Original Article

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Blood toxicity of silver nanoparticles in Pregnant Wistar Rats

Farahnaz Ataei[1,*]

1. Department of Biologoy, Falavarjan Branch, Islamic Azad University, Isfahan, Iran.

*Corresponding author: Farahnaz Ataei, Department of Biologoy, Falavarjan Branch, Islamic Azad University, Isfahan, Iran. E-mail: f.ataei@rocketmail.com.

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Abstract

Background: Investigation of toxicity of silver nanoparticle, especxially blood toxicity, is necessary because this nanoparticle is used a lot in diffrerent parts of life and invironment. The aime of this is evaluation the effects of silver nanoparticles with different concentrations on blood cells pregnant Wistar rats.

Materials and Methods: In this case control study, 30 pregnant rat were divided into 5 experimental groups (three treatment groups, one control group, and one injection control group). Treatment and Control groups received different concentration of silver nanoparticle (250, 500, and 1000 ppm) and normal food and water conditions during the experiment, respectivelly for 18 days. After this rime, rats were investigated in terms of blood cells.

Results: The results showed that being treated with silver nanoparticles led to significant reduction of RBCs at the concentrations of 500 and 1000 ppm ($p < 0.05$). In 250 ppm, silver nanoparticles showed no significant reduction. WBCs had significant changes in 1000 ppm concentrations compared to control group. In lower concentration, the amount of WBCs was incresed. This data showed that silver nanoparticles can active the immune system as alergic agents.

Conclusion: Based on results, silver nanoparticles revealed toxic effects on blood cells in high concentration (1000 ppm). So, these nanoparticles must be used with more caution.

Keywords: RBCs, WBCs, Blood Toxicity, Silver Nanoparticles.

Introduction

Different nanostructures are used in various fields such as agricultural, pharmaceutical, medical, industrial, etc (1, 2). These nanostructures are especially used in humn life such as production of cosmetics and sunscreens, sporting goods, and clothing and personal care (3-6). Beside of useful properties of nanostructures, the investigation of nanoparticles' characteristics as well diagnostic tools of actual toxicity in nanoparticles is needed due to anticipated growth in nanotechnology, increase of public exposure to nanoparticles, and the intentional and unintentional contact with them (7). Diffrenet studies have showed that nanostructures especially nanoparticles, nanorods, nanotubes and etc cause hemolysis and blood clotting (8). The uptake of nanostructues by each type of blood cells is different. Nanoparticle uptake by red blood cells and platelets is related to size and nanoparticle charge respectively (9). Translocation of nanoparticles into the circulatory system was correlated with the appearance of blood clots. Silver nanoparticle as a kind of nanostructure is used frequently (10, 11). The aim of this study is investigation of blood toxicity of silver nanoparticles in pregnant wistar rats.

Materials and Method

In this case control study, 30 pregnant wistar rats and nanosilver solution with a mean diameter of 10 nm, and at concentration of 1000 ppm was purchased from Razi and Sigma Company, respectivelly. Thirty pregnant Wistar rats were randomly divided into 5 groups

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including two groups as control and injection control groups and three groups as treatment groups (Treatment group 1 received 5.0 ml of silver nanoparticles with the concentration of 250 ppm, treatment group 2 received 5.0 ml of silver nanoparticles with the concentration of 500 ppm, and treatment group 3 received 5.0 ml of silver nanoparticles with the concentration of 1000 ppm). Since the formation of vaginal plug (G0), pregnant female rats were maintained in vitro for 7 days and from the seventh day of pregnancy until the eighteenth day of pregnancy were injected every other day with silver nanoparticles. On the 18th day of pregnancy, rats were analyzed in terms of blood cells.

Data Analysis

The results obtained in this study were analyzed using SPSS software (version 20). To compare the mean of blood cells in all groups, one-way ANOVA and Tukey tests were used. All the results were reported as mean ± SD (Mean ± Standard Deviation). The p <0. 05 were considered significant.

Results

Change in RBCs

According to aquired data, the amount of RBCs was reduced in all groups that were treated with silver nanoparticles (Figure 1). With increasing concentrations of nanoparticles, the RBC is reduced. The comparison of data betwwen control group and other groups showed that the reduction in the RBCs amount is significant in groups treated with nanosilver at the concentrations more than 500 ppm ($p < 0.05$).

Change in WBCs

Investigating the amount of WBCs revealed that among the three groups treated with nanosilver, concentrations of 250 and 500 ppm led to increase of WBCs and concentrations of 1000 ppm led to decrease of WBCs. So the effect of nanosilver on this blood cell was irregular. The nanostructure can induce immune response by increase of WBCs (Figure 2). The significant changes were seen in concentration more than 500ppm.

