

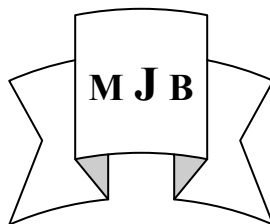
Uranium Intoxication in Relation to Biochemical Parameters (Urea, Creatinine and Total Antioxidants)

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Abstract

Introduction: Depleted uranium (DU) (as uranyl acetate) is a byproduct of the uranium enrichment process used to generate fuel for nuclear power plants. About 96% of the byproduct from the enrichment is (DU) [1], which can be used by the armed forces to increase the density of munitions to help them penetrate enemy armored vehicles and is also used as armor in some parts of military tanks [2,3].

Aim of the study: To estimate the LOEL (lowest observed effective level) dose of uranyl acetate.

Material and methods: 30 healthy young adult male albino Sprague Dawley rats were used. They were divided into 5 groups (6 animals in each group), all animals supplied with standard food during the experiment with water). Control group (1 ml/kg of normal saline i.p.), uranyl acetate treated groups (5, 10, 15, 20 mg/kg, i.p. single dose). Blood samples were collected and used to determine the serum urea, creatinine and total antioxidant status (TAS) levels.

Results: There are no significant changes in the serum urea, creatinine and total antioxidant status (TAS) levels at doses of (5, 10, 15 mg/kg) uranyl acetate treated group, while a significant changes are seen at 20 mg/kg uranyl acetate treated group.

Conclusion: These data show that the LOEL dose of uranyl acetate is 20 mg/kg.

Key words: Depleted uranium, LOEL dose of uranyl acetate, urea, creatinine, total antioxidant.

الخلاصة

المقدمة: اليورانيوم المنضب هو ناتج ثانوي لعملية تخصيب اليورانيوم (٩٦% من الناتج الثانوي) الذي يستخدم لتوليد الوقود لمحطات الطاقة النووية. يستخدم اليورانيوم المنضب للدروع و الحواجز الإشعاعية و ائقال الموازنة في السفن.

الهدف من الدراسة: لتقييم اقل جرعة لازمة لظهور التأثير السمي لخلات اليورانيوم.

الحيوانات، المواد وطرق العمل: ثلاثين ذكرا بالغاً من الجرذان البيض السويسرية استخدمت في هذه الدراسة. هذه الحيوانات قسمت بشكل عشوائي إلى خمسة مجاميع (ستة جرذان في كل مجموعة وجميع الحيوانات أعطيت غذاء طبيعي قياسي طوال التجربة): الحيوانات في مجموعة السيطرة (المجموعة الاولى) أعطيت ماء ملحي طبيعي ١ مل/كغم عن طريق البيريتون مرة واحدة ، الحيوانات في المجموعات الثانية والثالثة والرابعة والخامسة حُقنت بمادة خلات اليورانيوم جرعة واحدة (٥، ١٠، ١٥، ٢٠ ملغم/كغم على التوالي) في التجويف البطني (البيريتون). عينات الدم جمعت واستخدمت لقياس المؤشرات التالية: وهي يوريا الدم وكرياتينين المصل وفحص مضادات الاكسدة الكلي في المصل.

النتائج: لم يحدث تغيير ملحوظ في مستوى كل من اليوريا و الكرياتينين و مجموع مضادات الاكسدة في المصل لدى الحيوانات في المجموعات الثانية والثالثة والرابعة في حين بدا التغير الملحوظ في المجموعة الخامسة (جرعة ٢٠ ملغم/كغم) مقارنة مع مجموعة السيطرة.

الإستنتاج: هذه البيانات تبين إن أقل جرعة لازمة لظهور تأثير خلات اليورانيوم هي ٢٠ ملغ/كغم.

Introduction

Depleted uranium is so named because it has been partially depleted of radioisotopes, the abundance of both U^{235} and U^{234} is lower than natural (it may also contain U^{236}). The chemical properties of DU are the same as those of the enriched and natural forms [2].

Depleted uranium does not consist of pure uranium. At least three processes can introduce contaminants: in growth of radioactive progeny nuclides due to series decay of ^{238}U , the presence of fission products from reprocessed reactor fuel, and the presence of transuranic elements from reprocessed reactor fuel. The presence of radionuclides from all those sources is noted in environmental-monitoring reports from uranium enrichment facilities [4].

Depleted uranium has peaceful applications, such as counterweights in aircraft, missiles and racing sailboat keels and as a material used in hospitals for shielding X-rays or gamma radiation from equipment used for radiation therapy in addition to its in inertial guidance devices and gyro compasses [5; 6].

