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Histopathological Evaluation of Pulmonary Effects of Sodium Dichromate Cr VI in Rats

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Abstract: *In order to determine the toxicopathological effects of sodium dichromate Cr VI in the lung of rats, the present study used 30 rats (Rattus norvegicus) which divided into five equal groups, both (1st) and (2nd) groups were administered orally 3 mg and 9 mg /100gram B.W of CrVI orally for 30 days respectively. While (3rd) and(4th) groups administered the same doses as in (1st) and (2nd) groups respectively but for 60 days, in addition the (5th group) was kept as negative control. The results showed interstitial pneumonia, necrosis of small bronchioles and contained inflammatory cells in their lumens in addition there was necrotic bronchiolitis with papillae hyperplastic projections of lining columnar epithelial cells and peri-aggregation of mononuclear cells in (1st group). The (2nd group) showed peribroncheolitis and marked hyperplastic changes of ciliated columnar epithelia, also the alveoli showed marked emphysema, The (3rd group) revealed chronic necrotic bronchiolitis with papillae hyperplastic projections of lining columnar epithelial cells and peri-aggregation of mononuclear cells, while the (4th group) appeared great enlargement of bronchioles due to hyperplasia of lining epithelium as papillae and peri-mononuclear cells infiltration. We concluded that the Cr (VI) had a major toxic effects on the pulmonary tissues especially in highly repeated doses.*
Keywords: *Histopathology, sodium dichromate Cr (VI), Pulmonary, rats.*

I. Introduction

Chromium is release into the air by human sources (including burning of fuels and from metal industries) and by natural sources, including forest fires (1). Chromium is present in the atmosphere primarily in particulate form, it considered as an oxidizing agent which may reduce to chromium (III) and then adsorbed to particulate matter if large amounts of organic matter are present; drinking water supply and water sources are affected by Cr VI (2). After breathing can cause nose irritations and bleeding, upset stomachs and ulcers, respiratory problems, weakened immune systems, kidney and liver damage, alteration of genetic material, lung cancer and death (3 and 4). The highest exposure to Cr VI occurs to workers involved in chrome plating, chromate production, and stainless steel welding, exposure in these situations is typically by inhalation or dermal contact (5).

Characteristic clinical presentations of patients with Cr VI compound exposure include sinusitis, nasal septum perforation, allergic and irritant dermatitis, skin ulcers, respiratory irritation, bronchitis, asthma, and lung cancer (6). Lung cancer is the most serious long-term effect (6 and7). It is likely that no significant adverse nasal effects nor lung function effects will occur if acute exposure concentrations of Cr VI are less than 0.001 mg/m3 (5). However, an intermediate exposure to Cr VI concentration of 0.000005 mg/m3 has been calculated as a minimal risk level (MRL), a 20% decrease in the forced expiratory volume of the lungs was observed and was accompanied by erythema of the face, nasopharyngeal pruritus, nasal blocking, coughing, and wheezing (8). Dyspnea, cough, and wheezing were reported in two cases in which the subjects inhaled "massive amounts" of Cr VI trioxide. Marked hyperemia of the nasal mucosa without nasal septum perforation was found in both subjects upon physical examination (9).

II. Materials and Methods:

1- Lab animals: (n=30) male and female albino rats (*Rattus norvegicus*) aged about two months and body weight ranged between (150-200 grm).
2- Drug: Sodium dichromate Cr VI (BDH/England).
3- Dosage: depended on LD_{50} that reported by **(10)** represented 0.1 of LD_{50} of Cr (VI), we prepared 3mg/kg B.W by dissolved 30 mg of sodium dichromate in 10 ml of distilled water, the concentration was 3 mg/ml while the dose was 0.1ml/100gm B.W.
4- Experimental design: (n=30) rats were divided into equal 5 groups, each group composed of 6 animals as the following:

First and second (1st and 2nd) groups were administered daily 3and 9 mg/100gm /B.W of sodium dichromate orally for 30 days respectively.

