Metal-ion-mediated oxidative stress in the gill homogenate of rainbow trout (Oncorhynchus mykiss)

Abstract

Human activities play a major role in toxic and carcinogenic metal pollution of the environment. This study was undertaken to evaluate the effects of copper and mercury at the 400-to 1000-µM concentration range on some biochemical markers of oxidative stress, such as lipid peroxidation (LPO), glutathione-S-transferase (GST) activity, and reduced glutathione (GSH) content in the rainbow trout gill homogenates with or without supplementation of manganese, selenium, and bovine serum albumin (BSA). The integrity of DNA was also measured to assess metal ion toxicity. The results showed that the LPO and specific activity of GST were elevated. This indicated that cell-protecting antioxidant mechanisms were overtaxed and could not prevent membrane peroxidation. Following the addition of metals, the GSH content was also significantly reduced in a concentration-dependent manner. Mercury was found to be more effective than copper. The application of antioxidants proved beneficial in inhibiting LPO, reducing GST activity, and elevating the GSH levels in the gill samples. Manganese was more effective than selenium and BSA. Surprisingly, when BSA (1.0%) was added to the gill homogenates treated with a 1000-µM concentration of metal ions, instead of alleviating malondialdehyde (MDA) generation, a drastic elevation in the MDA levels, alleviation in GST activity, and a further decrease in glutathione (GSH) levels were observed, which were most likely the result of pro-oxidant activity of BSA. The results also indicated that mercury and copper functioned as genotoxic pollutants, which altered the DNA integrity by inducing the single and double-stranded DNA breaks in the gill cell nuclei. Collectively, toxicity of metal ions is related to the depletion of GSH content and inhibition of antioxidant enzyme GST, resulting in the propagation of LPO and DNA damage.

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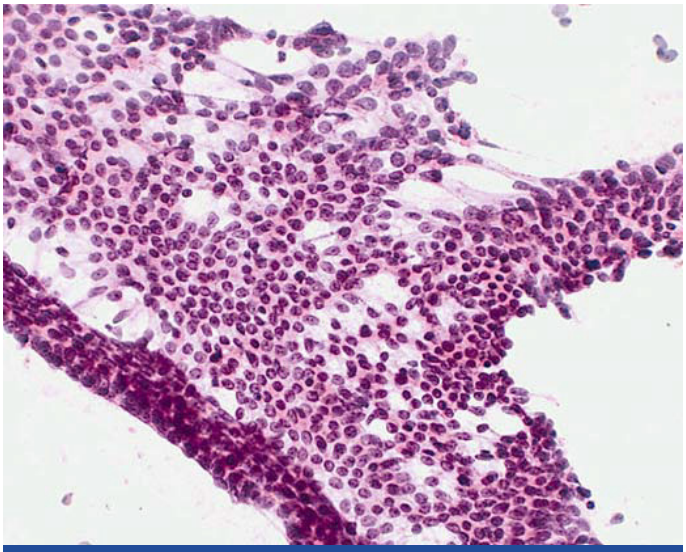
Correction

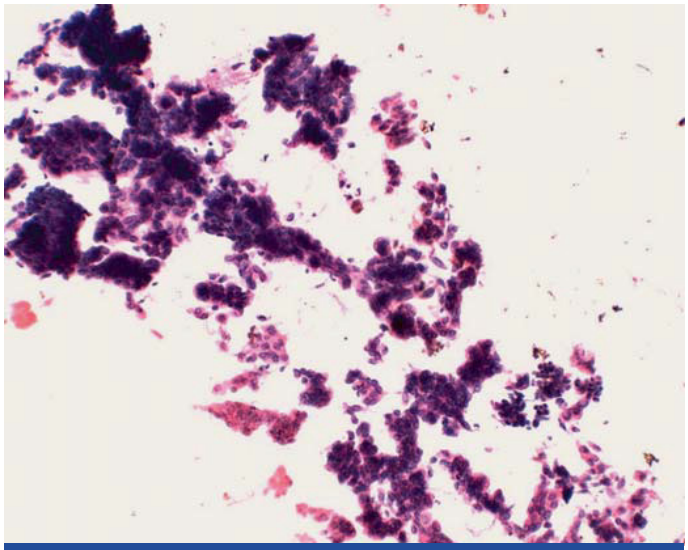
Ananthalakshmi Vijayakumar, The Diagnostic Utility of Intra-operative Cytology in the Management of Ovarian Tumours

(Published in Journal of Cilinical and Diagnostic Research. 2013 June; 7(6).1047-1050.

