Histopathological changes of heavy metals Nickel Chloride (II) and Potassium dichromate (VI) on the Liver and Kidney of Swiss Male Mice

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Key words: heavy metals, kidney, liver, Mice, histopathology

Abstract

Heavy metals are a very harmful environmental pollutant, Nickel and chrome induced toxicity and carcinogenicity, with an emphasis on the generation and role of reactive oxygen species is reviewed. Nickel and chrome are a known as haematotoxic, immunotoxic, neurotoxic, genotoxic, reproductive toxic, pulmonary toxic, nephrotoxic, hepatotoxic and carcinogenic agent. The present study revealed the toxic effects of nickel (Ni) (II) and chrome (Cr) (VI) on the liver and kidney structure of mature male mice weighing 20-30 g, (10-13 weeks old), were treated orally with different doses (20, 40 and 60 mg/kg of $NiCl_2$ and 20, 60 and 100 mg/kg of $K_2Cr_2O_7$). Dramatic Histopathological changes found in the liver and kidney of treated animals included degeneration, nuclear pycnosis, cellular swelling,necrosis, congestion of blood vessels and many others defects .

التغيرات النسجية للمعادن الثقيلة كلوريد النيكل وثنائي كرومات البوتاسيوم على الكبد والكلية في ذكور الفئران البيض

الخلاصة

تعتبر المعادن الثقيلة من الملوثات البيئية شديدة الضرر, النيكل والكروم يعد عناصر سامة ومسرطنة وكذلك توليد الجذور الحرة. وعرفوا بإحداث تأثير سام للدم , جهاز المناعي ,الجهاز العصبي ,الوراثة ,جهاز التكاثر, جهاز التنفس, الكبد و الكلية. في الدراسة الحالية اظهرت النتائج التأثير السام على التركيب النسجي للكبد والكلية في ذكور الفئران البيض البالغة (20-30 غم) وعمر (10-13 اسبوع)حيث عوملت بواسطة الفم بجرعات مختلفة من العنصرين (20,40, 60 ملغم/كغم من عنصر كلوريد النيكل و 20,60 , 100 ملغم/كغم من عنصر وثنائي كرومات البوتاسيوم. تغيرات نسجية مثيرة وجدت في تراكيب الكبد والكلية للحيوانات المعاملة تضمنت تنكس, احتقان الاوعية الدموية, انتفاخ الخلايا , تنخر وكذلك اكتناز الانوية.

Introduction:

Heavy metal hazards on human and animal health are increased and represent global environmental problems [1]. Nickel (Ni) and chrome (Cr) are one of essential trace elements for all multicellular organisms [2]. Due to its unique physical and chemical proprieties, metallic nickel and its compounds are widely used in modern industry which it major components of the alloys employed in the plate and screw used for connecting bones in orthopedic surgery and in the manufacture of artificial organs, it has important biological function of several proteins and enzymes [3]. Ni is a ubiquitous element that occurs in rocks, soil, plants and water ,but at high concentration Ni become toxic by breaks down the immunity by affecting the T-cell system and suppresses the activity of natural killer cells in rats and mice [4]. Ni element can induce severe kidney and liver lesion by altering several marker enzymes and metabolism of ascorbate cholesterol along with histopathological alterations on the other hand, there is evidence when exposure to hexavalent chromium cause hepatotoxicity in both human and laboratory animals, as well as progressive lung cancer occur when exposure to chromium (VI) [5, 6].

Also both Ni and Cr can cause DNA strand breaks, some morphological transformations in numerous cellular systems and chromosomal aberrations [7, 8]. The salts of nickel particles can be allergens and carcinogens in man by forming the oxygenated radicals [9]. Liver and kidneys are pivotal organs of the body responsible to maintain the homeostasis as liver is center of metabolism and detoxification, while kidneys are involved in elimination of the wasteful chemicals from body and selective reabsorption [10, 11]. Histopathology is considered an ultimate tool to find out the effect of pollutants like nickel and chrome on the tissue, because it active toxicants for the normal physiology of the animal especially liver and kidney [11]. Then the aim of the study to showed the lesions in liver and kidney of male mice have been proved to be the most sensitive and reliable indicators after $NiCl_2$ and $K_2Cr_2O_7$ treatment.

Materials and Methods

Prior to the start of the experiment,49 mature male mice (10-13 weeks age) weighted 20-30g, were acclimatized to the laboratory condition for one week, under control temperature, 22±2 C^o, at (12) hours light and (12) hours dark cycles. The mice were housed in plastic cages measuring 30×12×11 cm. Mice were divided randomly to seven equal groups each comprising of 7 animals. The first group was kept as negative control; the mice were received tap water without any treatment. The animals of three test group were exposed to different sub-lethal concentration of both nickel chloride (20, 40 and 60 mg/kg) and potassium dichromate (20, 60 and 100 mg/kg) via drinking water calculated according to the weight of animals. The experiment was lasted for six weeks at the end of experiment the animals were sacrificed kidney and liver organs of the control and treated groups was removed, then for histopathological examination, they were dissected and immediately kept in 10% formalin immediately for 24 hours and then the samples were processed for routine histological evaluation by [12] for light microscopic examination. The sections were then viewed and photographed.

