



## Effect of Human Growth Hormone on Blood Picture in Male Rabbits

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### Abstract

There has been in recent years an increase in the use of growth hormone (GH) by different people for sports enhancement and for looking and feeling good. However, there are few studies on animals to test the side effects of using growth hormone, especially with high doses for purposes other than medical. Therefore, this study was aimed to investigate the effect of two different high doses of recombinant human growth hormone (rhGH) on some blood pictures in male rabbits. Fifteen (15) white New Zealand male rabbits were divided randomly into 3 groups: a control group, a low-dose group, and a high-dose group. Rabbits were injected subcutaneously 3 times a week for 6 weeks. After the end of the treatment period, rabbits were sacrificed, and blood samples were collected and analyzed. Injection of the hormone resulted in an increase in the level of GH in the sera of the treated animals. With regard to the blood picture results, the hormone caused a significant increase in the red blood cell count, the concentration of hemoglobin, percent hematocrit, white blood cells, and the platelets; but had no significant effect on the mean corpuscular volume, mean corpuscular hemoglobin and the mean corpuscular hemoglobin concentration.

**Keywords:** Human Growth Hormone, Complete Blood Picture, Male Rabbits

## Introduction:

Growth hormone (GH), also known as somatotropin, is a polypeptide hormone mainly produced in specific cells called somatotrophs of the pituitary gland and released into the circulatory system (1). GH induces the production of insulin-like growth factor I (IGF-I), a key mediator of GH actions. The secretion of GH from the pituitary is primarily regulated by two hypothalamic peptides, the stimulating growth hormone-releasing hormone (GHRH) and the inhibiting somatostatin. There are other factors that control the secretion of growth hormone. Those that stimulate secretion include decreased blood glucose, decreased blood free fatty acids, starvation or fasting, protein deficiency, trauma, stress, exercise, testosterone, estrogen, and deep sleep (stages II and IV); and those that inhibit secretion include increased blood glucose, increased blood free fatty acids, aging, obesity, growth hormone (exogenous), and somatomedins (insulin-like growth factors) (2).

As an endocrine hormone, GH has a wide range of actions on peripheral organs and tissues, promoting protein synthesis and cell proliferation. GH stimulates growth and lipolysis, as well as affects carbohydrate and protein metabolism in humans (3, 4). Most people after the age of 25-30, begin a process of growth hormone deficiency, which accelerates at a loss rate of 1% to 2% per year (5). The decline of growth hormone with age, is directly associated with many of the symptoms of aging, including cardiovascular disease, increased body fat, osteoporosis, wrinkling, gray hair, decreased energy, reduced sexual function and interest, and other pre-mature aging symptoms. Many of these symptoms have been found in younger adults who have growth hormone deficiency (6). Athletes and many other people are using human growth hormone (hGH) for everything from sports enhancement, anti-aging, skin, brain, muscle, joint and organ regeneration, to turning back the clock, or simply for the purpose of looking and feeling younger inside and out. However, there are not many studies on animals to test the side effects of using hGH for purposes other than medical. For this reason hGH will be used with different doses to test its effect on some physiological parameters in rabbits. This study aims to investigate the effect

of two different high doses of growth hormone on blood picture in male rabbits.

## **Materials and Methods**

### **Animals**

Twelve-week old, healthy white New Zealand male rabbits (total 15) (weighing between  $0.900 \pm 2.385$  Kg ;  $\bar{X} = 1.35 \pm 0.098$ ) were obtained from a local breeder and maintained in a room (3 x 3 m) in the backyard of the researchers house. The room was cleaned daily and during that time the rabbits were left to roam freely in the backyard for about one hour then returned to the room. The animals were maintained under normal temperature and light cycles. The rabbits were given water and food ad libitum. The animals were kept and maintained under these conditions for 4 weeks prior to the experiment.

### **Chemicals**

Growth hormone (GH) (somatropin 4IU) was imported from South Egypt Drug Industries Company (SEDICO), Egypt.

### **Experimental procedure**

The rabbits were weighed and divided randomly into 3 groups (5 rabbits in each group) : 1- control group (received 100  $\mu$ l of physiological saline), 2- low dose group ( received 50  $\mu$ g growth hormone / Kg body weight), and 3- high dose group ( received 100  $\mu$ g growth hormone / Kg body weight) (7). The rabbits were injected subcutaneously using 1 ml syringe 3 times a week for 6 weeks (8, 9). After the end of the 6 weeks period, the rabbits were weighed, slaughtered and blood samples were taken from the 3 groups. From each rabbit, blood samples (3 ml) were collected into ethylene diamine tetra acetic acid (EDTA) tubes for hematological parameters analysis.

### **Hematological parameters**

Hematological parameters including white blood cells (WBC), red blood cells (RBC), hematocrit (HCT), Hemoglobin (HGB), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), and platelets were

evaluated using an automatic blood cell analyzer ( XP-300 Automated Hematology Analyzer, Sysmex America, Inc).

