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Toxicological SciencesJournal homepage: <http://www.ijfmts.com/>

Original Research Article

Evaluation of gross and histological changes of aorta in postmortem period: A preliminary study

Rajesh V Bardale¹, Nitin S Ninal^{2,*}, Manohar K Shelake²¹Dept. of Forensic Medicine, Government Medical College and Hospital, Sangli, Maharashtra, India²Dept. of Forensic Medicine & Toxicology, Government Medical College, Aurangabad, Maharashtra, India

ARTICLE INFO

Article history:

Received 08-01-2021

Accepted 22-03-2021

Available online 28-04-2021

Keywords:

Aorta

Death

Histopathology

Postmortem interval

ABSTRACT

After death postmortem degradation of cells occur by means of autolysis. Various tissues and body fluids like heart, liver, kidney, uterus, labial mucosa, gingival epithelium, salivary glands, skin, and its appendages and body fluids such as blood cells and cerebrospinal fluid cells were studied to know the pattern of autolytic changes. The present study was undertaken to evaluate gross and histological changes of aorta in human and to identify different morphological changes that occur at different postmortem intervals. The study consisted of 10 male cadavers and their age ranged from 20 years to 76 years (mean age 43.4 years). The results of the present study show that the aorta undergoes progressive morphological changes in the postmortem period. These changes were observed on gross examination and at cellular level by light microscopy. The limitations of present study are 1) small sample size, 2) evaluation of aorta in single environment and 3) study of male sex only. Further large studies are required to establish whether the criteria of postmortem changes in aorta can reliably be used to estimate the death interval.

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1. Introduction

After death postmortem degradation of cells occur by means of autolysis. Various tissues and body fluids like heart, liver, kidney, uterus, labial mucosa, gingival epithelium, salivary glands, skin, and its appendages and body fluids such as blood cells and cerebrospinal fluid cells were studied to know the pattern of autolytic changes.^{1–14} It is anticipated that aorta may also exhibit various autolytic cellular changes in postmortem period. In a study conducted using multi-detector computed tomography, it was noted that after death aorta shrunk at all levels and become oval in shape in descending thoracic and abdominal aorta.¹⁵ In another study conducted on rats, aorta was examined for functional, metabolic and histological changes after warm ischemia. As per histological study, aorta after warm ischemia showed a greater loss of smooth muscle and endothelial cells than aorta examined immediately after death.¹⁶ However, from

above study only limited data is available. Considering this the present study was undertaken to evaluate gross and histological changes of aorta in human and to identify different morphological changes that occur at different postmortem intervals.

2. Material and Methods

This was prospective study carried out at Dept. of Forensic Medicine at Tertiary Care Institute from December 2014 to March 2015. The study consisted of 10 male cadavers and their age ranged from 20 years to 76 years (mean age 43.4 years). The death was due to various causes (head injury, n = 6; hanging, n = 2; pulmonary consolidation, n = 1 and ischemic heart disease, n = 1). Cases having trauma to chest and/or abdomen were excluded from the study. All bodies were kept at room temperature in the waiting room of mortuary. The average ambient temperature during the period varied from 33° C to 11.5° C and average humidity ranged from 97% to 18.25%. Segments of aortas were

* Corresponding author.

E-mail address: drnitinninal@rediffmail.com (N. S. Ninal).

obtained at the end of postmortem examination. A 5 cm segment of aorta was collected. The segment was collected from descending thoracic aorta at level of heart. The earliest sample obtained was at the period of 3 hours of postmortem interval (PMI). Subsequently the segments of aortas were kept at room temperature and sub-sampling was done for histological examination. The sub-samples for histology were taken at 3, 6, 12, 24 and 36 hours interval after death. Total 50 samples were studied. The sub-sampling was done carefully to avoid traumatic artefacts. The remaining segments of aorta were kept for gross observation for period of 3, 6, 12, 24, 36, 48, 60, 72, 84, 96, 108 and 120 hours interval after death. The samples were collected from those bodies where exact time of death was known. All sub-samples were subjected to light microscopy. Tissues were fixed in 10% formalin, embedded in paraffin wax, and stained with hematoxylin-eosin (H and E). The aortas were studied for tunica adventitia, tunica media, tunica intima, smooth muscle, and elastin.

3. Results

The results of the present study show that the aorta undergoes progressive morphological changes in the postmortem period. These changes were observed on gross examination and at cellular level by light microscopy. The gross examination findings are mentioned in Table 1 (Figure 1A to H). The light microscopic examination findings are mentioned in Table 2 (Figure 2 A to C, Figure 3 A to B and Figure 4). It appeared that from 3 hours PMI, the aorta showed progressive shrinking and by 12 hours PMI, it became harder. By 96 hours PMI, it appeared mummified and continued till 120 hours PMI. After that period, further gross study of aorta was abandoned. On microscopic examination, the three layers of aorta could be identified by 6 hours of PMI. After that period it showed degenerative changes by 36 hours of PMI, there was widespread breaking of elastin lamellae and nuclei showed karyorrhexis. After this period microscopic examination of aorta was abandoned.