Result

Consecutive administrated of nickel chloride causes histopathological alteration in the studied organs. Fig (1) showed section for liver from the control animal. Fig.(2) illustrated section of liver after exposing the mice to (20mg/kg) $NiCl_2$ showing lymphocytic infiltration, dilation and elongation of central vein, degeneration of hepatocytes ,vacuolization and necrosis Fig (3) showed vacuolization of hepatic cells, necrosis and pyknotic nuclei in liver after exposing the mice to (40mg/kg) $NiCl_2$. Moreover irregulated dilated central vein has been noticed and hemorrhage is also noticed in some interstitial tissues with pyknotic nuclei when exposed to (60 mg/kg) nickel chloride Fig (4). Many defect has been sowed when exposed to 20 and 60 mg/kg of Cr (VI) such as degeneration and vacuolization of hepatocytes, pyknosis of nuclei and congestion of the central vein Fig (5,6). In fig (7) showed degeneration, vacuolization and hypertrophy of hepatic cell as well as

loss cytoplasm density when exposed to 100 mg/kg of Cr (VI). Fig (8) showed section for kidney from the control animal. On other hand necrosis in the cells, enlarged of renal tubules, shrinkage of glomerulus and enlarged lumen was showed in the tissue of kidney that treated with 20 and 40 mg/kg of $NiCl_2$ Fig (9, 10).). In fig (11) vascular clot, hemolytic changes and convoluted tubule with variable shapes and diameter showed in the kidney of mice exposed to and 60 mg/kg of $NiCl_2$. Shrinkage and disrupted of glomeruli, lymphocytic infiltration and tubular degeneration in the structure of kidney exposed to 20 and 60 mg/kg of Cr (VI) fig (12, 13). Histopathological study revealed degeneration, congestion of blood vessel and marked lymphocyte infiltration in the tissue of kidney exposed to 100 mg/kg of Cr (VI) fig (14).

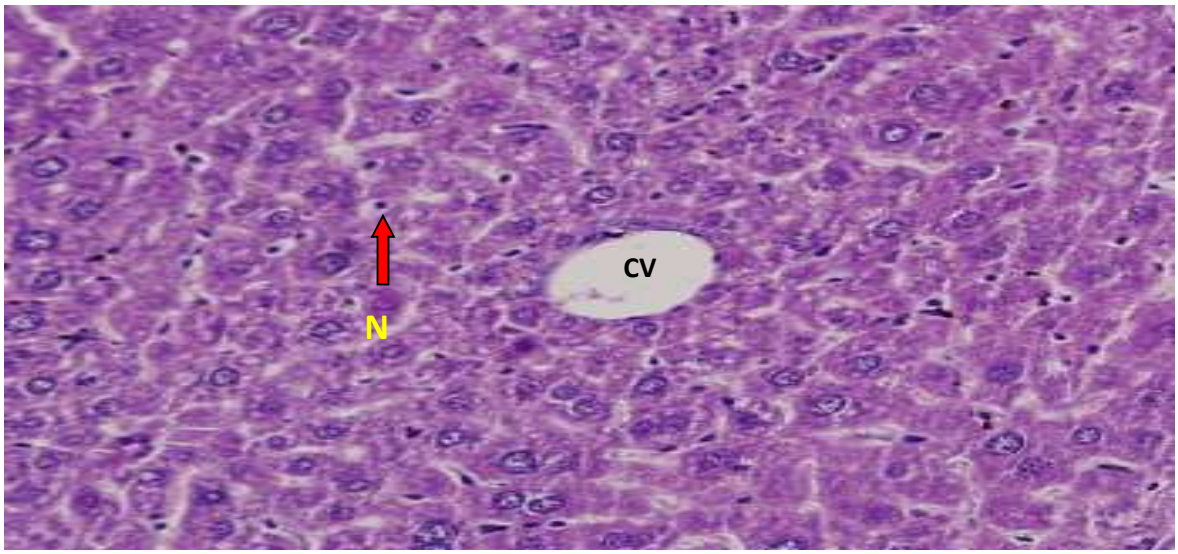

Fig.(1):Cross histopathological section of the liver from intact male mice showing the normal structure include hepatocyte → **nucleus(N)**, **central vein(CV)** (H&E.stain,X200).

