The Bioscan 6(4) : 583-585, 2011
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.in

PATHOPHYSIOLOGICAL CHANGES IN LUNGS OF RAT EXPOSED TO FOUNDRY ENVIRONMENT

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KEY WORDS
Foundry environment
Animal model
Pathophysiological changes
Lungs

Received on :
06.08.2011

Accepted on :
12.11.2011

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ABSTRACT
Foundry industry is characterized by multitude of concomitantly occurring exposures such as silica dust, metal dust, various chemicals, noise, heat, radiations etc. Animal model Rat exposed to foundry environment showed pathophysiological changes. Aim of the experiment was to determine the effects of foundry environment on pathophysiological changes in lungs. Male albino rats were exposed in foundry environment for period of 8h, 16h and 24h. It was observed that increase in alveolar congestion leading to reduction in alveolar space, increased thickening of alveolar wall and blood vessels were according to increase in period of exposure as compared to normal.

INTRODUCTION

Foundry Industry occupies a key role in the economy of the country. The occupational health problems in foundry industry are many due to variety of stress factors such as noise, inadequate illumination, high concentration of silica dust, metal dust coal dust and heat are very important. Silica dust is serious problem in this industry affecting the working environment. In foundry silica dust produced in various operations freely fly in the air. The fly dust enters the respiratory tract and causes respiratory stresses. Takayoshi *et al.* (2007) observed effects of particle size of intratracheally instilled crystalline silica on pulmonary inflammation, which causes changes in bronchoalveolar lavage fluid and pulmonary tissues. Yasuo *et al.* (2005) demonstrated expression of clara cell secretary protein in the lungs of rats exposed to crystalline silica. In previous study More and Sawant, (2010) have observed that the workplace environment of foundry was extremely adverse. In the present study efforts have been made to correlate the physiologic responses of foundry workers to animal model.

MATERIALS AND METHODS

Study area

MIDC Shiroli is one of the industrial areas near Kolhapur city. It is located six kilometer away from city. There are fifty foundries in Kolhapur, and about 9000 workers are working. In India near about 6000 foundries are present. In foundry variety of foundry process are carried out which includes making the pattern, preparation and mixing of sand, making and assembling the mould, melting metal in furnace and finally removing all adherent sand and superfluous metal from the finished casting. Workers are involved in these different activities. The environmental conditions are hot, noisy and dusty. The overall occupational environment inside the foundry in different sections affects the physiological behavior of workers. Mostly silica dust, coal dust and metal dust produced in foundry operations affects the respiratory system of workers.

Selection of animal model

To study physiological reactions to foundry dust exposure, albino rats (*Rattus norvegius*) were exposed for period of 8 h, 16 h and 24h respectively in the foundry environment. The physiological reactions of rats were similar to those of human. Therefore, the rat animal model was preferred and used to investigate the mechanism of response and to identify pathophysiological changes in lungs related to foundry dust exposure.

Experimental protocol of the animal model

The male albino rats (*Rattus norvegicus*) weighting about 220 to 240 g were selected as experimental animals. Rats were divided into two groups control and experimental. Experimental groups of animals were divided into five sets for each section of foundry and exposed for 8h, 16h and 24h respectively inside the foundry in five different sections during

exposure the rats were fed with gold mohair rat feed (Hindustan Lever Ltd. Mumbai) and water *ad libitum*. The control groups had three rats which were kept in laboratory environment. Experimentations were conducted according to "INSA – Ethical guidelines for use of animals in scientific research."