Third and fourth groups (3rd and 4th) groups were administered daily 3and 9 mg/ 100 gm B.W of sodium dichromate orally for 60 days respectively.

While the animals of fifth group (5th group) was administered daily distilled water for 60 days and served as negative control group.

All the animals of the five groups were sacrificed post the experiment time of toxicity and get the organs involved in our study (lungs) which obtained and had preserved in 10% neutral buffered formalin for histopathology (**11**).

III. Results

The histopathological results of our study that revealed in rats of (1st group) which administered **3mg/30 days** a great thickening of inter-alveolar septa due to heavy infiltration of mononuclear cells (**Figure-1**) also in lumens of small bronchioles which mostly necrotized and contained inflammatory cells in their lumens (**Figure-2**); the latter appeared thickened lining epithelia and emphysematous alveoli which greatly distended.

The results of (2nd group) that revealed in rats of that administered **9mg/30days** showed peribroncheolitis and marked hyperplastic changes of ciliated columnar epithelia (**Figure-3)** also the alveoli showed marked emphysema (**Figure-4**&**5**).

The results of (3rd group) that revealed in rats of that administered **3mg/60days** showed severe chronic necrotic bronchiolitis with papillae hyperplastic projections of lining columnar epithelial cells and peri-aggregation of mononuclear cells (**Figure-6**). The walls of pulmonary blood vessels appeared thickened due to hypertrophy of tunica media (**Figure-7**).

The results of (4th group) that revealed in rats of that administered **9mg/60days** showed great enlargement of bronchioles due to hyperplasia of lining epithelium as papillae and peri-mononuclear cells infiltration (**Figure-8&9).**

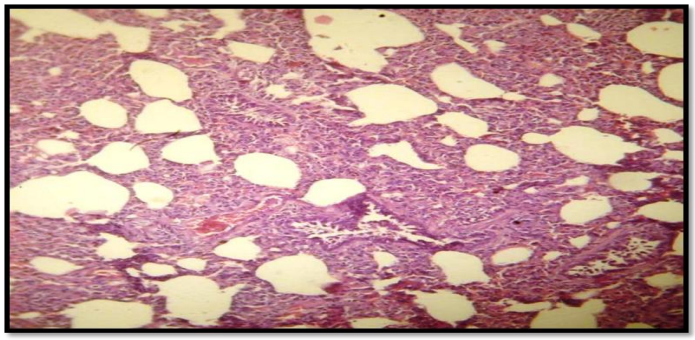

Figure-1: Microphotography in rat of (1st group) treated with Cr VI 3mg/30days orally; showed chronic interstitial pneumonia; thickened inter-alveolar septa and emphysema (H&E stain, 10X).

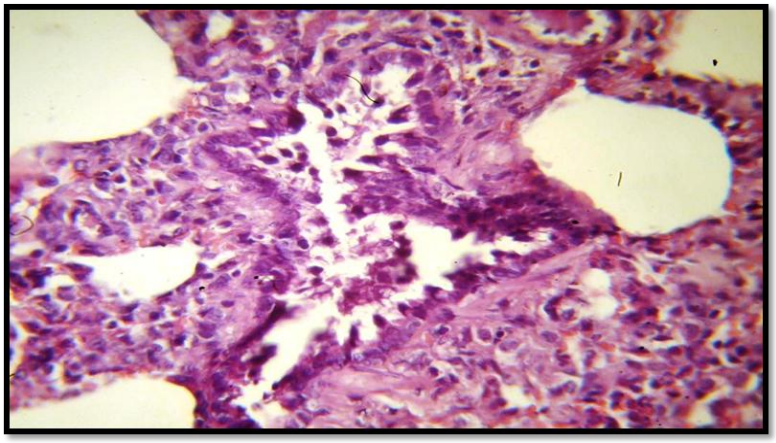

Figure-2: Microphotography in rat of (1st group) treated with Cr VI 3mg/30days orally; showed necrotic bronchiolitis, contained inflammatory cells (H&E stain, 40X).