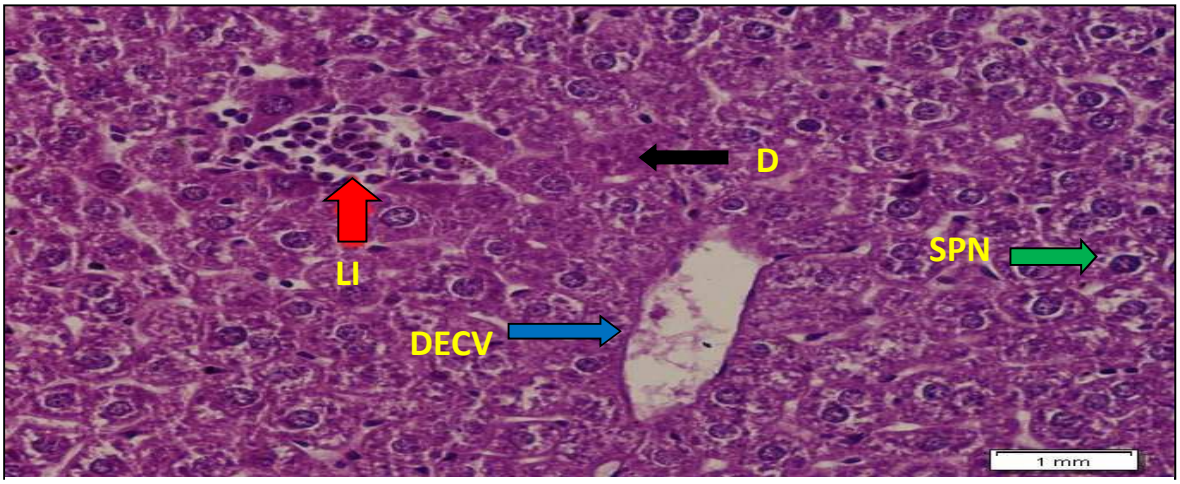

Fig.(2):Cross histopathological section of the liver of male mouse treated with 20 mg/kg $NiCl_2$ showed → **degeneration** of hepatocytes ,vacuolization and → **lymphcytic infiltration(LI)** → **dilation and elongation of central vein(DECV),** variable changes of hepatic, → **swelling and pyknotic heterochromic nuclei (SPN)** with showing necrosis (H&E. stain ,X200).

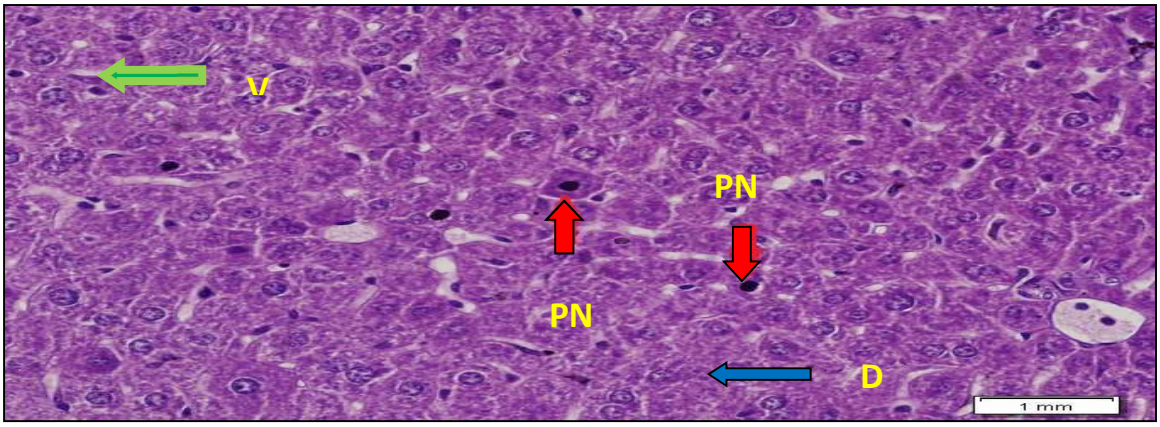

Fig.(3): Cross histopathological section of the liver of male mouse treated with 40 mg/kg $NiCl_2$ showed **degeneration (D)** of hepatocytes, **vacuolization(V)**, heterochromaic **pyknotic nuclei(PN)** showing the beginning of necrosis, (H&E stain.X400).

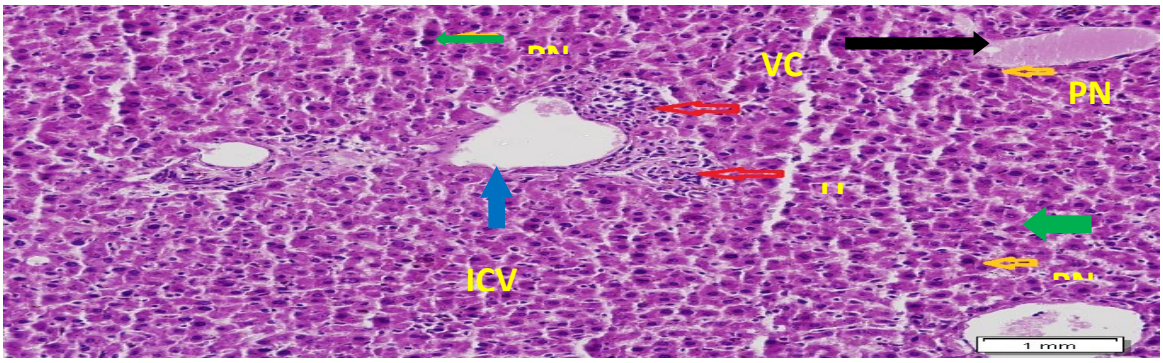

Fig.(4):Cross histopathological section of the liver of male mouse treated with 60 mg/kg of $NiCl_2$ showed degeneration of hepatocytes ,chronic **lymphocyte cell infiltration(LI)** around **irregulated dilated central vein(ICV)** and with **pyknosis uncleus(PN)** and **vascular congestion(VC)** (H&E.stain