Physiological study

Histological technique for lung

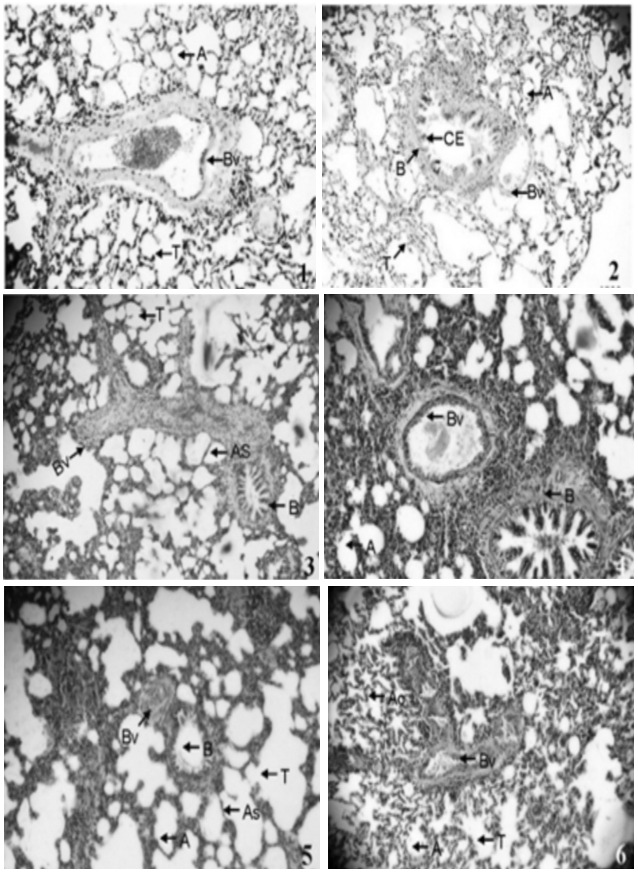
The experimental animals after exposure inside the different sections of foundry for appropriate time were sacrificed by cervical dislocation. The animals were cut open and lung tissues were fixed in 20 % CAF (2g Calcium Acetate in 10 % Formalin). The tissues were dehydrated and paraffin blocks were prepared. The sections were fixed on glass micro slides by using albumen as adhesive and staining done by Haematoxylin-Eosin (HE) by standard procedure.

RESULTS

Histopathology of lungs

Fig. 1 of plate I and II shows T.S. of lung of control rat indicating, bronchiole, alveoli, normal thickness of interalveolar septum and blood vessel.

Mild alveolar congestion reducing alveolar space was observed in T.S. of lung from 8 h exposure to 16 h exposure which later becomes moderate after 16 h exposure and severely moderate after 24 h exposure (Fig. 6 and 7 of Plate I).



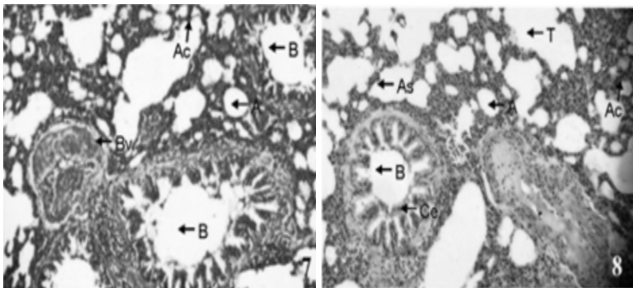


Plate 1: 1. Photograph of lung of control (1) H & E x 40, showing Bronchiole (B), Blood vessel (Bv), Terminal bronchiole (T) and Alveoli (A), 8h exposure shows B, Bv, A, T, As and 16h exposure shows Alveolar congestion (Ac) (5, 6, 7 and 8)

