Estimation of Early Postmortem Interval through Biochemical and Pathological Changes in Rat Heart and Kidney

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Abstract

Background: Accurate estimation of time passed since death is a complicated task in forensic medicine. Objectives: To investigate oxidants/antioxidants changes for estimating postmortem interval (PMI) in rat heart and kidney and whether these changes were correlated with histopathological findings.

Methods: Eighty-four male albino rats were sacrificed and both hearts and kidneys were extracted at intervals of one hour (0-1, 1-2, 2-3, 3-4, 4-5, 5-6, 6-7). Levels of MDA, NO and TSH as well as the activity of GR, GST and CAT were estimated. Both heart and kidney were examined histopathologically.

Results: In heart tissue, MDA and NO were significantly increased at 3-4h and 4-5h after death, respectively. On the other hand, TSH, CAT and GR started to be (p<0.05) decreased at 1-2h PM, while GST was significantly decreased at 2-3h after death. Regarding kidney tissue, MDA and NO started to be (p<0.05) increased at 5-6h after death while GR and GST were decreased (p<0.05) at 3-4h PM. TSH commenced to be decreased (p<0.05) at 4-5h after death, while CAT significantly decreased at 6-7h after death. Structural deterioration of heart started 3-4h compared to renal sections that began 5-6h after death.

Conclusion: The relationship between oxidant and antioxidant parameters is crucial in determining the PMI. Kidney was found to be more resistant to oxidative damage.

Introduction

Accurate estimation of time passed since death is one of the most complicated tasks in forensic medicine especially in homicide or unwitnessed death investigations (1). It assists in distinguishing ante-mortem pathology from post-mortem artifact (2).

Postmortem physiological and physical changes are usually inferred to estimate postmortem interval (PMI) especially during periods of decaying process. These include changes in body temperature, distribution of rigor mortis, death stains and growth of bugs on the corpse (3,4).

In living tissue, there is continuous formation of free radicals which are scavenged by means of antioxidant (5).

After death, it cannot be assumed that oxidant/antioxidant balance be adequately controlled by the body, so changes in oxidant/antioxidant parameters are evaluated as biochemical disturbances (6).

The aim of this study was to investigate if the changes in oxidant/antioxidant parameters can be relied upon in estimating the early postmortem interval in rat heart and kidney and whether or not these changes correlated with histopathological findings in these tissues.

Methods

Eighty-four male albino rats were sacrificed and both heart and kidney were extracted at intervals of one hour (0-1, 1-2, 2-3, 3-4, 4-5, 5-6, 6-7). Heart and kidney tissues were divided into two parts. The first part was dissected into small pieces and were used for estimation levels of malondialdehyde (MDA), nitric oxide (NO) and total thiol (T-SH) as well as the activity of glutathione reductase (GR), glutathione S transferase (GST) and catalase (CAT). The second part of hearts and kidneys were immediately fixed in neutral buffered formalin (10%) for histopathological and catalase (CAT). The second part of hearts and kidneys were immediately fixed in neutral buffered formalin (10%) for histopathological studies.

Results

Regarding the heart, MDA and NO increased (P<0.05) at 3-4h and 4-5h PM, respectively. On the other hand, TSH, CAT and GR started to be decreased (P<0.05) at 2-3h PM, while GST was decreased at 2-3h PM (Table. 1).

Regarding the kidney, MDA and NO increased (P<0.05) at 5-6h PM while GR and GST were decreased (P>0.05) at 3-4h PM and afterwards. TSH decreased (P>0.05) at 4-5h PM while CAT became significantly decreased at 6-7h PM (Table. 2).

Linear regression analysis of independent variables for predicting time of death was EPI= 8.607 - 0.240GR + 0.002MDA - 0.014 NO. GR, MDA and TSH of kidney were significant factors (R²=69.7%). Regarding the heart, GR, MDA and NO were significant factors (R²=97.2%). Histopathological examination: H & E stained cardiac sections showed gradual deterioration in the structural integrity starting 3-4h PM compared to sections obtained 1h PM (Fig. 1). On the other hand, renal sections revealed gradual deterioration in both cortex and medulla at 5-6h PM compared to 1h PM (Fig. 2).

Conclusions

In the present study, the oxidant/antioxidant balance in both heart and kidney was in favor of antioxidants up to 2h and 4h, respectively. MDA and NO increased in parallel to the increase in the extent of damage in the tissues. The concentration of heart tissue was decreased significantly after the 1st hour of death. On the other hand, kidney tissue showed significant increase at 4-5h after death. These changes may be attributed to the difference in tissue contents of thiols.

Catalase activity in the heart is very low in comparison with kidney. The low catalase activity in the heart is partially responsible for the high vulnerability to oxidative injury. However, the kidneys deal with waste products filtered out of blood and it contain a reasonable amount of peroxides, therefore the kidney tissue catalase activity. From the current results, it was observed that oxidative damage started earlier in the heart than in kidney. This could be explained on the basis of difference of antioxidant activities of both organs. The difference in the enzyme responses may be due to the differences in the amount, nature, and activities of these enzymes.

These results are preliminary, although significant results were found in this animal study. Therefore, further research on animals for more duration up to 24h and others on humans are needed.

References