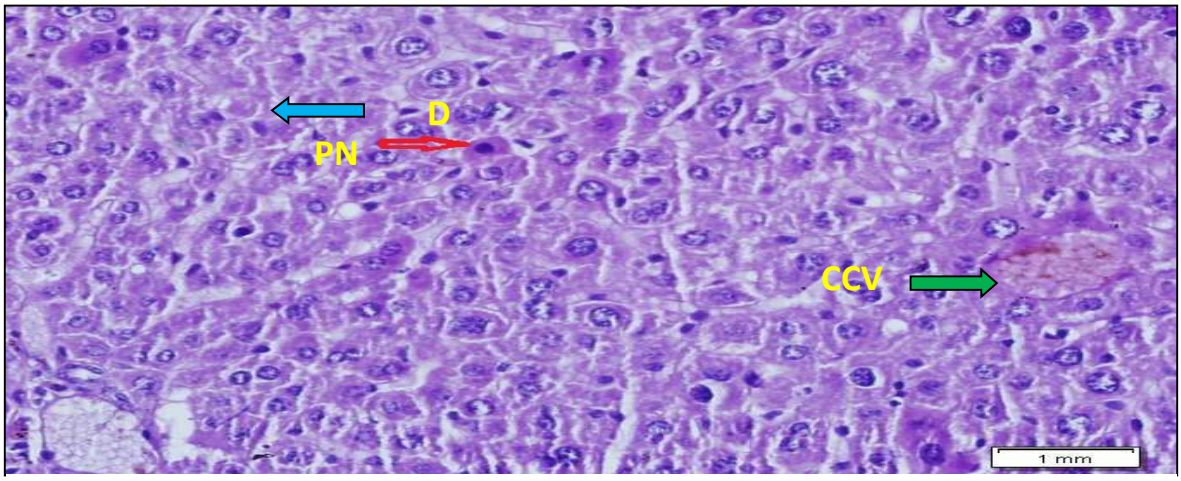

Fig. (5): Cross histopathological section of the liver of male mouse treated with 20 mg/kg of $K_2Cr_2O_7$ showed **degeneration of hepatocytes (D)**, vacuolization, **pyknosis of nuclei (PN),Vacuole in nucleus (VIN)** and **congestion central vein(CCV)** (H&E. stain, X400).

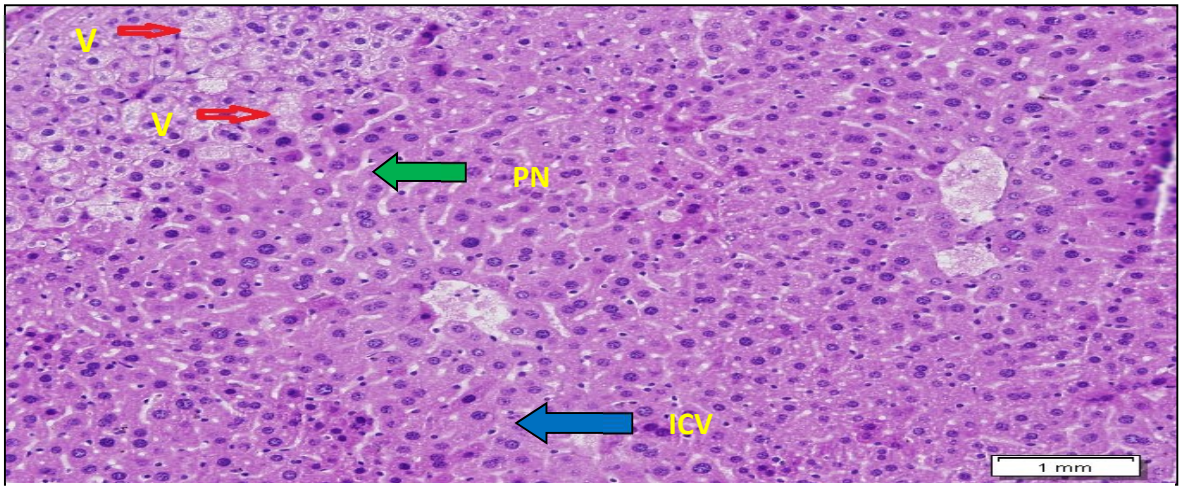

Fig.(6) :Cross histopathological section of the liver of male mouse treated with 60 mg/kg of $K_2Cr_2O_7$showed degeneration of hepatocytes , **vacuolization(V),** heterochromic **pyknotic nuclei (PN)** dilated and **irregular central vein(ICV**) ,this showing beginning of necrosis (H&E. stain,X200).