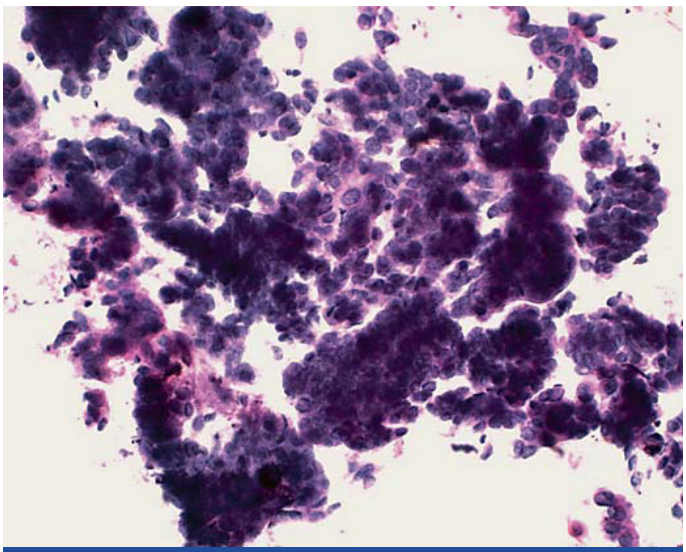
In this article corrections were done in legends of some images to acknowledge the source of that image [Table/Fig-2,3,4,5,6] and Reference [17] was added.



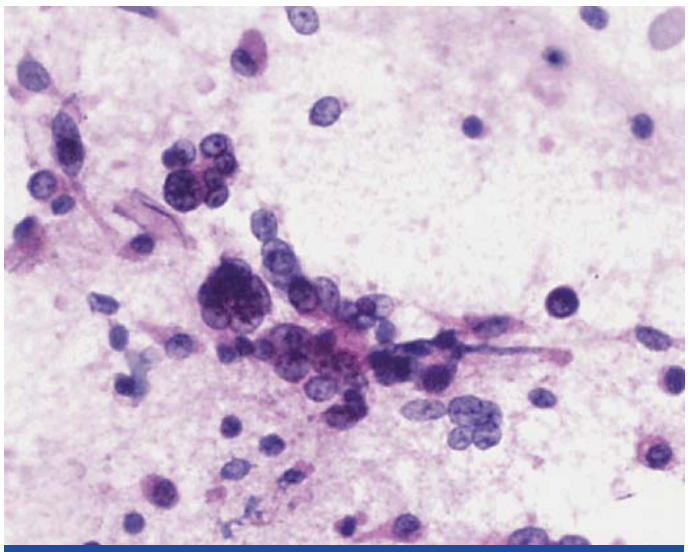
[Table/Fig-2]: Serous benign cystadenoma. Monolayer and 2D cellular aggregate. Cells with uniform size and shape. Oval bland nuclei with regular chromatin and small, fine nucleoli, scant cytoplasm. Preservation of polarity and cohesiveness. Clean background. HE, x 200
(Image courtesy: Dr. Alvarez Santin C. et al.)