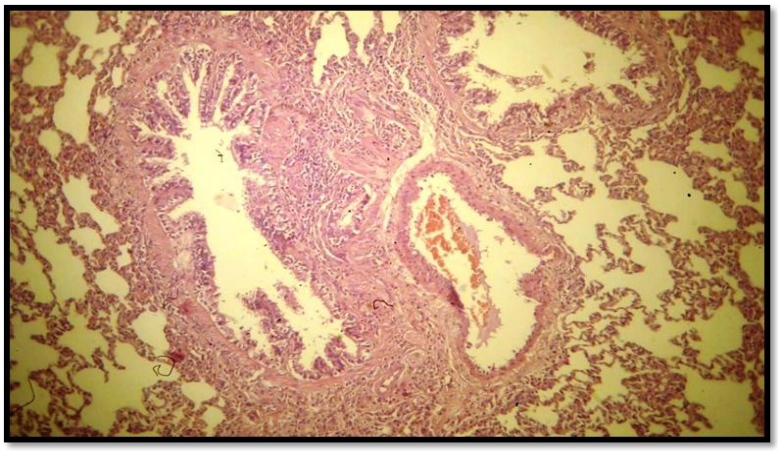

Figure-3: Microphotography in rat (2nd group) treated with Cr VI 9mg/30days orally showed; chronic peribroncheolitis, and papillae projections of hyperplastic lining epithelia, marked emphysema also,(H&E stain, 10X).

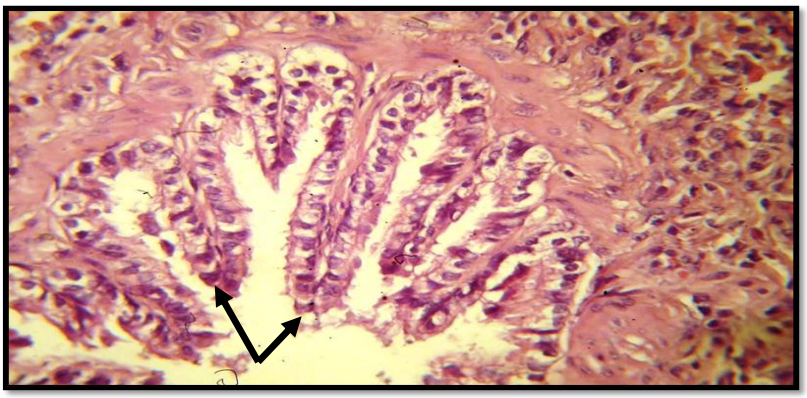

Figure-4: Microphotography in rat of (2nd group) treated with Cr VI 9mg/30days orally showed; long papillae projections of hyperplastic lining epithelia (arrow), and hypertrophy of smooth muscles surrounding,(H&E stain, 40X).

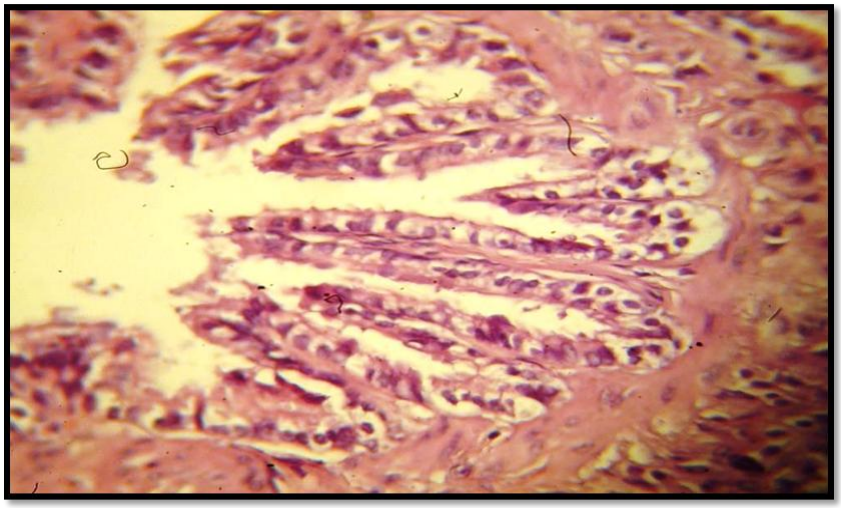

Figure-5: Microphotography in rat (2nd group) treated with Cr VI 9mg/30days orally showed; long papillae projections of hyperplastic lining epithelia and hypertrophy of smooth muscles surrounding,(H&E stain, 40X).