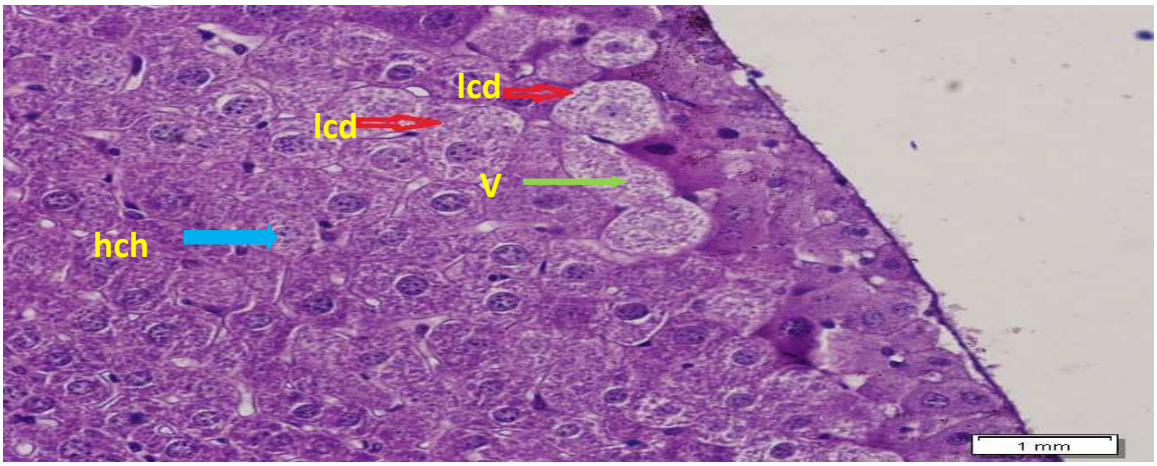

Fig. (7): Cross histpathological section of the liver of male mouse treated with 100 mg/kg of $K_2Cr_2O_7$showed degeneration of hepatocytes , **vacuolization(v)** , **hepatic cell hypertrophy (hch**)and **loss cytoplasm density(lcd)** (H&E. stain, X 200).

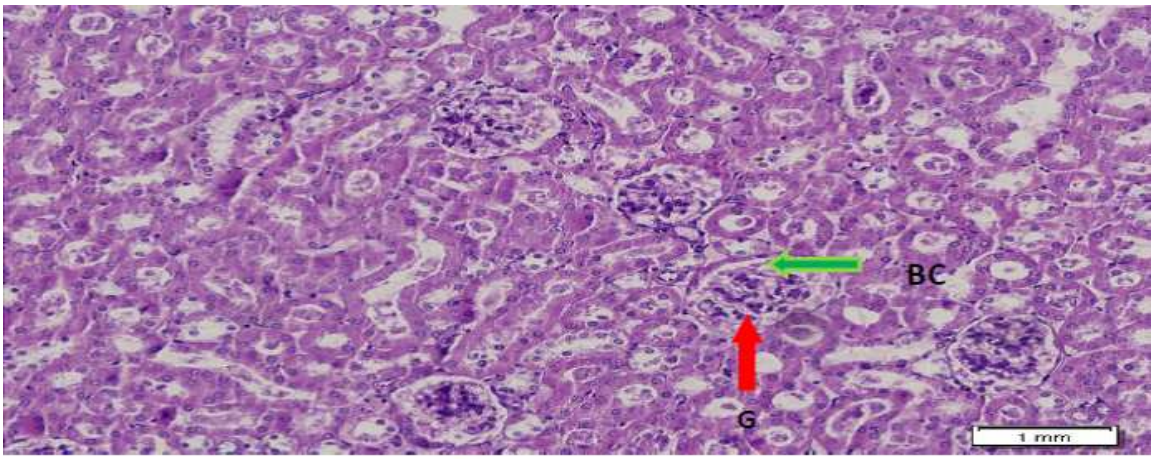

Fig.(8):Cross histological section of the kidney from intact male mice showing the normal structure include **Bowman's capsule (BC), glomeruli (G)** and **convoluted tubules (CT)** (H&E.stain,X200).

