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Anthropological and Diatomological Examination of Bones Recovered From Dry Pond

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Abstract

Aim of the present study was to examine the combined contribution of anthropology and diatomology for establishing the identity and cause of death through bones, recovered from dry pond in a farm. Detail analysis of the bone was performed to establish identity and cause of death. In addition to routine examination of bone marrow of humerus, pelvis, clavicle, sacrum, mandible, femur and tibia using anthropological methods, diatomological and toxicological examinations were also performed to estimate sex, age and stature and cause of death. In this case, nitric acid extracts of the intact femur and clavicle bone marrow were prepared and examined for the presence of diatoms. Various kinds of diatom frustules were recovered from marrow extracts, indicating that the cause of death was drowning. Poison was not detected in these bones during toxicological examination. Bones were without any injury mark. The use of diatom test was helpful in proving death due to drowning and excluding the possibility of death due to some other reason. Probably it would be accidental drowning as on the basis of back ground rationale. The application of anthropological and diatomological examinations significantly enhance the medicolegal investigation of bones. Anthropological data facilitated identification of individual and the diatom test established cause of death.

Keywords: Anthropology; Bones; Diatomology; Drowning; Diatom test.

Introduction

The medicolegal investigations of bones are highly challengeable to the forensic scientists[1], however, the identity of the decedent and the cause of death are of paramount importance.

In this case, we examined bones, which were recovered from dry pond in a farm for anthropological examination and removal of bone marrow for diatom analysis. These analyses were used to confirm identity of the decedent or to exclude possible identities and to determine whether drowning was the cause of death. The diagnosis of drowning in such type of cases is practically impossible because of disappearance of anatomical, biochemical and histopathological parameters. In such hard situation, only the 'diatom test' provides reliable information. Diatoms are well known microscopic unicellular phytoplankton algae belonging to class Bacillariophyceae. Due to presence of highly unique cell wall made of silica (hydrated silicon dioxide), diatoms resist decomposition and play significant role in solving drowning cases in forensic examinations.

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The use of diatom as a diagnostic tool in drowning cases has already been considered as supportive evidence[2,3] rather than definite test. In this case, drowning medium was not available; hence, diatom profile of tissue could not be compared for confirmation of drowning.[4] Even a single diatom in femoral bone marrow has been found consistent with drowning as a cause of death.[5] However, diatom test should be considered positive when number of diatom is found at least 20/100 µl of pellet obtained from 10 g lung sample and 5 g from other organs.[6]

In the present case study, the diatom test along with anthropology were applied to the bones recovered from dry pond in the farm. We evaluated the combined contribution of anthropology and diatomology to establish identification of exhibit and cause of its death.

Case History

A *gumsudagi* (missing) report was registered by son regarding missing of his 80 years old father since August 31, 2016. As per *gumsudagi* report, his father was suffering from epilepsy and poor sight. Some unidentified bones were found in the month of July 13, 2017 in a dry pond in his own farm which were suspected to be the bones of the farm owner's father. After F.I.R. bones were forwarded to State Forensic Science Laboratory, Rajasthan, Jaipur for forensic examination.

Materials and Methods

The bones that were found in dry pond included intact mandible, humerus, radius, ulna, clavicle, scapula, ribs, pelvis, sacrum, femur, tibia, fibula and vertebrae. The bones were carefully washed with water to remove the adhered soil and were properly dried. The bones were examined carefully to observed any injury. The examination confirmed that none of the bones had any injury or any cut mark. The bones were received only for identification of origin but it was further decided by the authors to analyse them in detail for establishing the identity and cause of death. In addition to routine examination of the humerus, pelvis, clavicle, sacrum, mandible, femur, tibia and ulna using anthropological methods to give estimate of the sex, age and stature of the individual, the diatomological examination was also carried out to determine the cause of death. In this case, nitric acid extracts of the bone marrow of the intact femur and clavicle were prepared and examined for the presence of diatoms.

Anthropological examination: The morphometric analysis of bones were recorded for estimation of age, sex and stature of the individual. The length of long bones, measurement of pelvis, sub pubic angle and mandibular angle were recorded. Femur and humerus were used for estimating the stature with help of standard regression formulae.[7]

Toxicological examination: Two vertebrae were forwarded to the Toxicology Division of the Forensic Science Laboratory for poison analysis.

Diatomological examination: Femur and clavicle were selected for diatom examination which were thoroughly washed with re-distilled water. Traditional acid digestion method was used for the extraction of diatoms.[8] Approximately 50 g samples of femoral and clavicle bone marrow was put into 50 ml of concentrated analytical grade nitric acid and marrow-acid suspensions were simmered on hot plate for 2 days in a fuming chamber. The suspension was allowed to cool at room temperature and centrifuged (2500–3000rpm, 10–20 min). The supernatant was discarded and the pellet re-suspended in distilled water and again centrifuged. This washing process was repeated at least thrice for the complete removal of acid contents from the sample. The final dried pellets were mounted on four glass slides (of each sample). Mounting was done directly in DPX. The diatoms were identified with the help of Olympus Light Microscope BX 50 at 1000X oil immersion. All the chemicals used in the complete process were free of diatom.

