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The effects of TiO_2 nanoparticles on white blood cells in mice

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ABSTRACT

By developing nanotechnology, researches about its destructive effects on organisms become important more and more. Titanium dioxide is used in production of various paints, cosmetics and so on. In this study, the effects of titanium dioxide nanoparticles on white blood cells of laboratory mice were investigated. Forty mature Syrian mice from Wistarrace were selected, and divided in four groups: placebo group, control group and two groups of 10 and 100 ppm doses of nanoparticles. Titanium dioxide nanoparticles were solved in water (20 nm) and mice were fed orally for 14 days. After this period blood samples were taken and white blood cells were counted. Titanium dioxide nanoparticles increased white blood cells and lymphocytes significantly whereas neutrophils were decreased severely. According to results, white blood cells were affected by nanoparticles. Therefore, titanium dioxide can affect also defense potential of blood.

Keyword: nanoparticle, titanium dioxide, blood cells,mice

INTRODUCTION

Lymphocytes are the base of body's adaptive immune system. These cells are originated from lymphoid progenitor cells. Lymphoid cell lines are formed mainly from T cells and B cells. myelocytes Which are granulocytes, megakaryocytes and macrophages are originated from myeloid progenitor cells and play roles such as innate immunity, adaptive immunity and blood coagulation[1].

By converting micro particles to nanoparticles, some of physical properties will be changed including: increase in surface to volume ratio and reach to quantum effects territory [2] increase in surface to volume ratio causes superiority of external atoms behavior to internal atoms behavior.Thisphenomenon affects chemical properties [2, 3]. Once the particles are small enough, they will show new quantum mechanical behavior and properties [4]. There is many evidences about potential dangers of titanium dioxide for human health and environment because of its unique physicochemical properties such as small size, increase in surface per mass, chemical composition, surface structure, form and accumulation, and high reactivity.

This material enters the body via various ways including inhalation, swallowing and injection, and affects cell components (such as proteins), fat balances and cell performance and cause cell toxicity. Cytotoxic effects of TiO_2 are depending on its physicochemical properties especially the size. Smaller particles cause more damage than bigger ones [4].

Titanium dioxide nanoparticles can be used in pain production, cosmetics, ceramic production, photocalysts production, water and sewage and many other industries [5] because of its unique properties. According to

numerous applications of TiO_2 nanoparticles in recent years, this research was carried out to study the effects of titanium dioxide nanoparticles on white blood cells in mice.

MATERIALS AND METHODS

Forty male mature Syrian mice (Wistarrace) from the age of two weeks and the weight of30± 3 gr were divided into four groups: control group, placebo group, and 10 ppm and 100 ppm doses of nanoparticles per body weight.
Animals were kept in propylene cages which their floors were covered by sawdust under controlled condition (20-25℃ temperature, 25-30% relative humidity, 12 hours darkness and 12 hours light, with free access to water and food).

Mice were kept for seven days before enforcing treatments to adapt to environment. Experimental groups received 10 ppm and 100 ppm doses of nanoparticles orally via gavage. To prepare desire doses, nanoparticles with the size of 20nanometer were prepared from Iranian nanomaterial Pioneers Company and were solved in ordinary water for 15 minutes using ultrasonic machine.

After the end of the period, chemicals were anesthetized using ether and blood samples were taken from the heart using 5 cc syringes. Ethics of international pain society for laboratory animals were considered. White blood cells amount and numbers were measured.

Obtained data were analyzed using one way ANOVA at 5% probability level, and using SPSS13 program.

RESULTS AND DISCUSSION

The number of white blood cells was increased significantly ($P<0.05$) in experimental groups in proportion to control group (Figure 1).

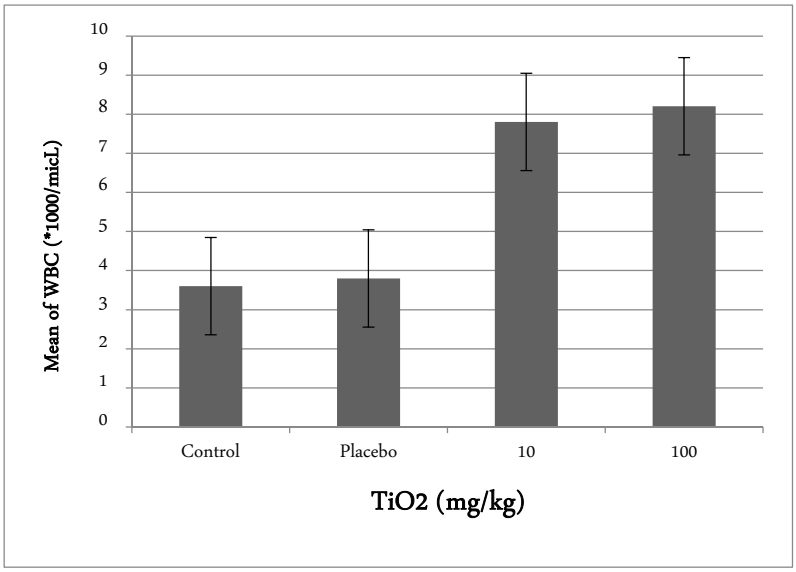

Figure1. Mean comparison of white blood cells in all treatment groups

The percentage of lymphocytes were increased significantly ($P<0.05$) in experimental groups in proportion to control group (Figure2).

