divided into two sections viz; Biotaphonomy and Geotaphonomy.

Biotaphonomy is the study of how the environment affects the decomposition of the body. Specifically, it is the examination of biological remains in order to ascertain how decomposition/ destruction occurred. This can include factors such as animal scavenging, climate as well as the size and age of an individual at the time of death. Biotaphonomy also deals with the common mortuary services and their effects on decomposition.

Geotaphonomy is the examination of how the decomposition of the body affects the environment. It includes how the soil was disturbed, pH alteration of surrounding area and acceleration or deceleration of plant growth around the body. By examining these characteristics, it is possible to determine the timeline events during and after death.



Today, Forensic Science is a well-established discipline especially in the human science (Forensic anthropology). In veterinary science, it plays a very important role in the identification and traceability of animals.

Forensic anatomy analytical techniques:

Role of embryology in fingerprinting, footprints, and other body prints: The knowledge of embryology is a branch of anatomy which is also applicable in forensic studies. Notably, the patterns of fingerprints are enclosed at the interface between the dermis, and such a pattern cannot be destroyed by surface skin injuries and thus remain unchanged throughout life. In addition to fingerprints, footprints, ear prints and muzzle print also follow the dermal pattern.

Role of biometry: In Biometric technology the prints are seen, collected, studied, evaluated and compared with stored data and exact cross match with the culprit. The biometric system therefore, is a pattern recognition device that acquires physical or behavioral data from an individual extracts a silent feature set from the data, compares this feature set against the features set stored in the database and provides the result of the comparison.

Anatomists are consulted frequently for the identification of skeleton remnants found under suspicious circumstances. Unless the characters are measured and expressed in figures, accurate scientific evaluation is not possible. **Lord Kelvin** has stated, "I often say that when you can measure what you are speaking about and expressed it in numbers, you know something about it but you cannot express it in number. Your knowledge is useless and of unsatisfactory kind, it may be the beginning of knowledge but have scarcely in your thought advanced to the stage of science whatever the matter may be." Identification points did not have static base, it may give wrong results for unknown cases. The biological data always shows normal distribution curve. Hence, it is necessary to calculate, Demarking Points, which can be calculated on the basis of Standard Deviation (SD). It is calculated by $\text{Mean} \pm \text{SD}$ which gives 99.75 percent accuracy. In vetero-legal cases cent percent accuracy is essential. The maximum and minimum limits are to be calculated by adding and subtracting SD to and from the mean values of each measurement. These values are referred as Demarking Points (DP).



Determination of the sex of an individual from the skeleton remnants from the examination of a single bone is considered to be almost an impossible task. Pearson (1990) contributed to determining sex by the examination of single long bone. Singh and Singh (1971) demarcated sex from the various biometrical parameters of different bones in the body.

Role of Osteology: The scientific study of bone is called osteology. The biological profile of every skeleton is unique. The knowledge of osteology is of great importance in animal height estimation, sex determination, determination of age and ancestry.

Role of hair evidence: Hairs are composed primarily of the protein keratin, can be defined as slender outgrowths of the skin of mammals. Each species of animal possesses hair with characteristics length, colour, shape, root appearance and internal microscopic features that distinguish one animal from another. Hair cast is reliable without any expense gives 99 percent accuracy for identification of species and sex which can be confirmed by scanning electron microscopy. Because hairs can be transferred during physical contact, their presence can be associated a suspect to a victim or a suspect/victim to a crime scene. Comparison of the microscopic characteristics of questioned hairs to known hair samples helps to determine whether a transfer may have occurred or not.

Animal identification in forensic science is fundamental for many reasons. Analyses of animal remains, e.g. hair or bone, at a criminal scene may help to provide evidence for a contact of a suspected assailant or to diagnose some toxic cases e.g. the presence of arsenic, lead or molybdenum in animals. In restaurants, animal remain investigation can help to identify meat adulteration, e.g. meats of cat, dog or donkey instead of rabbit, goat or sheep. Furthermore, animal identification is important in case of illegal trade provided proof of principle that hair examination can give some evidence of the age.

Animal species identification can be done based on many features including morphology of animal remains, particularly hair and bone. For example, osteon morphology can be used as a tool to distinguish mammalian from non-mammalian species. Hair morphology is another important tool that can be used to identify animal species. Four main types of hair were described in different mammals, of which guard hair is the most important in differentiation between various animal species.