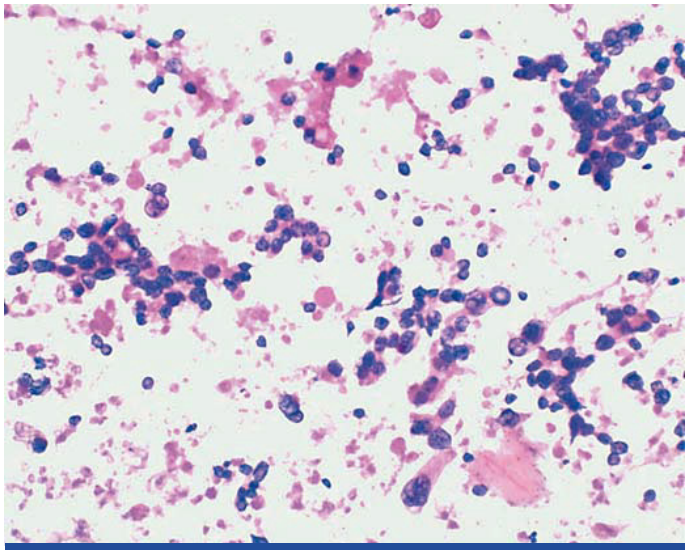
[Table/Fig-4]: Serous borderline tumor. Branching papillary pattern with peripheral detachment of small epithelial nests. Low nuclear atypia. Clean background. HE, x100
(Image courtesy: Dr. Alvarez Santin C. et al.)



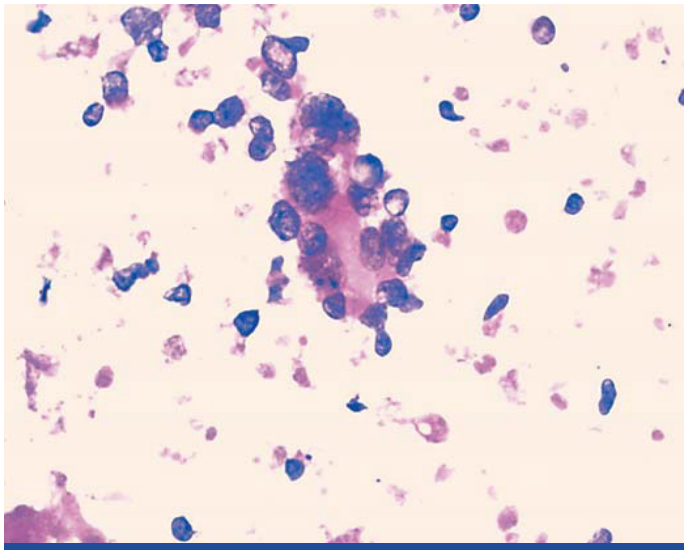
[Table/Fig-3]: Serous borderline tumor. High cellularity. 2D and 3D dense cell groups. Scarce single cells. Low to moderate nuclear atypia. Oval and round nuclei, small, fine nucleoli, scant cytoplasm. HE, x200
(Image courtesy: Dr. Alvarez Santin C. et al.)



[Table/Fig-5]: Serous carcinoma. Numerous single cells and small 3D groups. Loss of polarity and cohesiveness. High nuclear atypia. Irregular chromatin and prominent or macro nuclei. HE x200
(Image courtesy: Dr. Alvarez Santin C. et al.)



[Table/Fig-6]: Clear cell carcinoma. High cellularity. Loosely cohesive cell clusters. Small, round papillary groups. Single cells. Eosinophilic secretion. HE, x 200
(Image courtesy: Dr. Alvarez Santin C. et al.)



[Table/Fig-7]: Clear cell carcinoma. Three dimensional papillary groups with hyalinized cores. Hobnail cells with peripheral nuclear protrusion. High nuclear atypia, hyperchromasia. Vacuolated cytoplasm. HE, x 400
(Image courtesy: Dr. Alvarez Santin C. et al.)

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(Post publication article amended on Oct 17, 2013).

REFERENCES

[17] Alvarez Santín C, Sica A, Melesi S, Feijo A, Garrido G, Rodríguez Alvarez MC. Contribution of intraoperative cytology to the diagnosis of ovarian lesions. *Acta Cytol*. 2011; 55(1): 85-91.