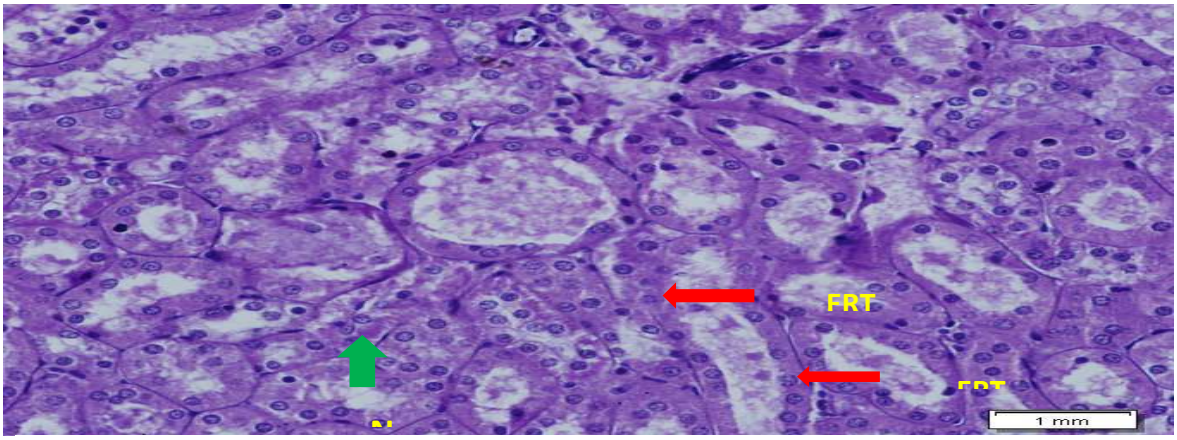

Fig.(9) Cross histopathological section of the kidney of male mouse treated with 20 mg/kg of $NiCl_2$ showed **Necrosis (N)** of cells and **enlarged of renal tubules (ERT)** (H&E. stain,X400).

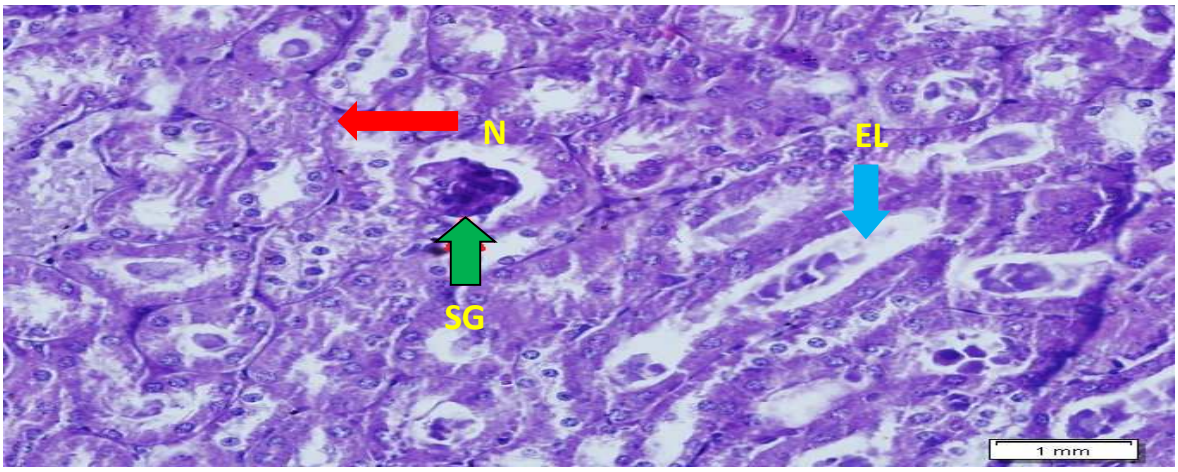

Fig.(10): Cross histopathological section of the kidney of male mouse treated with 40 mg/kg of $NiCl_2$ showed **shrinkage of glomerulus (SG)**, marked tubular **Necrosis (N)** and **enlarged lumen(EL)** with disintegration and distortion of convoluted tubule variable shapes and diameter (H&E. stain, X 200).

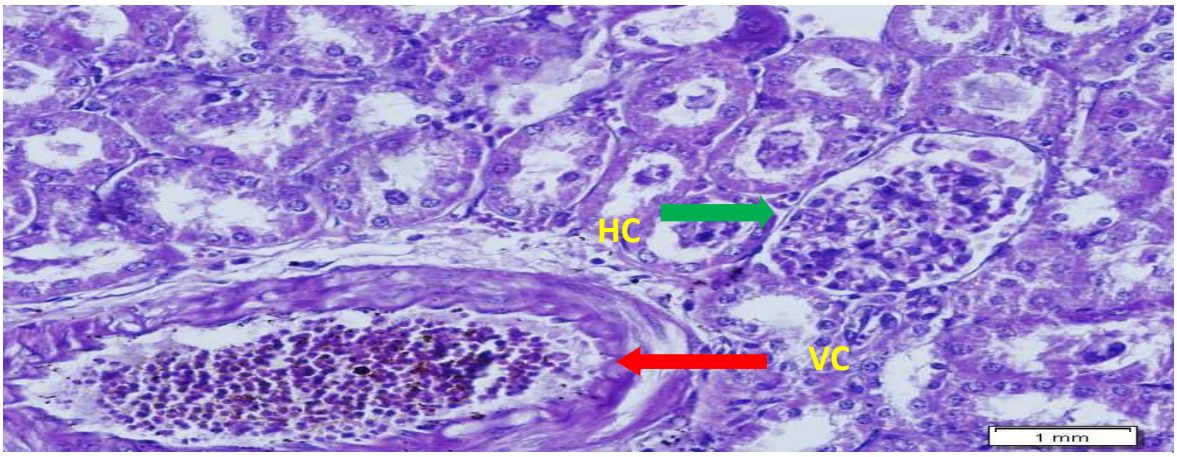

Fig.(11): Cross histopathological section of the kidney of male mouse treated with 60 mg/kg of $NiCl_2$ showed **vascular clot (VC)**, **hemolytic changes(HC)** and mild tubular disintegration and distortion of convoluted tubule with variable shapes and diameter (H&E. stain, X400).