4. Discussion

The wall of aorta is composed of three layers; the tunica intima, the tunica media and the tunica adventitia. The tunica intima is the inner most layer and is lined by endothelium. The internal elastic lamina separates this layer from tunica media. The tunica media is the middle layer and bounded externally by external elastic lamina. This layer consists of smooth muscles and elastin. The tunica adventitia is the outer layer. It consists of loose mesh of connective tissue and some elastic fibres.

After death cellular death of different organs occur at different interval depending on the requirement of oxygen, availability of substrate for anaerobic metabolism and

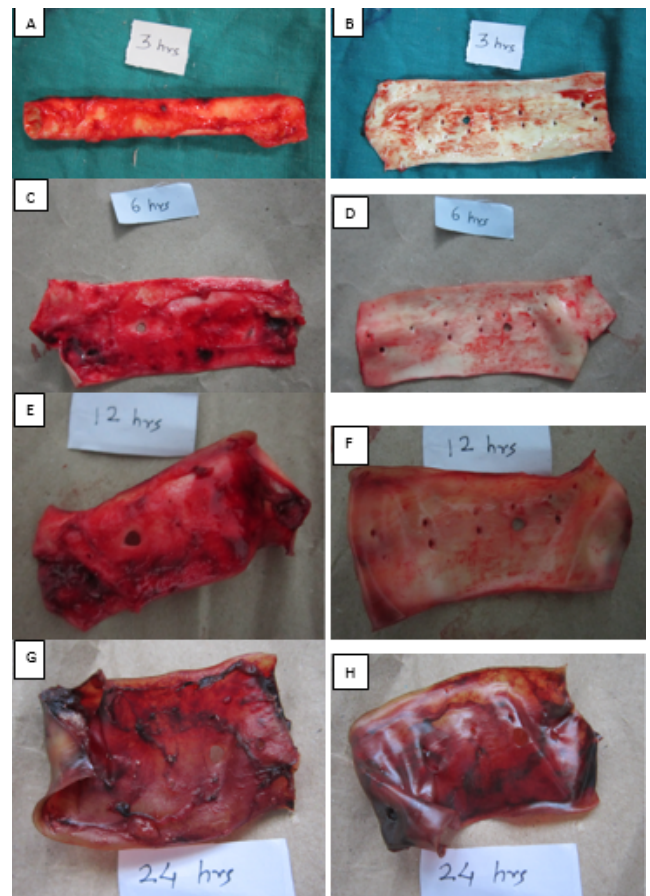


Fig. 1: Gross findings- A and B: external and internal surface at 3 hr PMI; C and D: external and internal surface at 6 hr PMI; E and F: external and internal surface at 12 hr PMI; G and H: external and internal surface at 24 hr PMI.

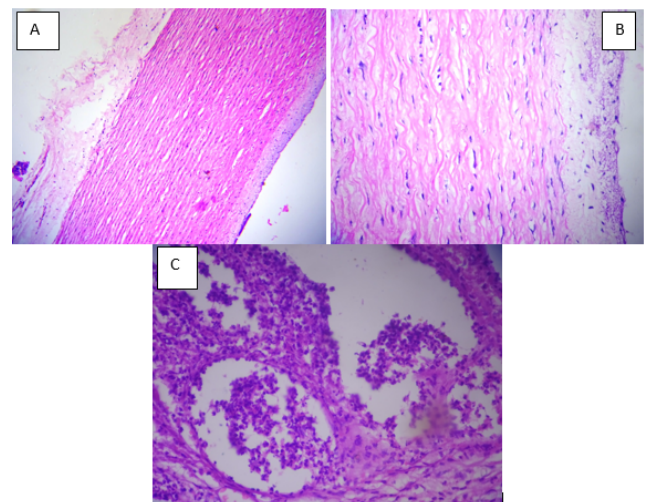


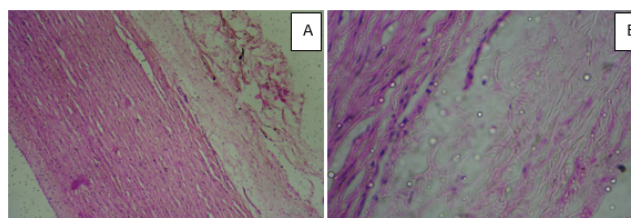
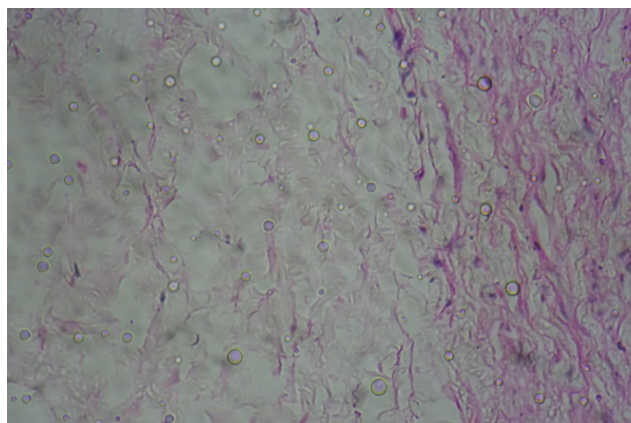
Fig. 2: Microscopic findings at 3 hr PMI- A: tunica adventitia, tunica media, and tunica intima identified; B(3 hr PMI): B: elastin lamellae intact. Smooth muscle shrunken with pyknotic nuclei C: Vasa vasorum identifiable but endothelial cells disintegrated (H and E, original magnification X 100 [A], X 400 [B and C])