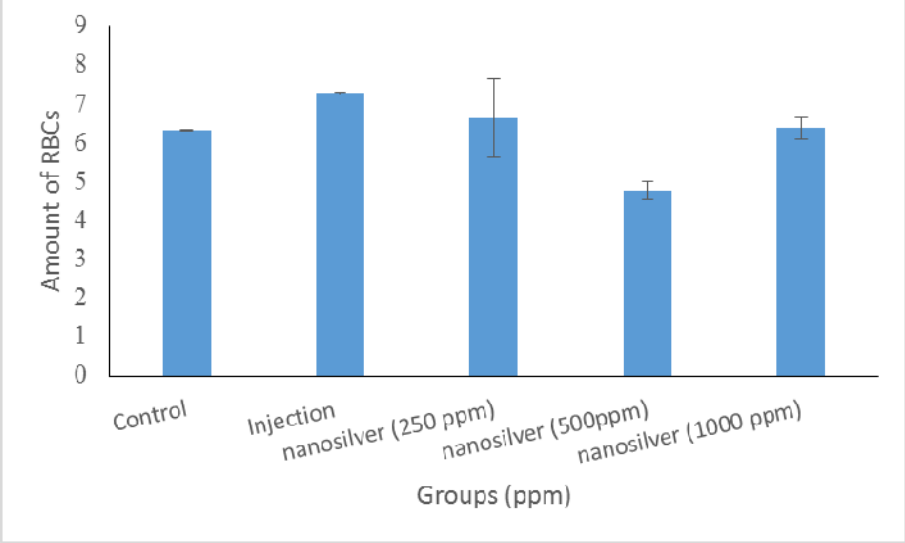

Figure 1. The effect of different concentration of nanosilver on RBCs

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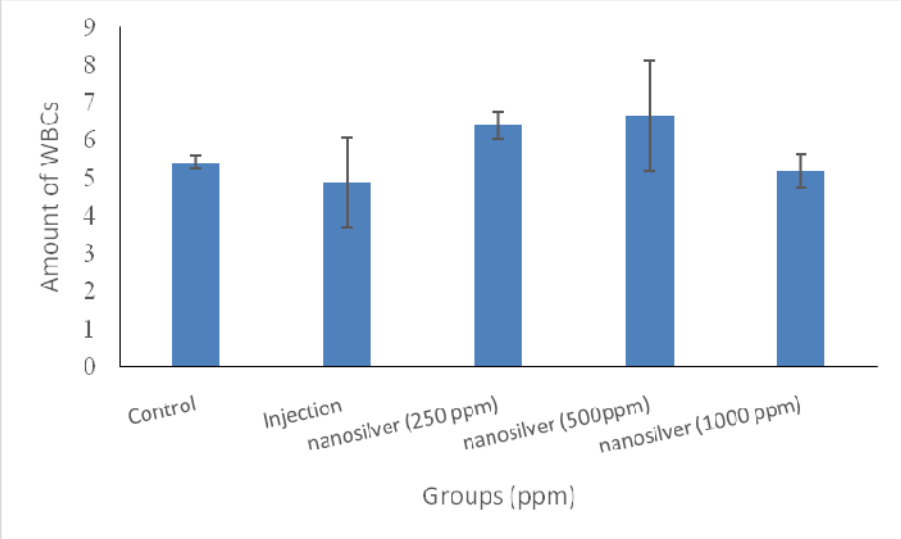

Figure 2. The effect of different concentration of nanosilver on WBCs

Discussion

In this study, the effect of silver nanoparticles concentrations on blood cells was explored in in pregnant Wistar rates. In all groups, the reduction of RBCs were observed.The observed reduction in RBCs after being treated with 500 ppm of silver nanoparticles was statistically significant compared to control group ($p < 0.05$). This dtat showed that these nanoparticles can lead to hemolysis. The results showed that the RBC have well tolerated the different concentrations of the nanostructures less than 500 ppm. However, comparison with control group, silver nanoparticles had a hemolytic rate in concentration more than 500 ppm. A similar study showed that Ag nanoparticle has blood toxicity in high concentrations (7). They mentioned that the interaction of silver nanoparticles with blood tissues, especailly with membrane lead to ditruction of membrane and thus blood toxicity. So, according to other studies, the nanostructures have toxicity on blood cells. The toxicity of different nanostructures was proven by different researcher groups (12, 13). The toxicity of Ag nanoparticles has been shown on different cells in many publications such as human lung cells, human macrophages, and human mesenchymal stem cells and so forth (14-16). Previous studies illustrated that the high concentration of Ag nanoparticles has toxicity on blood mononuclear cells (17). Ag nanoparticle is one of the nanostructures used in different parts of life (18, 19). Thus, according to other studies as well as this study suggested that the high concentration of silver nanoparticles mus be used with more caution.

Conclusion

This study revealed silver nanoparticles can change the amount of RBCs and WBCs in concentration of 1000 ppm and lead to avctivation of immune system as well as hemolysis in pregnanat wistar rats.

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