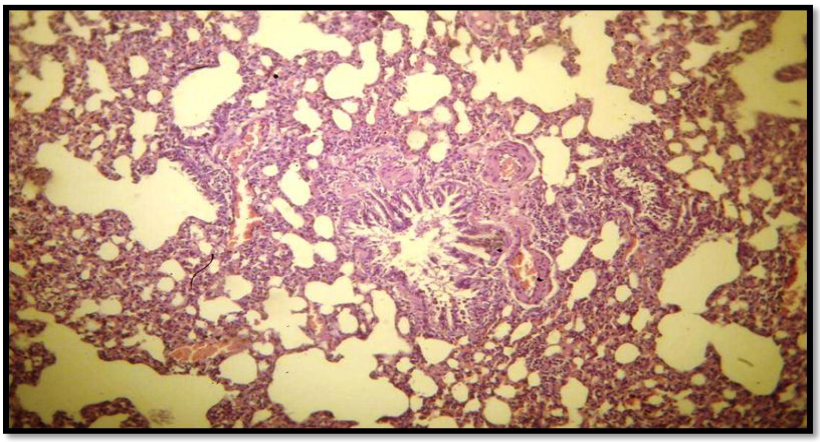

Figure-6: Microphotography in rat of (3rd group) treated with Cr VI 3mg/60days orally showed; chronic necrotic bronchitis, contained inflammatory cells and emphysema, (H&E stain, 10X).

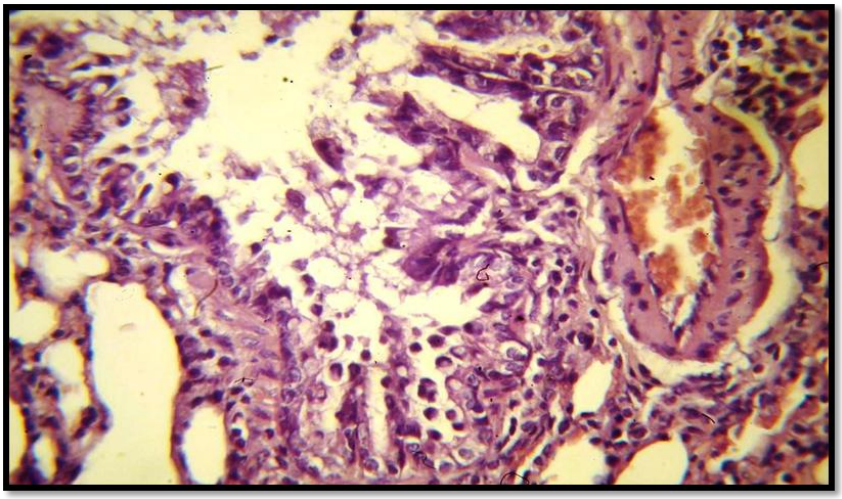

Figure-7: Microphotography in rat of (3rd group) treated with Cr VI 3mg/60days orally showed; chronic necrotic bronchitis, contained inflammatory cells necrotic debris and appearance of papillae projections of hyperplastic lining epithelia, (H&E stain, 40X).