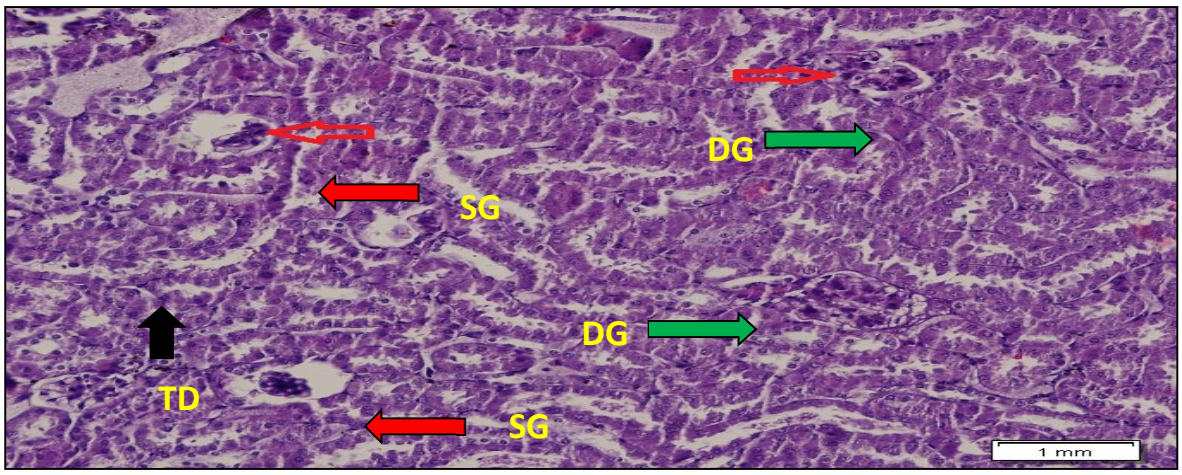

Fig.(12): Cross histopathological section of the kidney of male mouse treated with 20 mg/kg of $K_2Cr_2O_7$ showed **shrinkage of glomeruli(SG)**, **disrupted glomeruli(DG)** structure and marked **tubular degeneration(TD)** (H&E. stain, X100).

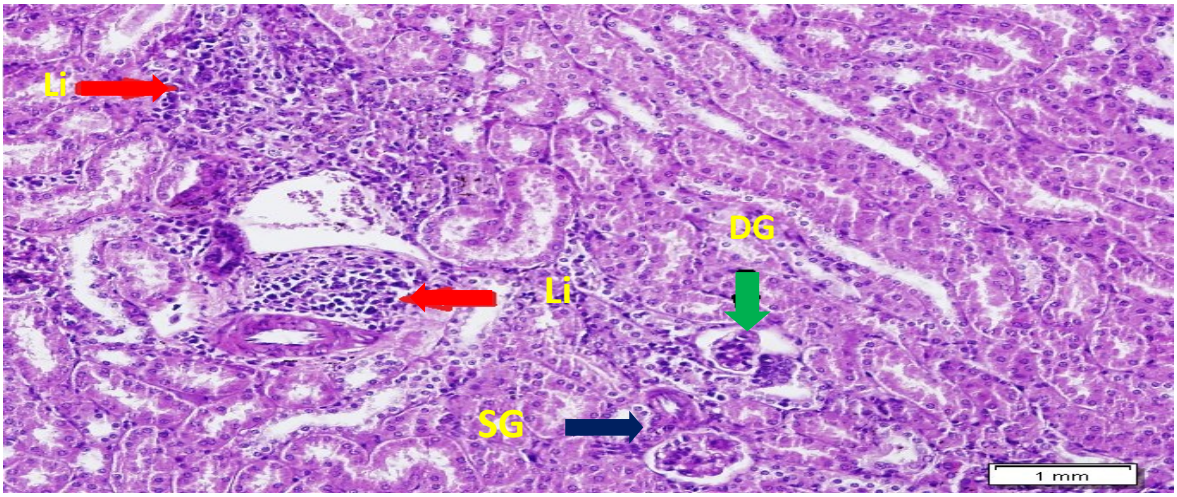

Fig.(13): histopathological section of kidney mice treated with 60mg/kg of $K_2Cr_2O_7$ showed **shrinkage of glomeruli(SG)** , **disrupted glomeruli(DG)** structure and **lymphocytic infiltration(Li)** (H&E. stain, X200).