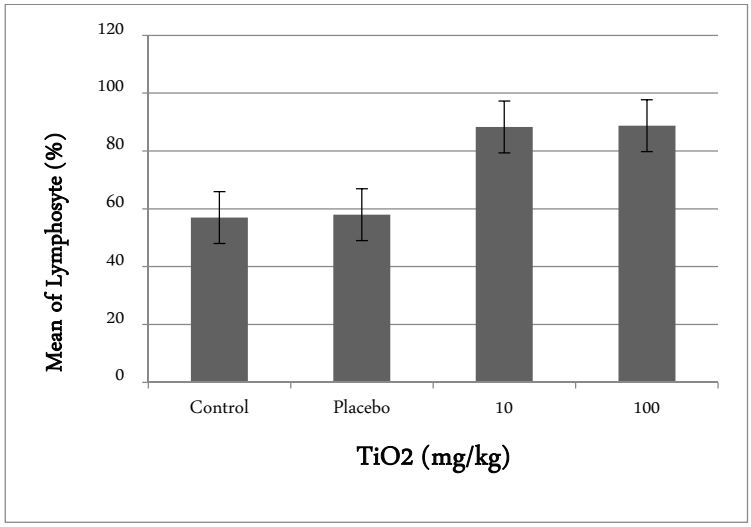

Figure 2.mean comparison of lymphocytes in all treatment groups

Neutrophils percentage was reduced in experimental groups in proportion to control group (Figure 3).

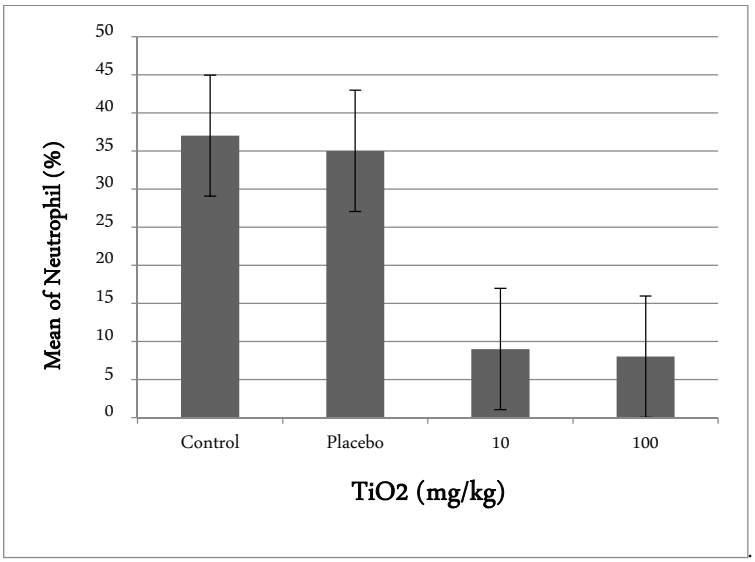

Figure 3. Mean comparison of neutrophils percentage in all treatment groups

Using nanoparticles in medicinal products and oral pigments expose people-especially children to danger [6].However, the toxicity of many nanoparticles is being investigated[5].

Results of this study showed significant increase in white blood cells and lymphocytes plus severe decrease in neutrophils because of titanium dioxide nanoparticles.

Thymus gland plays important role in immunologic development of T cells and titanium dioxide toxicity reduces this activity. Also, it is thought that with the arrival of nanoparticles and increased inflammation of the lymph nodes, the cells involved in inflammatory reactions more and also makes G1 phase cells divide into S phase cells and be transferred further[7,8]. According to reports, this nanoparticle can enter the body via swallowing, injection, and skin, and injection.This material can pass biological membranes easily and cause antioxidant imbalance. Therefore, it can induce oxidative stress in various organs [9].

Concentration and time of using nanoparticles can reduce or increase white blood cells in each mentioned stages. Considering that titanium dioxide in high concentrations can control cell activities, stimulating oxidative stress in cells and antimitotic properties and reduction in antioxidants and increase in cells involvement in immune processes cause decrease in blood cells numbers [10].

Body increases white blood cells to compensate extant reduction.Of course, inflammation of lymph nodes also helps to increase the number of white cells, but over time, these glands are weak and atrophied that cannot be compensated and this high toxicity will reduce cell numbers.

Nanoparticles penetrate tissues and cause improper performance of organs.Furthermore, they enter lymphatic system by penetrating the tissues [11].

According to reports, nanoparticles which have thick coatings, escape from phagocytic uptake and enter lymph stream and in case of incomplete phagocytosis these particles will be accumulated in lymphatic nodes [10].Whenever nanoparticles are accumulated in a tissue, they will be absorbed by cells or not; In case of absorption, final replacement will be in lysosome or cytoplasm depending nanoparticle properties. If nanoparticles be replaced in cytoplasm, large materials cause cell death or direct injuries because of these reactions[11].

CONCLUSION

According to results, titanium dioxide nanoparticles increased white blood cells and lymphocytes significantly whereas neutrophils were decreased severely. According to results, white blood cells were affected by nanoparticles. Therefore, titanium dioxide can affect also defense potential of blood.

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