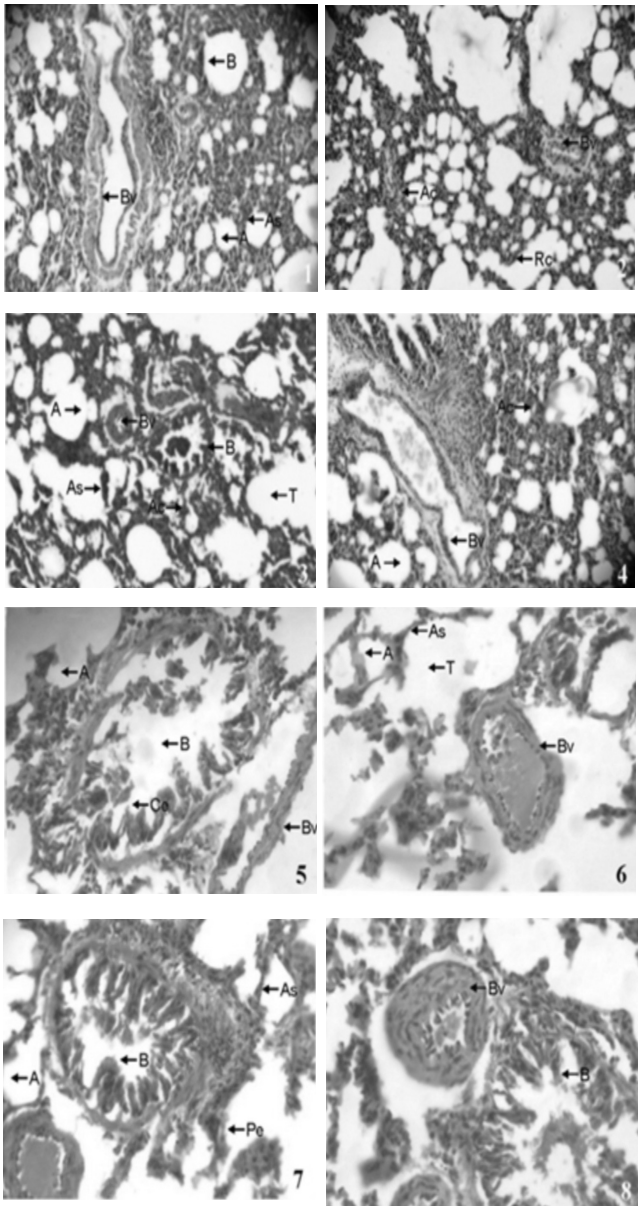


Plate 2: II Photograph of lung of 24h exposed rat H & E x 40 showing B, Bv, T, A, As Alveolar congestion (Ac), RBC congestion (Rc) and Pulmonary edema (Pe) (1 to 8)

Mild thickening or alveolar wall was observed from 8h exposure which become moderate after 16 h exposure and later moderately severe in T. S. of rat lung after 24 h exposure respectively (Fig. 7 and 8 of plate II).

The blood vessel showed no change up to 8 hr exposure but thickening of wall of blood vessel was mild up to 16 h exposure and moderate after 24h exposure in foundry environment. The lumen of wall of blood vessel completely reduced after 24 h exposure (Fig. 3, 6 and 8 of Plate II).

DISCUSSION

Variety of gases, fumes and vapours are reported in foundry environment where cupola furnaces are used. These foundries emit CO, SO_2 and particulate matter (dust). (Rao, 1996). Air pollution in foundries was reported by Mathew *et al*. (1984). Air in the foundries contains irritants like formaldehyde, phenol and various amines. These contaminants are generated by core shell making and moulding process which irritates the eyes and the respiratory tract Aakesson *et al*. (1986).Various metal fumes are also generated during founding processes, especially during melting and pouring operations in ferrous foundries. Iron oxide is the major fume generated in iron and steel operation. "Metal fume fever", results from exposure to these contaminants. This is an acute illness of short duration which commences some hours after inhalation of the metallic fumes. The symptoms include muscular pain, dry throat, coughing, headache and nausea chills and sweating may occur later. The changes in the organ system occur because of effects of foundry dust particles.

Histopathological observations of lung of rat exposed to foundry environment shows that, thickening of alveolar wall, thickening of wall of blood vessels, alveolar congestion peribroncheal edema, and inflammatory cells was more surrounding the blood vessels and fibrosis between bronchial wall Plate I and II.

Takayoshi *et al*. (2007) observed effect of particle size of intratracheally instilled crystalline silica on pulmonary inflammation, which causes changes in blood, bronchoalveolar lavage fluid and pulmonary tissues, similar changes in experimental animals exposed to foundry environment, were also observed in this experiment.

Yasuo *et al*. (2005) documented expression of clara cell secretary protein in the lungs of rats exposed to crystalline silica in vivo he showed that how clara cell secretion protein plays role in regulating the acute inflammatory response in the lung. Hiroko *et al*. (2006), observed expression of hem oxygenase-1 in the lungs of rats exposed to crystalline silica, the levels of Ho-1(heme oxygenase-1) were increased following intratracheal instillation of crystalline silica, which increases alveolar macrophages, which indicates Ho-1 is related to lung injury.

In present study, pulmonary edema, RBCs, congestion, patchy fibrosis in alveolar wall, alveolar congestion observation was that the wall of blood vessel shows thickening and reduction lumen of blood vessel (Plate I and II). This may be result in cardiopulmonary impairments. These changes may be responsible for migrations of PMNs from blood stream to lung.

ACKNOWLEDGEMENT

The authors are thankful to U.G.C. New Delhi for granting Teacher Fellowship and to the Professor and Head, Department of Zoology, Shivaji University, Kolhapur for providing necessary facilities.

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