### Statistical analysis

Statistical analysis was performed using a computer run package (Graph Pad Prism 7). One way ANOVA followed by Tukey's HSD test was performed to show the statistical significance among the means of the groups. Results were expressed as mean  $\pm$  standard error of the mean (SEM). The N value for the control group and the high dose group was 5, and for the low dose group the value was 5. P-value below 0.05 was considered to be statistically significant.

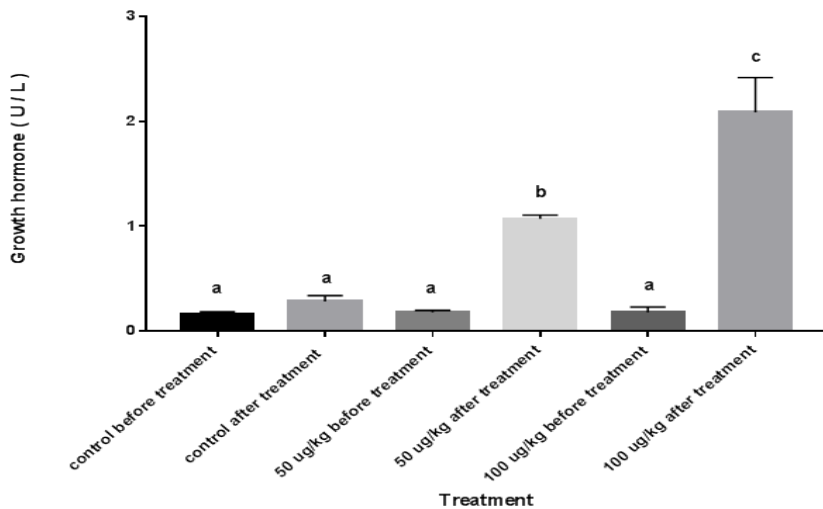
### Results

The rabbits used in this experiment appeared physically healthy throughout the period of the experiment and showed no signs of toxicity as a result of injection of growth hormone. However, one of the rabbits from the 50 $\mu$ / Kg treated group died in the middle of the experiment; this death appears to be of natural causes since all other treated rabbits were healthy even the ones that were treated with higher doses.

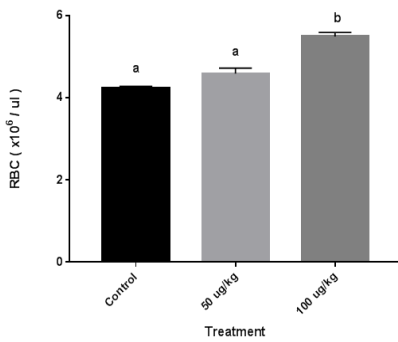
The results of the levels of GH in the serum of the control and treated rabbits are shown in Figure 1. Statistical analysis shown that there no significant differences ( $p > 0.05$ ) in the levels of GH in the sera of the three groups before treatment. After the end of the treatment period GH level did not change significantly in the control group. However, in the treated groups the GH levels increased significantly after the end of the treatment period in comparison with the corresponding levels before treatment. Furthermore, the level of GH in the serum of the 100  $\mu$ g/kg treated group was significantly higher ( $p = 0.0014$ ) than that of 50 $\mu$ g/kg treated group after the end of the treatment period.

The effect of GH on the RBC count was studied and results represented in Figure 2. The number of RBC increased after treatment with 50  $\mu$ g/kg and 100  $\mu$ g/kg GH. There was no significant difference between the number of RBC in control rabbits and the number found in the blood of 50  $\mu$ g/kg GH treated rabbits. Significant differences were found between the results of the control group and that of the 100  $\mu$ g/kg GH treated group and between the results of 50  $\mu$ g/kg GH treated group and that of the 100  $\mu$ g/kg treated group. The concentration of HG was also found to increase in

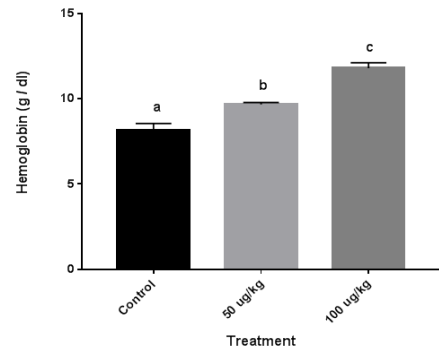
a dose-dependent manner with the increase in concentration of GH (Figure 3). Similar trend was observed with the hematocrit (Figure 4). The results of the effect of GH on MCV, MCH, and MCHC are shown in Figures 5- 7 respectively. There were no significant differences between the means of three parameters. Statistical analysis showed no significant differences between these 3 means. The hormone caused a significant increase in the numbers of WBC (Figure 8). The platelets count was also found to increase in a dose-dependent manner with the increase in the concentration (Figure 9).