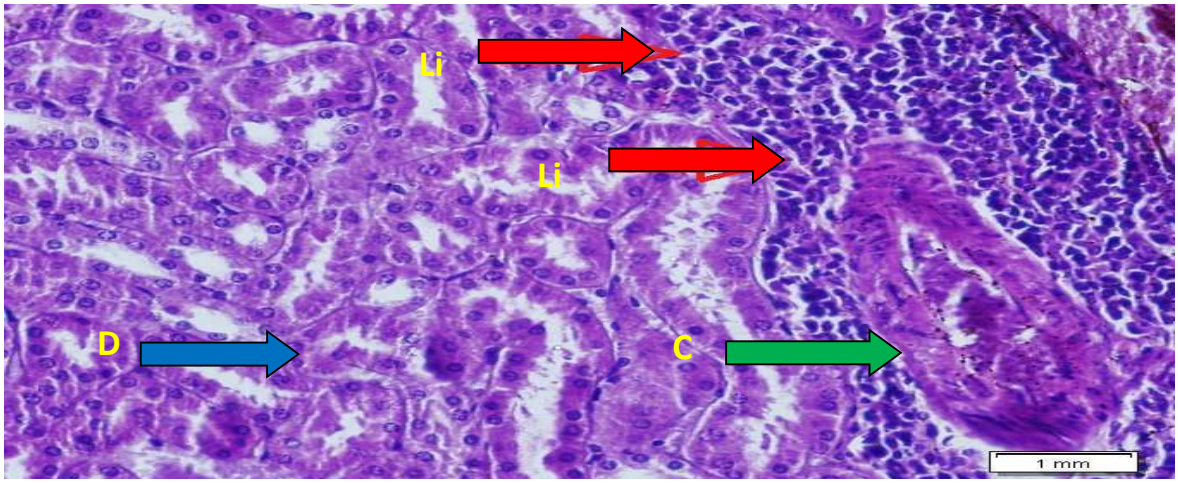

Fig.(14): Cross histopathological section of the kidney of male mouse treated with 100 mg/kg of $K_2Cr_2O_7$ showed **Degeneration(D)**, **congestion(C)**of blood vessel and marked **lymphocyte infiltration(LI)** (H&E. stain, X400).

Discussion:

The histopathological sections of liver and kidney from male mice exposed to different doses of Nickel chloride and potassium dichromate caused severe damage include: congestion, nucleus pyknosis degeneration and necrosis lesion. At present time very limited studies focus on $NiCl_2$ and its effects to induced apoptosis and oxidative stress in the different organs especially (liver, kidney and testis) for animals and humans [13]. The reasons behind these effects can be attributed to accumulations of the chemical pollutants (Ni& Cr) are known to adversely affect the histology and functioning of liver, kidneys because the heavy metals are active toxicants for the normal physiology of the animal [14]. The present study in agreement with what found by [15], who revealed that the male rats received 8mg/kg of heavy metal $K_2Cr_2O_7$ via water causes sharp histological damages in the livers, like focal necrosis, blood vessels congestion, high infiltration lymphocytic around the blood vessels, nuclei karyolysis and pyknotic and Kupffer cells proliferation, these change may be attributed to oxidation stress especially on plasma membrane or through inhibition oxidation phosphorylation process hence available energy for protein synthesis. The present results are in agreement with what finding by [16] showed highly damage in liver of mice treated with 16 mg/kg of nickel chloride via water like diffusion and hemolysis of cytoplasm, pyknotic nucleus, necrosis and degeneration of the cells. [17] demonstrated that when male rats treated with 2mg/kg of sodium dichromate mediated oxidative stress mechanism and caused a significant decline in the superoxide dismutase enzyme (SOD) activity and in glutathione (GSH) level as a signs of anti-oxidant system, while a significant elevated in the level of Malonedialdehyde (MDA) as a signs of oxidative stress and destroyed of lipid layers in the hepatic cell. As well as this result in good agreement with some previously studies like obtain by [18, 19]. Hepatocellular damage result from increased oxidative stress of rats received Nickel element. This finding in agreement with [18] who found many disorder in the liver of mice treated with different doses of $NiCl_2$ such as apoptosis, pycnotic chromatin , more diffused and hemolysis of cytoplasm, vacuoles , damage plasma membrane and nucleus fragmentation which may be due to the stress. However the present data has good agreement with what finding by [20]. they found sever damage in the histological of liver organ of mice treated with different doses of Copper Sulphate and Lead Nitrate include degeneration, nucleus karyorrhexis whereby its chromatin is distributed irregularly throughout the cytoplasm and vacuolization of cytoplasmic. [21]. Found sharp apoptosis necrosis and other types of lesion in the liver following oral injection of Cd and Zn element into the mice. This finding is in agreement with finding by [22]. who showed many pathological change in the liver of mice after treated with different doses of lead include fatty degenerative changes, necrosis of the parenchyma of hepatic

lobule and a loss of normal architecture of the hepatocytes. Similar types of histological changes have been reported by [23, 24].

Conclusion

In conclusion, based on the results observed in the present study and discussion the male mice treated with different doses of $K_2Cr_2O_7$& $NiCl_2$ causes many lesions on histological section of livers and kidneys by inducing necrosis, congestion, necrosis and degenerations to the many cells.

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