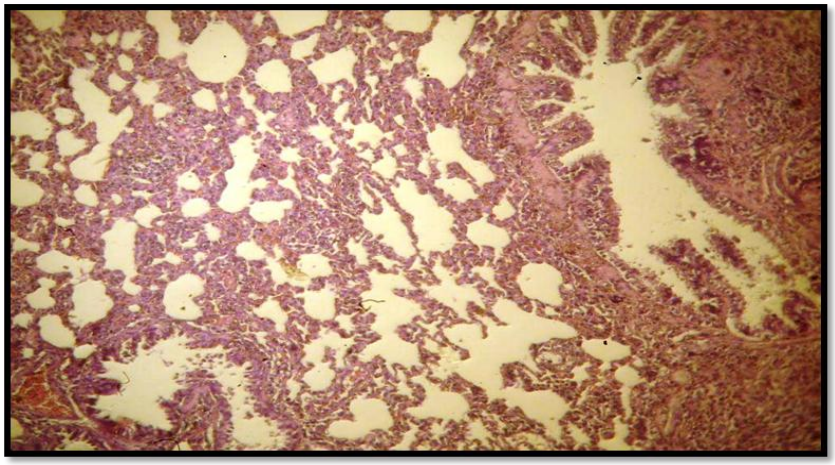

Figure-8: Microphotography in rat of (4th group) treated with Cr VI 9mg/60days orally showed; hyperplasia and necrotic bronchiolitis, thickening of inter alveolar septa and emphysema, (H&E stain, 10X).

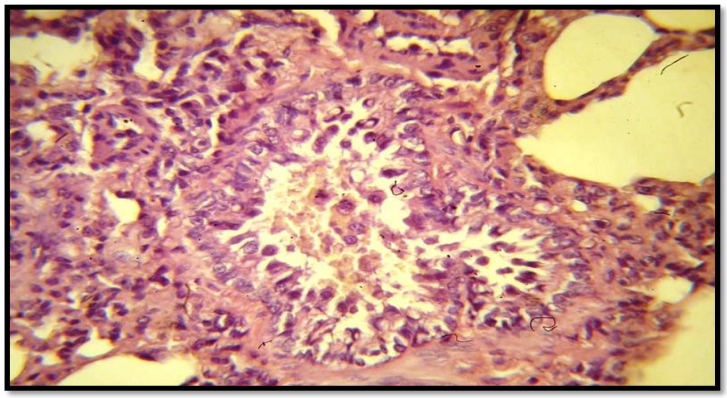

Figure-9: Microphotography in rat (4th group) treated with Cr VI 9mg/60days orally showed; severe necrotic bronchiolitis (arrow), contained pulmonary macrophages and lymphocytes (H&E stain, 40X).

IV. Discussion

The result of this research revealed the great effect of sodium dichromate on the alveolar epithelial and other structures like blood vessel walls and bronchioles that due to the irritant effect of this material Cr VI and that the same when mentioned by (**4)**. Group **(1&3 groups**) which receive 3mg/100gm b.w. of sodium dichromate Cr VI for 30 and 60 days respectively showed changes like great thickening of inter-alveolar septa due to heavy infiltration of mononuclear cells , also in lumens of small bronchioles which mostly necrotized and contained inflammatory cells in their lumens and later appeared thickened lining epithelia and emphysematous alveoli which greatly distended in the first group, while third group showed severe chronic necrotic bronchiolitis with papillae hyperplastic projections of lining columnar epithelial cells and peri-aggregation of mononuclear cells and the walls of pulmonary blood vessels appeared thickened due to hypertrophy of tunica media that changes due to the duration of the administration of sodium dichromate hexavalent chromium caused marked alveolar thickening associated with fibroblasts and myofibroblasts proliferation and collagen production in interstitial tissue leading to pulmonary fibrosis that also mentioned in the results that reported by **(12).**

The results of 2nd and 4th groups that treated with 9mg/100gm bw for 30 and 60 days respectively showed peri-broncheolitis and marked hyperplastic changes of ciliated columnar epithelia also, heavy enlargement of bronchioles due to hyperplasia of lining epithelium as papillae and peri-mononuclear cells infiltration that may agreed with results of **(13)** who reported that the exposure to Cr VI compounds for long term results in damage to the lower respiratory tract. The respiratory tract in humans is a major target of inhalation exposure to chromium compounds, also chromate sensitive workers acutely exposed to Cr VI compounds may develop asthma and other signs of respiratory distress. We concluded that the sodium dichromate Cr VI had a serious toxic effects to the lung in the experimental rats.

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