Study The Effects of Lead and Cadmium on The Kidney and Liver of Albino Rats

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Abstract

A HIGHLY harmful heavy metal known as lead (PB) affects different organs' physiology and histology. Cadmium is a toxic element affecting some organs such as renal, and bones. This study aims to observe the microscopic tissue lesions of lead and cadmium in the liver and kidney. In this study, fifteen albino rats were divided into three groups. The first group is provided with oral normal saline, the second group is given a lead solution orally for three weeks at a dose of 17 mg/kg, and the third group is given a cadmium solution orally for three weeks at a dose of 15 mg/kg. The tissue sections are put directly in 10% neutral formalin solution to fix them for 24-48 hours and then cut into small pieces 1 cm³, then carried out the process of ascending alcohols and then in xylene, waxed in the form of molds and cut the pieces with a microtome on the thickness of (4-5) μm and then dyed with the routine stain hematoxylin and eosin. The findings included that the first group shows the normal architecture of the liver and kidney. The second group showed necrosis in the peripheral area due to the toxic effect of lead with fatty changes resulting from liver damage; the kidney showed proliferation of inflammatory cells (neutrophils), and mesangial cells in addition to the presence of coagulative nephritis. The third group showed liver fibrosis and inflammatory cells while the kidney showed mononuclear cells in chronic nephritis. We can conclude that lead and cadmium have negative and pathological changes in the kidney and liver tissue; these changes include accumulation of the inflammatory cells, congestion, and necrosis, in the liver, and kidney while showing nephritis in the kidney.

Keywords: Lead, Cadmium, Rats, Histopathology, Liver, Kidney.

Introduction

Food quality and safety is a public health issue of increasing importance, and consumers need to buy safe products without any health risks. Therefore, the growing demand for food safety is associated with eating foods that contain heavy metals [1]. The heavy metals like cadmium and lead are man-made pollution. The heavy metals accumulate inside the tissues of the organisms and lead to harmful effects, as they reach the cells and tissues of the body and bind to DNA, proteins, and leading to cellular destruction [2,3]. Lead is a pollutant that could threaten life in several ways. All lead-treated rats showed inclusion bodies inside the nuclear and kidney tubular. The lead causes a kidney enzyme deficiency in rats [4]. Cadmium and lead are widespread pollutants in animals and humans. Tissue-specific changes included oxidative damage, accumulation of metals in tissues, negative changes in biochemicals, and hematological factors. Cd and Pb produce more histopathological changes in rats in humans and animals [5].

For this reason, the heavy metals have severe signs on the human and animal body, such as central nervous system, leading into mental disorders, and lung and liver damage [6]. Overcrowding of the people in small area, burning of toxic waste, the use of leaded gasoline, and industrialization, rapid growth in buildings increase the level the heavy
metals in the wastes and the surrounding environment [7]. For this previous causes, this study aims to study of microbiological changes of lead and cadmium in the liver, kidney and lung in albino rats.

**Materials and Method**

**Study design**

Albino rat classified equally into three groups, each one consisting of five rats. The first group are administrated normal saline orally, and the second group is administrated lead solution orally 17 mg/kg for (21) days, and the third group is administrated cadmium solution orally 15mg/kg for (21) days.

**The used materials**

Lead solution (1000 ppm) and cadmium solution (1000 ppm) made by BDH company, England. distal water (Iraq). Ketamine (dutchfarm, Holand) and xylazine (VMD, Belgium).

**The histological sections**

The kidney and liver samples were put directly in 10% neutral formalin solution to fix them for 24-48 hours and then cut into small pieces 1 cm³, then carried out the process of ascending alcohols and then in xylene, waxed in the form of molds and cut the pieces with a microtome on the thickness of (4-5) μm and then dyed with the routine stain hematoxylin and eosin [8].

**Results**

The first group shows the normal architecture of the liver and kidney wherever, whereas the liver tissues showed normal histological structure which consists central vein or portal area and thread-like arrangement of hepatocyte cells as shown in Fig. (1).

The first group showed normal looking of the sections of the renal tissues with renal glomeruli and renal tubules as shown in Fig. (2).

The second group (G2) shows necrosis in the peripheral area due to the toxic effect of lead with fatty changes resulting from liver damage, the renal tissues showed the proliferation of neutrophils, mesangial cells, and coagulative nephritis. G3 showed liver fibrosis, and inflammatory cells, while the renal tissues showed mononuclear cells and chronic nephritis.

**Discussion**

The first group shows the normal architecture of the liver and kidney. G2 shows necrosis in the peripheral area due to the toxic effect of lead with fatty changes resulting from liver damage, the renal tissues showed the proliferation of neutrophils, mesangial cells, and coagulative nephritis. G3 showed liver fibrosis, and inflammatory cells, while the renal tissues showed mononuclear cells and chronic nephritis.

A study showed that renal tissue shows hemorrhage and blood vessel congestion due to lead accumulation [9]. Administration of lead orally leads to histopathological effects on the renal tissues [10]. Increase in the thickness of the basement membrane due to damage with vacuoles [11].