The hair consists of two parts, hair root which is embedded in the dermis of the skin, and hair shaft which extends above the epidermis as a cylindrical structure. The hair shaft consists of three distinct morphological layers medulla (the central layer), cuticle (the outer layer), and the cortex (between the medulla and the cuticle). The medulla, the innermost layer of the hair shaft, is a honeycomb-like keratin structure with air spaces in between. The hair medulla can be continuous, discontinuous or fragmental, depending on the species. The cortex contains keratin fibers and pigments which is responsible for the coloration of the hair. The cuticle, the outermost layer, consists of overlapping keratin scales. Two main patterns of cuticle scales were identified: (i) imbricate, this includes ovate, acuminate, elongate, flattened and crenate cuticles; and (ii) coronal, which include simple, serrate or dentate cuticles. The distance between every two successive scale margins can be close, intermediate or wide, depending on the animal species. The pattern of the cuticle scales, the type and the diameter of the medulla and/or the characteristics of pigmentation can be used for animal species identification as well as for differentiation between animal and human hair at crime scene. Ahmed, *et al.*(2018) reported that hair histology act as a tool for forensic identification of some domestic animal species.

Muzzle printometry: Surface makings of the muzzle present numerous grooves forming definite pattern which may be used for the identification of animal by studying the muzzle prints. This method is useful in identification of animal as in human finger prints and may be employed on an organized farm to avoid the frauds made in insurance. It is also useful for identification fraternal and identical twins. Dhande (2012) mentioned that muzzle printometry is an anatomical technique for identification of animal and correlation in milk production

Role of teeth: Forensic dentistry in science represents the overlap between the dental and the legal professions. The stored materials, which cannot be putrefied which can be utilized during lawsuits against dentists, identification procedure of cadavers having only skeleton or which undergone putrefaction can be possible (Rath and Panda, 2017). One possible way to estimate the age of an adult is the microscopic examination of osteons. Younger adult have fewer and larger osteon while older adults have smaller and more osteons fragments. Another potential method for the determination of an adult skeleton is to look for the arthritis. Arthritis cause noticeable rounding off of the bones. The degree of rounding from arthritis coupled with the size and number of osteons is helpful to determine the age of an individual.

Unusual Teeth in Mammals:

Elephant's tusk: upper incisors grow to form tusk, used in offence and defense. The lower incisors disappeared. The tusks are made of ivory which is a specialized dentine. Both sexes of African elephants have tusks but in India only males bear tusks.

Pig's tusk: In wild boar the upper canines are enlarged to form stout tusks. The wart hog (*Phacochoerus*) of Africa bears 4 upward curving tusks, used for digging in the soil for storage roots and tubers of the plants.

Barking deer's tusk: The male muntjaks and musk deer possess tusks which are the enlarged form of upper canine teeth, used for self defence.

Walrus's tusk: modified form of upper canines, primarily used to break the clams on the ocean floor.

Fangs / tusks: large pointed *Canine teeth in human*

Wolf tooth: these are vestigial first premolar tooth found in horse.

Determination of sex: Depending upon the bone, the sex by looking for distinctive sexual dimorphisms. The pelvis and skull are commonly used for sex determination. The examination of conjugate diameter, transverse diameter, ischial arch and the location of sacrum is helpful in the determination of sex with great accuracy.

The skull also contains multiple markers that can be used for the determination of sex. Specific markers on the skull include the temporal line, the eye sockets, the supraorbital ridge, nuchal lines and the mastoid process. The recent studies show that the dimensions of the foramen magnum are also very useful to determine the sex. The sexual dimorphism begins to occur during puberty and is not fully completed until and after sexual maturation (Ingrid and Maciej, 2015).

Forensic scientists are able to see other marks present on the bones. Post fracture is evident by the presence of bone remodeling. The examination of any fractures on the bones can potentially help to determine cause of death as well as time of death by determining if a fracture occurred at antemortem (before death), perimortem or post mortem (Anastasi, *et al.*, 2016).



Role of DNA analysis: The deoxyribonucleic acid (DNA)- a chain can be accessed in of nucleotides and a part of genetic makeup of an individual (human/animal) can be accessed from any part of body i.e. hair, blood, bone etc. the DNA when isolated from any given part/structure of body and further examined, is always unique for a particular individual. In this way the interaction of body part at the molecular level is useful in the identification of individual (animal/human). The DNA can be used as a biometric tool to classify and guide the identification of unknown biological samples such as hair, blood, teeth, saliva, bone fragment, semen etc.

More recent techniques like carbon dating (radiocarbon analysis), CT scanning etc are also useful techniques to determine the age, sex and stature of individual.

Conclusively therefore, anatomical sciences are vital in forensic science/education and investigation and Anatomist who are interested in Forensics should be allowed to participate. This will ultimately create opportunity and collaboration among Anatomist and other Forensic scientists for exchange of ideas and for proper investigations having highlighted areas where Anatomical sciences will integrate well with Forensic science/investigation. In the future, a combine's approach of these advance tools with other radiological techniques may lead to an imaging data set with unsurpassable anatomical, physiological and pathological information, offering unique advantages in the field of forensic science.