The effect of different doses levels of silver nanoparticles (AgNPs) on the kidney and liver in Albino male Rat. Histopathological study

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Received 26, March, 2014
Accepted 4, June, 2014

Abstract:
Objective: In this study ,the effects of silver nanoparticles (Ag NPs)were investigated on the liver and kidney tissues. Methodology: The produced nanoparticles have an average particle size of about 30 nm. Eighteen male albino rats were used by dividing them into three groups, each group comprise 6 rats. First group(control group) given food and water like other groups by liberty. Second group was tail injected by (AgNPs) at dose of (0.4 mg/kg. body weight/day). Third group was injected by (AgNPs) at dose of (0.6 mg/kg. body weight/day) for 15 days. All animals were sacrificed at the end of experiment. The liver and kidney tissues specimens were fixed in 10% formalin and histological preparations were carried out then stained with H&E. Pathological changes in liver and kidney tissues were showed. Results: Histopathological studies revealed the harmful effect of the silver nanoparticles uses on the liver and kidney rats, second group that treated with Ag NPs (0.4 mg/kg.body.weight/day), kidney sections showed enlargement of collecting tubules, increase in interstitial tissue medulla, necrosis and enlargement in proximal and distal convoluted tubules. Liver showed enlargement of the central vein and degeneration of hepatic cells. Third group that treated with Ag NPs (0.6 mg/kg. body weight/day); kidney sections showed hyperplasia of the interstitial connective tissue of renal medulla with hemorrhages, renal cortex showed, degenerative changes and necrosis of proximal and distal convoluted tubules. Liver section showed congestion and necrosis of hepatic cells. Conclusion: Silver nanoparticles cause damage in liver and kidney tissues. Recommendation: Further study is needed for the effect of Ag NPs on the other tissues.

Key words: Nanoparticles, Silver nanoparticles, Albino male rat, liver and kidney.

Introduction:
The use of nanotechnological products in human activities has been steadily increasing in recent years. Because of this, it is of vital importance to study the biological effect of various nanoparticles and nanocomposite materials, and especially their effects on animal and human organs. In this context, the number of commercial products comprising nanomaterials is increasing. Among the commercially available nano-sized materials, silver nanoparticles are by far the most used nanocompounds [1] owing to its potent antimicrobial activity [2]. Indeed, silver nanoparticles (AgNPs) have been used in commercial products such as personal care, household and medical products, as well in textiles, and food products [3], and are known for their antimicrobial properties and
have been used in bandages, socks (to prevent foot infections), and laundry detergent [4, 5, 6, 7, 8]. Nanoparticle toxicity, including human health and environmental implications, is still considered not completely elucidated and relatively unexplored [9, 10, 11]. Concerning human health, studies have demonstrated that nanoparticles have toxic effects at the cellular, subcellular and biomolecular levels, such as genes and proteins [12, 13].

Major consumer goods manufacturers have already produced products that take advantage of the antibacterial properties of Ag NPs, despite concerns about safety using AgNPs. In daily life, people may encounter nanosilver-containing room sprays, laundry detergents, water purifiers, and wall paint [14, 15, 16]. Owing to an increasing number of medical applications for Ag NPs and the increased exposure associated with the widespread use of nanosilver, the toxicological and environmental issues related to nanosilver must be addressed [17]. In humans, it is well known that long-term ingestion of silver compounds can cause irreversible skin discoloration [18]. The permissible exposure limit recommended by the National Institute for Occupational Safety and Health is 0.01 mg/m3 for all forms of silver [19]. In addition, among several metal nanoparticles, silver was found to be the most toxic to germ line stem cells [20]. The toxicity of AgNPs, however, also depends upon their surface chemistry [21].

[22] was reported that AgNPs are released into the aquatic environment during the washing process of silver-treated fabrics. Because silver is a soft white lustrous element, an important use of AgNPs is to give products a silver finish. Still, the remarkably strong antimicrobial activity is the major direction for development of nano-silver products. More than 800 consumer products that contain nanomaterials, roughly 30% are claimed to contain silver particles. An example is the addition of AgNPs to socks to kill the bacteria associated with foot odor. The revealed that the silver can easily leak into waste water during washing, thus potentially disrupting helpful bacteria used in waste-water treatment facilities, or endangering aquatic organisms in lakes and streams. In vitro studies have demonstrated that nano-silver has effects on DNA. Furthermore, nanosilver is incorporated in products such as water filters and washing machines; the presence of AgNPs in these products easily leads to a leakage into the aqueous environment and aqueous environmental species [22].

In the current study, such an approach is used to assess the potential toxic effects of Ag NPs on the kidney and liver tissues.