In this study, the male rats were treated with Pb, the histological sections demonstrated changes in the liver tissue such as congestion, necrosis, central vein dilation, liver vacuolation, inflammatory cell infiltration, and hyperplasia [12].

Lead is toxic for all organs and has significant negative effects on the kidney, CNS, and liver. A significant increase in liver enzymes SGPT and SGOT was observed due to lead toxicity. The lead acetate can induce changes in the hepatic architecture compared to the control group with vacuolated granular cytoplasm and mononuclear cellular infiltration [13].

Chronic exposure to lead causes changes in the liver (sinusoids and portal triads). The changes included nuclear vesiculation, anisokaryosis, cytoplasmic inclusions, hydropic degeneration, necrosis, and glycogen reduction. Furthermore, the portal triads have chronic inflammation, hemosiderosis, hyper of the kuffer cells, and fatty change [14].

The broilers fed with CdCl2 showed abnormal tissues, irregular hepatocytes, hemorrhage, in the broiler liver, and decreased levels of some enzymes such as GSH and increased MDA levels [15].

**Conclusion**

We can conclude that lead and cadmium have negative and pathological changes in the kidney and liver tissue; these changes are included accumulation of the inflammatory cells, congestion, and necrosis, in the liver, and kidney while showing nephritis in the kidney.
Fig. 1. The liver tissues showed normal histological structure which consists central vein or portal area (red arrow) and thread-like arrangement of hepatocyte cells (blue arrow) (X40) (H & E) in (G1).

Fig. 2. Section of the kidney showing the normal-looking appearance of renal glomeruli and renal tubules (Proximal and distal convoluted tubules. (X40) (H & E) in the control group (G1).
Fig. 3. Histological changes are dead necrotic area (red arrow) with the fatty vacuoles (blue arrow). (H&E stain 40X) in the group that administrated the lead for three weeks (G2).

Fig. 4. Histological changes of the kidney are proliferation of neutrophils, mononuclear cells (lymphocyte and mesangial cells) (blue arrow), with coagulation (red arrow), (coagulative nephritis) (H&E stain 40X) in the group that administered the lead three weeks (G2).

Fig. 5. shows the histopathological appearance of the liver, liver fibrosis (Black arrow), and collection of polymorphonuclear cells especially neutrophils (yellow arrow) and a few macrophages (red arrow). These refer to chronic hepatitis. (H&E stain 40X) in the group that administrated the cadmium for three weeks (G3).
Fig. 6. Histological changes of the kidney are focal intertubular MNCs Infiltration (red arrow) and vacuoles (yellow arrow) (H&E stain 40X) in the group that administrated the cadmium three weeks (G3).

References
دراسة تأثير الرصاص والكادميوم على الكلى والكبد في الجرذان البيضاء

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المستخلص:
الرصاص هو معدن ثقيل شديد الضرر يعرف (pb) يثير على بعض الأعضاء مثل الكلى والعظام. الهدف من دراستنا هو ملاحظة آفة الأنسجة المجهرية للرصاص والكادميوم على الكبد والكلى. في هذه الدراسة، تم تقسيم خمسة عشر جرذان إلى ثلاث مجموعات. تعطى المجموعة الأولى محلول ملحي طبيعي عن طريق الفم، وتعطى المجموعة الثانية محلول الرصاص فموياً لمدة ثلاثة أسابيع بجرعة 17 ملغم/كم، وتعطى المجموعة الثالثة محلول الكادميوم فموياً لمدة ثلاثة أسابيع بجرعة 15 ملغم/كم.

توضع قطع الأنسجة مباشرة في محلول الفورمالين المتعادل 10% لتثبيتها لمدة 24-48 ساعة ثم تقطع إلى قطع صغيرة 1 سم مربع. ثم تم عملية كحولات تصاعدية ثم في الزيلين متمسكة على شكل قوالب و İşbuine تحتوي على تقطيع بميكروتوم بمسكة (4-5) ميكرومتر ومن ثم صبغها بالصبغة الروتينية الهيماتوكسيلين والأوبيوسين. وتشمل النتائج أن المجموعة الأولى أظهرت بنية طبيعية للكبد والكلى. أما المجموعة الثانية فقد أظهرت نخراً في منطقة الخلايا الالتهابية نتيجة التأثير السام للرصاص مع تغيرات دهنية ناتجة عن تلف الكبد. أظهرت الكلى نخراً في الخلايا الالتهابية (العدلات) والخلايا النخامية بالإضافة إلى وجود التهاب الكلية التخثري. المجموعة الثالثة أظهرت تلف الكبد والكلى التهابي بينما أظهرت الكلى خلايا وحيدة النواة في التهاب الكلوية المزمن. ويمكننا أن نستنتج أن الرصاص والكادميوم لهما تأثير سلبي ومرضي على الكبد والكلى، ولا يمكن أن نشتهتون التغيرات تراكم الخلايا الالتهابية والاحتقان والنخر في الكلبيات والكلى مع ظهور التهاب الكلية في الكلية.

المصطلحات: الرصاص، الكادميوم، الفئران، التشريح المرضي، الكبد، الكلى.