Results

The main findings of our studies were:

Anthropological examination

1. All bones were found intact and without injury mark / or cut marks.
2. The gross anatomical characters of bones indicated human origin.
3. All bones were found light in weight, fragile, porous and completely fused epiphyses indicating that the bones belonged to an old age person.
4. Sub-pubic angle was narrow nearly 67°, with narrow greater sciatic notch, pelvic inlet smaller and almost heart shaped,

ovoid obturator foramen, body of S1 vertebra wider than alae of sacrum, sacrum long and narrow with shallower concavity. All these data indicated that the bones belonged to a male individual (Fig. 1-3)

5. Mandibular angle was found to be nearly 120°, mental foramen was near upper (alveolar) border, socket of some teeth were obliterated and weared. These bones were highly porous and scapular blades were highly fragile. The dentition and all other features indicated that the bones belonged to an adult individual (Fig. 4-8)
6. Stature was estimated to be of 165 cm approximately, on the basis of prescribed regression formulae.

Fig. 1: Showing Pelvis of the male individual.

Fig. 2: Showing Sacrum of the individual, the porosity is clearly visible.

Fig. 3: Showing the pelvic bones of the individual, the porosity is evident in both the pelvic halves.

Fig. 4: Showing the symphyseal surface.

Fig. 5: Showing the mandible, obliterated sockets and wearing of teeth.

Fig. 6: Mandibular angle and position of mental foramen.

Fig. 7: Showing porosity in the femur head.

Fig. 8: Showing porosity in the condylar portion of the femur.

Toxicological examination

No poison was detected during toxicological examination.

Diatomological examination

A nitric acid extracts of femoral and clavicle bone marrow revealed the significant number of diatom frustules. About 63 diatoms of 8 different genera identified in femoral bone marrow viz *Achnanthus* sp., *Amphora* sp., *Cocconeis* sp., *Cymbella* sp., *Diatoma* sp., *Gomphonema* sp., *Navicula* sp. *Nitzschia* sp., and whereas, about 72 diatoms were observed in clavicle marrow represented by 9 genera including aforementioned genera and *Cyclotella* sp. (Table 1).

Table 1: Results of Diatomological Studies

S. No.	Diatoms genera	Femur bone marrow	Clavicle bone marrow
1.	*Achnanthus* sp.	+	+
2.	*Amphora* sp.	+	+
3.	*Cocconeis* sp.	+	+
4.	*Cymbella* sp.	+	+
5.	*Diatoma* sp.	+	+
6.	*Gomphonema* sp.	+	+
7.	*Navicula* sp.	+	+
8.	*Nitzschia* sp.	+	+
9.	*Cyclotella* sp.	–	+

Discussion

Bones were assessed for anthropological characteristics. The aim of the anthropological examination was to establish the sex, age, and stature of the individual. The extent of the examination is dependent upon the types and completeness of bones.

Sub-pubic angle was narrow nearly 67°, with narrow greater sciatic notch, pelvic inlet smaller and almost heart shaped, ovoid obturator foramen, body of S1 vertebra wider than alae of sacrum, sacrum long and narrow with shallower concavity, these data indicated that the bones belonged to a male individual.[7,9,10,11]

The dentition of mandible and all other features of the epiphysis, morphology of pelvis indicated that the bones belonged to an adult individual. Mandibular angle was found to be nearly 120°, mental foramen was near upper (alveolar) border, socket of some teeth were obliterated and weared. All the bones were found light in weight, highly porous and scapular blades were highly fragile which possibly might be due to osteoporosis on account of advanced old age or may be because of the bones remained in water for long time as circumstantial evidence. However, the features of the dentition, epiphysis and the morphology of the symphyseal surface[12] revealed that the skeleton belonged to an advanced old aged person and by the study of femur and humerus, stature was estimated to be of 165 cm approximately, which very well correlated with the police record.[11]

In the present case, poison was not detected during toxicological examination. Moreover, all the bones were found to be intact and without any injury marks. The bones were remained submerged in water for a long period; in such circumstances the diagnosis of cause of death is practically impossible. In such hard situation only the 'diatom test' provides reliable information regarding drowning. During diatomological examination, good number and different kinds of diatom frustules were observed in femur and clavicle.

Though, diatom test is considered as supportive evidence by several scientists[2,3] rather than definite test in the diagnosis of drowning because diatoms were also found in non-drowned bodies.[13] In this case, control water was not available; hence diatom profile of tissue could not be compared for

confirmation of drowning.[4] However, Auer and Mottonen[14], reported that accurate diatom count can discriminate between drowning and non–drowning cases. Pachar and Cameron[15] also suggested for quantitative and qualitative estimation to improve the reliability and applicability of diatom test in drowning cases.

In our study, the presence of diatoms is ~135 per 100 g including femoral and clavicle marrow, which is more than twice to the minimal established limit, i.e. 5 complete diatoms/10 g tissue except of lung by Ludes *et al*.[6] However, it cannot be ignored that besides the above a number of diatoms would have been destroyed during acid digestion, washing[16] and low sensitivity of bone marrow for diatoms in drowning.[17] Therefore, presence of different kinds and more than the sufficient number of diatom frustules in bone marrows indicate that drowning was the cause of death and excluding the possibility of death by any other means.

Conclusion

Considering all these facts, i.e. advanced old age, back ground rationale (suffering from epilepsy and poor sight), possibility of accidental drowning could not be ruled out.

In this way, we find that the combined application of anthropological and diatomological examination may significantly enhance the medicolegal investigation of bones. Anthropological data facilitates the identification of individual and the diatom test establishes the cause of death.

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