Table 1: Showing Gross Changes in Aorta with Increasing Postmortem Interval

Postmortem interval (in hours)	Gross Changes in Aorta
3	Aorta shrunken. Lumen decreased. External surface moist and soft. Intima moist, sticky and appears retracted.
6	Surface moist and sticky. Intima reddish due to blood stain
12	Surface dry, brownish, and sticky. Slightly shriveled. Intima dry and blood stained
24	Surface dry, firm, shrunken and shriveled. Brownish-red. Intima firm.
36	Surface dry, firm, shrunken and shriveled. Brownish. Intima firm
48	Surface dry, firm, shrunken and shriveled. Brownish. Intima firm
60	Surface dry, firm, shrunken and shriveled. Semi-translucent. Brownish. Intima firm
72	Surface dry, firm, shrunken and shriveled. Semi-translucent. Dark brown. Intima firm to hard
84	Surface dry, hard, little-bit brittle. Dark brown. Intima firm to hard
96	Surface dry, hard, shriveled and mummified
108	Surface dry, hard, shriveled and mummified
120	Surface dry, hard, shriveled and mummified

Table 2: Showing Microscopic Changes in Aorta with Increasing Postmortem Interval

Postmortem interval (in hours)	Microscopic Changes in Aorta
3	Tunica adventitia, tunica media, and tunica intima identified. Elastin lamellae intact. Smooth muscle shrunken with pyknotic nuclei. Vasa vasorum identifiable but endothelial cells disintegrated.
6	Tunica adventitia, tunica media, and tunica intima identified. Tunica adventitia showing disruption. Elastin lamellae intact. Smooth muscle disrupted with pyknotic nuclei. Vasa vasorum identifiable but endothelial cells disintegrated
12	Tunica adventitia shows disruption with eosinophilic staining. Smooth muscles disintegrated with nuclei showing karyorrhexis. Elastin shows separation and begins to break at places.
24	Elastin lamellae disrupted with nuclei showing karyorrhexis.
36	Elastin identifiable with eosinophilic staining

**Fig. 3:** Microscopic findings at 12 hr PMI- A: tunica adventitia shows disruption with eosinophilic staining; B: Smooth muscles disintegrated with nuclei showing karyorrhexis (H and E, original magnification X 100 [A], X 400 [B])**Fig. 4:** Microscopic findings at 24 hr PMI- Elastin lamellae disrupted with nuclei showing karyorrhexis (H and E, original magnification X 400)

amount of autolytic enzymes. As far as human aorta is considered, currently very limited information is available on the postmortem changes occurring at various intervals. Takahashi et al (2013) studied the antemortem and the postmortem chest and abdominal CT scan for changes in aorta in 58 cases. They noted that after death, the aorta shrank at all levels and became oval in shape in descending thoracic and abdominal aorta. Contraction was greater in younger cases than the older cases. The findings of present study are consistent with the observation that the aorta shrank in postmortem period. This was observed as early as 3 hours PMI.

Moriyama et al (2001) studied male Brown Norway rats for functional, metabolic and histological changes in aorta after warm ischemia. Segments of thoracic aorta were collected and studied at six different postmortem intervals; immediately after death and maintaining sacrificed rats at room temperature. Histologically after 6 hours of warm ischemia, there was slight separation of elastic fibres and focal vacuolation were seen. After 12 hours period of warm ischemia, pyknotic nuclei and shrunken smooth muscle cells were noted. After period of 24 hours of warm ischemia there were pyknotic or not-clearly-stained nuclei of smooth muscle cells noted. The findings of present study are in

accordance with this study. However, the onsets of cellular changes were earlier in the present study than the cited study. This could be attributed to difference of the study subject (human verses rat) and because of difference in the environment.

The limitations of present study are 1) small sample size, 2) evaluation of aorta in single environment and 3) study of male sex only. However, useful information can be deduced from the results of this preliminary study. In conclusion, it can be stated that the aorta show progressive changes in postmortem period. It shrunk in size as early as 3 hours PMI. Cellular changes are exhibited earlier by 3 hours PMI. Further large studies are required to establish whether the criteria of postmortem changes in aorta can reliably be used to estimate the death interval.

5. Conflicts of Interest

All contributing authors declare no conflicts of interest.

6. Source of Funding

None.

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Author biography

Rajesh V Bardale, Associate Professor

Nitin S Ninal, Assistant Professor

Manohar K Shelake, Assistant Professor

Cite this article: Bardale RV, Ninal NS, Shelake MK. Evaluation of gross and histological changes of aorta in postmortem period: A preliminary study. *IP Int J Forensic Med Toxicol Sci* 2021;6(1):9-12.