Materials and Methods

Animals:

A total of 30 adult male albino Sprague Dawley rats aged 7 - 9 weeks with weight of (100 – 110 g), were obtained from the animal house of the College of Medicine / Kufa University. The animals were apparently healthy and they were caged in the Animal House of the College of Medicine / Babylon University, under controlled temperature

$25 \pm 2^{\circ}C$ and normal diurnal rhythm in cages (2 rats /cage). They were fed a standard commercial pellets and allowed free access to tap water.

Study design:

After 3 weeks acclimatization period, the animals in this pilot study were randomly divided into 5 groups (each with 6 rats, randomly taken) among which is a control group that received saline only (1ml/kg, bw, ip). The other four treated groups received uranyl acetate in a single doses of (5, 10, 15, 20 mg/kg, bw, ip) and were killed after 24hr from dosing.

Materials:

Uranyl acetate powder (purity 99%) (Fluka, Switzerland). After 24hr from dosing, rats in all groups were anesthetized by diethylether. Blood samples were collected (3-5 ml from each rat) by an intra-cardiac punctures then centrifuged at 3000 rpm for 15 minutes to separate the serum. Sera were then transferred into suitable plane tubes and preserved at $-20^{\circ}C$. The sera were used for the estimation of urea, creatinine, and total antioxidant.

Statistical analysis of data:

All data were expressed as mean $\pm$ S.D, statistical analysis have been done by using LSD and ANOVA by using computer program SPSS Version 19. $p < 0.05$ were considered significant for all data.

Results

Effect of different treatments on creatinine level in serum

Figure (1) summarizes the effect of different treatment of uranyl acetate on creatinine level in sera of treated groups (5, 10, 15 mg/kg) and untreated group

(control). There are no significant changes in the sera creatinine level at the doses of (5, 10, 15 mg/kg) uranyl acetate treated groups when compared with that of control group. However, there is a

significant increase ($p < 0.05$) in serum creatinine level at the dose of (20 mg/kg) uranyl acetate treated group when compared with that of the control group.