Materials and Methods:
Ag NPs have been obtained from school of Applied Sciences, University of Technology, Iraq. Eighteen male albino rats were used by dividing them into three groups, each group comprise 6 rats. First group(control group) was given food and water like other groups by liberty. Second group was tail injected by (AgNPs) at concentration (35µm) at dose of (0.4 mg/kg. body weight/day). Third group was injected by (AgNPs) at concentration (35µm) at dose of (0.6 mg/kg. body weight/day) for 15 days. All animals were sacrificed at the end of experiment. The average weight of animals was ranged (170-200) gm; the age of mature male rats was four months.. The environmental conditions were strictly controlled with a temperature of 23±1°C, and a 12h light/ dark cycle.

Histopathology
Kidneys and liver were collected and fixed with 10% formalin,
processed by paraffin method, cut at six micrometers in thickness by using rotary microtome and stained with Hematoxylin and Eosin (H&E) [23]. Sections were examined by histopathologist with Olympus Microscope (Japan). Photos were taken by digital camera (sony-japa 14 Migapixill).

Results:
Histopathological changes of kidney and liver are as follow: Control group: kidney sections showed normal nephritic tubules and renal cortex. The liver sections showed normal hepatic portal traid, central vein and normal hepatocytes (Figures 1, 2, 3). Second group treated with Ag NPs (0.4 mg/kg. body weight/day); kidney medulla, reveals slight enlargement in collecting tubules and increase in interstitial tissue thickness, and the cortex showed shrinkage in renal glomeruli, necrosis and enlargement in the proximal convoluted tubules and distal convoluted tubules (Figures 4, 5). Liver showed enlargement in the central vein and degeneration in the hepatic cells cytoplasm (Figure 6). Third group that treated with Ag NPs (0.6 mg/kg. body weight/day); kidney sections showed hyperplasia of the interstitial connective tissue of renal medulla with hemorrhages, renal cortex showed glomerulonephritis. Degenerative changes and necrosis in the proximal convoluted tubules and distal convoluted tubules (Figures 7, 8). Liver section showed congestion and necrosis of hepatic cells, central vein enlargement (Figure 9).
Fig. 4. Rat kidney medulla, revealed slight enlargement in collecting tubules (1) and increase in interstitial tissue thickness (2). H&E. 200X. (Second group)

Fig. 5. Rat kidney cortex, showed shrinkage in renal glomeruli (1), necrosis and enlargement in the proximal convoluted tubules (2) and distal convoluted tubules (3). H&E. 200X. (Second group)

Fig. 6 Rat liver lobule, showed enlargement in the central vein (1) and degeneration in the hepatic cells cytoplasm (2). H&E. 200X. (second group)

Fig. 7 Appear rat kidney medulla, noticed hyperplasia in the interstitial connective tissue (1) among the loops of Henle and collecting tubules with hemorrhage (2). H&E. 200X. (Third group)

Fig. 8. Rat kidney cortex showed glomerulonephritis (1). Degenerative changes and necrosis in the proximal convoluted tubules (2) and distal convoluted tubules (3). H&E.200X. (third group)

Fig. 9. Rat liver lobule, showed central vein enlargement (1). Congestion and necrosis in hepatic cells (2). H&E.200X. (third group)
Discussion:
The present study showed that nanosilver is able to induce changes in tissues of kidney and liver in Albino male rats.

Conclusion:
The silver nanoparticles have direct destructive effect on kidneys and liver. Whether nano-sized or not, there are always the problems to humans health and environment.

Reference:
Baghdad Science Journal  Vol.11(4)2014

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تأثير جرع مختلف من جزيئات دفائق الفضة على أنسجة الكلية وكبد ذكور الجرذان البيض. دراسة نسيجية ووظيفية رقيقة على سلمان

الخلاصة:

الهدف: أجريت الدراسة للتقصي عن تأثير الجزيئات الدفائق الفضية للفضة على النسيجية والكلية. المنهجية: تم استخدام ثلاث جرذان سنويين، وهما مجموعتان من الفضة. المجموعة الأولى هي مجموعتان من الفضة الدقيقة بجرعة (0.4) مليغرام/كيلوغرام من وزن الجسم يوميًا. حققت المجموعة الثالثة بالجزيئات الدقيقة الفضية وبجرعة (0.6) مليغرام/كيلوغرام من وزن الجسم يوميًا وعلى مدى خمسة عشر يوم. تم التحضير بالحيوانات في نهاية التجربة. أخذت نماذج نسيجية من الكلية والكبد، وثبتت في محلول الفوري. تم تحليل النتائج بناءً على النتائج.</p>