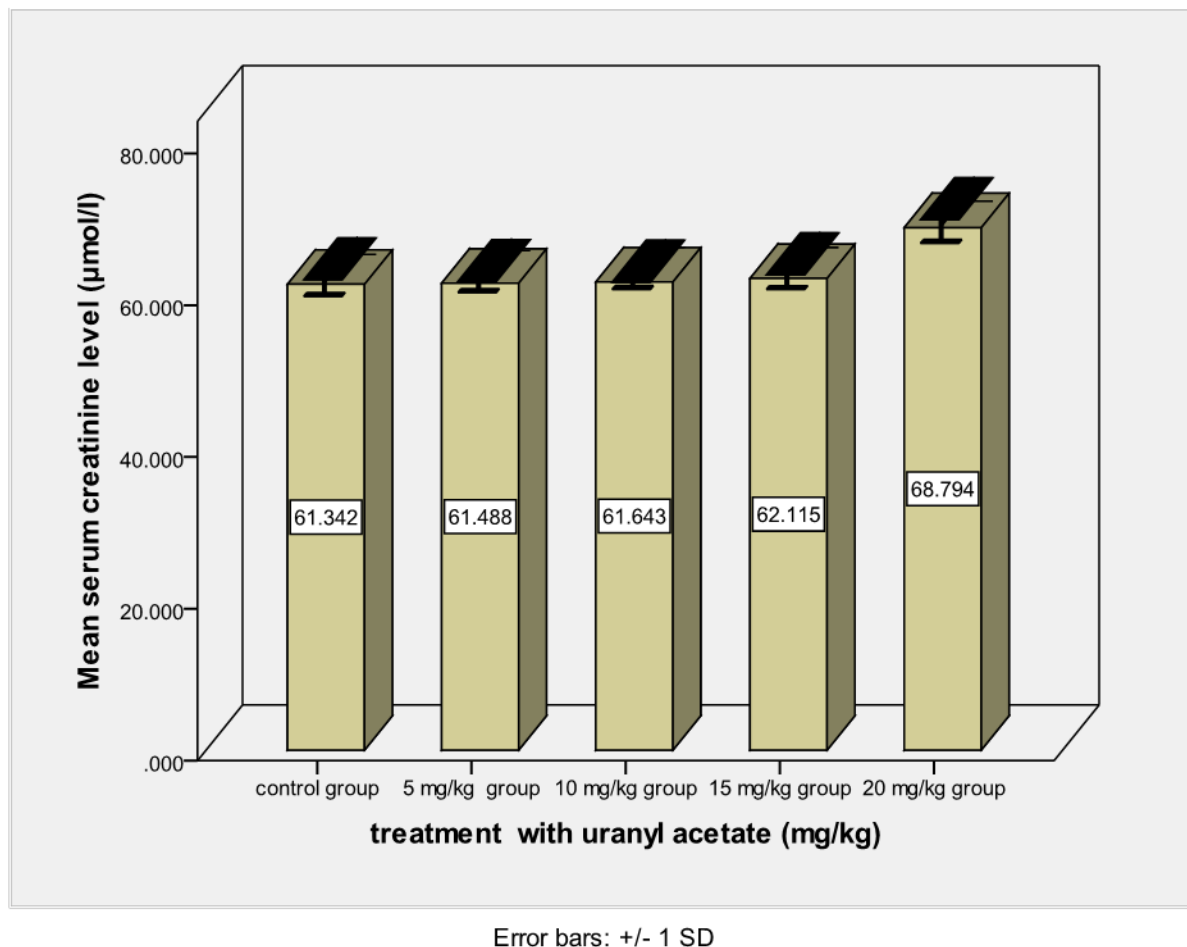


Figure 1 The effect of different treatment of uranyl acetate on creatinine level in serum of rats.

Effect of different treatments on urea level in serum

Figure (2) summarizes the effect of different treatment of uranyl acetate on urea level in sera of treated groups (5, 10, 15 mg/kg) and untreated group (control). There are no significant changes ($p > 0.05$) in the sera urea level

at the doses of (5, 10, 15 mg/kg) uranyl acetate treated groups when compared with that of the control group. However, there is a significant increase ($p < 0.05$) in serum urea level at the dose of (20 mg/kg) uranyl acetate treated group mean value is when compared with that of the control group.

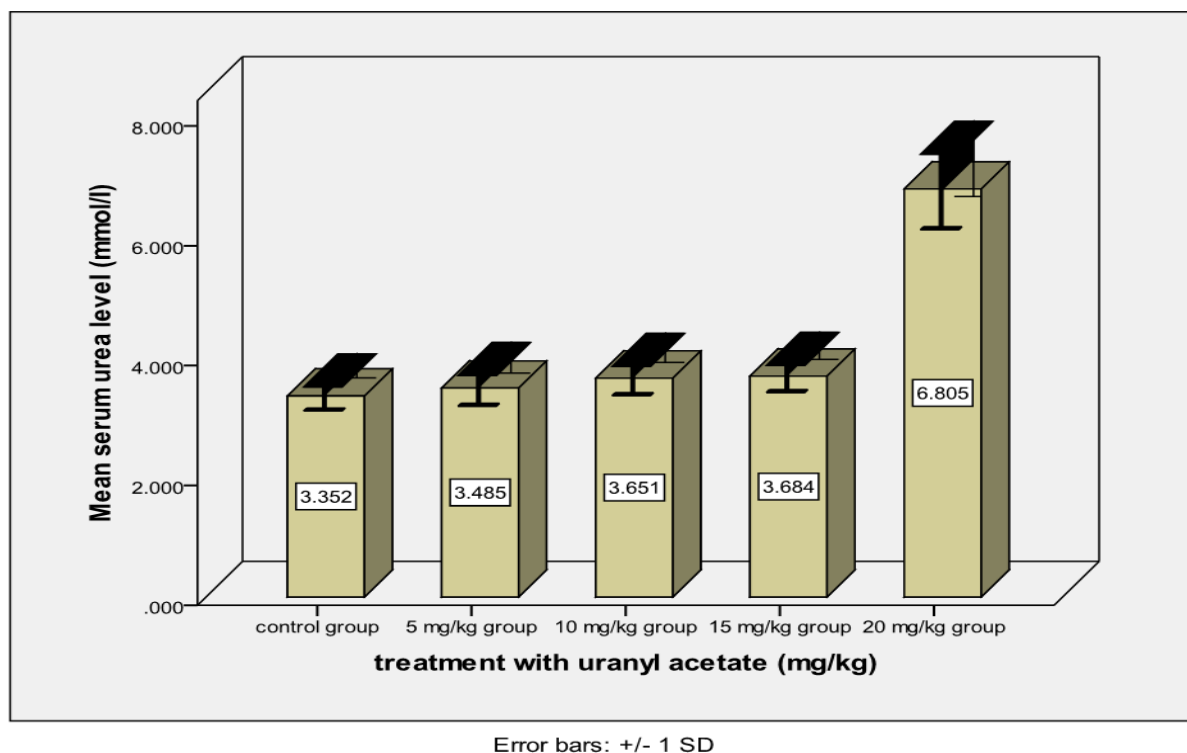


Figure 2 The effect of different treatment of uranyl acetate on urea level in serum of rats.

Effect of different treatments on total antioxidant level in serum

Figure (3) summarizes the effect of different treatments of uranyl acetate on total antioxidant level in sera of treated groups (5, 10, 15 mg/kg) and untreated group (control). There are no significant changes ($p > 0.05$) in the sera total antioxidant level at the doses of (5, 10,

15 mg/kg) uranyl acetate treated groups when compared with that of the control group. However, there is a significant decrease ($p < 0.05$) in serum total antioxidant level at the dose of (20 mg/kg) uranyl acetate treated group when compared with that of the control group.

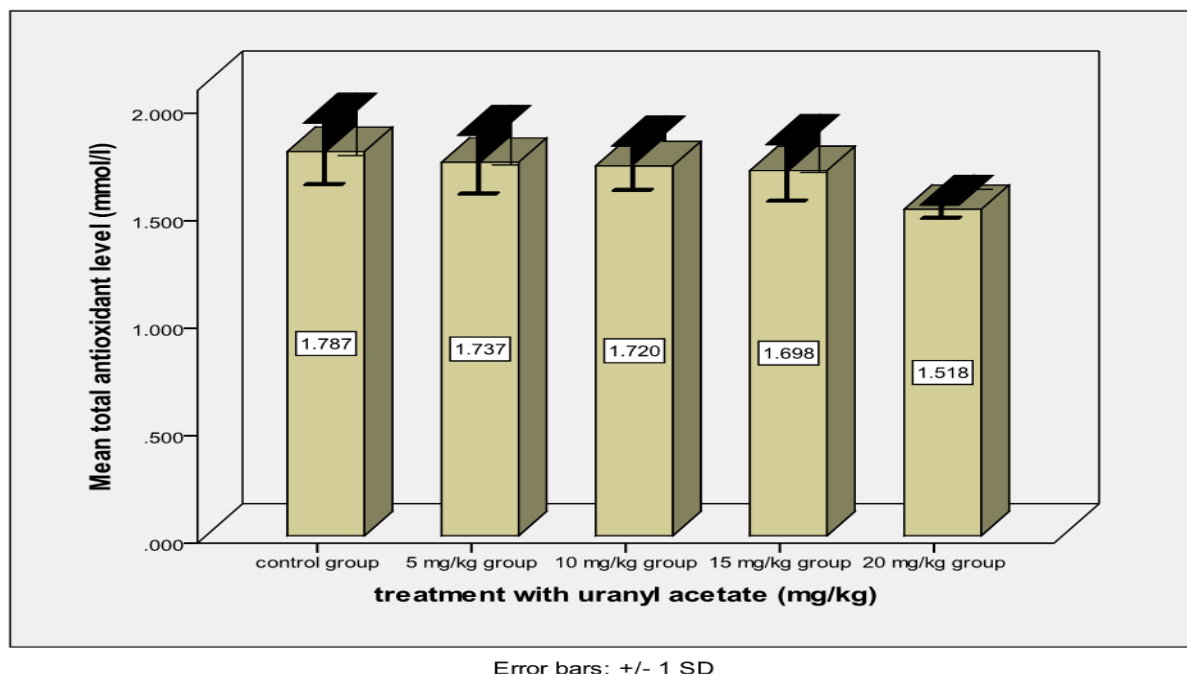


Figure 3 The effect of different treatment of uranyl acetate on total antioxidant level in serum of rats.

Discussion

The most sensitive target of uranium toxicity to mammals, and perhaps humans, is the kidney. Acute, high-level exposure to uranium compounds can clearly cause nephrotoxicity in humans [7].

A mechanism involving bicarbonate activity in the kidneys has been proposed for uranium-induced renal toxicity. Uranium is usually combined with either bicarbonate or a plasma protein in the blood. In the kidneys, uranium is released from bicarbonate and it is free to combine to form complexes with phosphate ligands and proteins in the tubular wall to cause damage. Uranium is not tightly bound and is released again within a few days (2). Within a week following exposure, uranium is largely cleared from the kidneys, and the tubules begin to regenerate [8]. Although the regenerated epithelium has histological differences from its normal state, it is

often difficult to detect histological signs of kidney damage a month after exposure because all remaining functional damage is subtle. An alternative mechanism through which uranium exerts its renal toxicity has suggested that uranium compounds inhibit mitochondrial oxidative phosphorylation and sodium-dependent and sodium independent adenosine triphosphate (ATP) use in renal proximal tubules [9]. Perhaps both of these activities combine to cause renal damage.

This is the first pilot study to estimate LOEL of UA by ip. route. It shows that there is no detectable toxic effect in the acute administration of uranyl acetate at doses of (5, 10, 15 mg/kg, ip) relevant to the studied parameters. The detectable toxic effect was seen at dose of UA (ip) (20 mg/kg, ip) and this is relevant to elevations in the levels of serum creatinine, urea and decrement in the

serum levels of total antioxidant as compared with control.

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