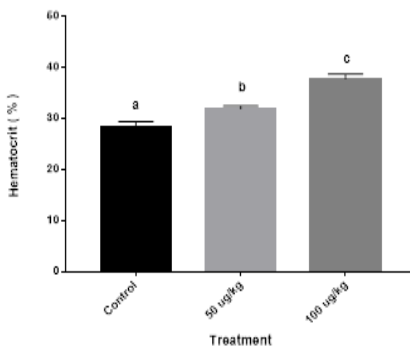
**Figure 1:** The mean concentration of growth hormone (GH) from the control rabbits and the rabbits treated with two different doses of growth hormone. The concentrations are before and after treatment with GH. Similar letters on the bars indicate no significant differences. Different letters indicate significant differences.



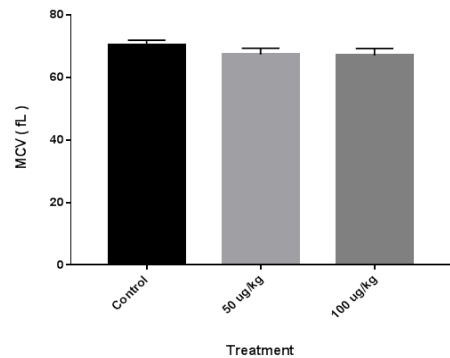
**Figure 2:** Means of red blood cell counts (RBC) from the control rabbits and the rabbits and the growth hormone (50  $\mu\text{g}$  and 100  $\mu\text{g}/\text{kg}$ ) treated rabbits. Similar letters on the bars indicate no significant differences. Different letters indicate significant differences.



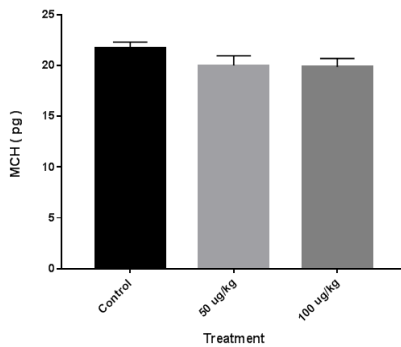
**Figure 3:** The mean concentration of hemoglobin (HGB) in the control rabbits and the growth hormone (50  $\mu\text{g}$  and 100  $\mu\text{g}/\text{kg}$ ) treated rabbits. Similar letters on the bars indicate no significant differences. Different letters indicate significant differences.



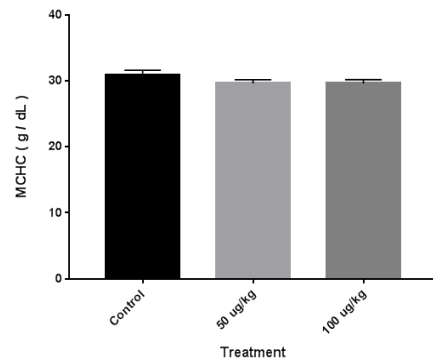
**Figure 4:** The mean percent of hematocrit (HCT) from control rabbits and the growth hormone (50  $\mu\text{g}$  and 100  $\mu\text{g}/\text{kg}$ ) treated rabbits. Similar letters on the bars indicate no significant differences. Different letters indicate significant differences.



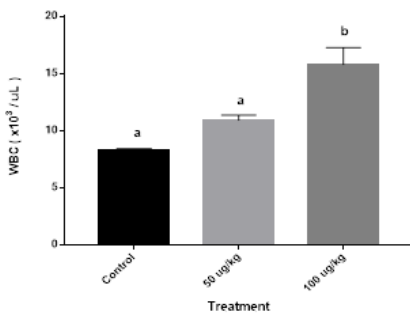
**Figure 5:** The mean corpuscular volume (MCV) of control rabbits and those treated with growth hormone (50  $\mu\text{g}$  and 100  $\mu\text{g}/\text{kg}$ ) treated rabbits. Similar letters on the bars indicate no significant differences. Different letters indicate significant differences.



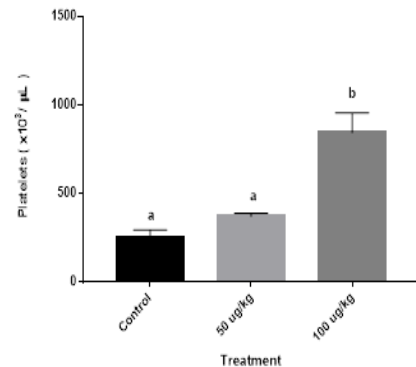
**Figure 6:** The mean corpuscular hemoglobin (MCH) of the growth hormone treated rabbits (50  $\mu\text{g}$  and 100  $\mu\text{g}$  / kg ) and the control rabbits. Similar letters on the bars indicate no significant differences. Different letters indicate significant differences.



**Figure 7:** The mean corpuscular hemoglobin concentration (MCHC) of control and growth hormone (50  $\mu\text{g}$  / kg and 100  $\mu\text{g}$  / kg) treated rabbits. Similar letters on the bars indicate no significant differences. Different letters indicate significant differences.



**Figure 8:** The mean white blood cells (WBC) count of control and growth hormone (50  $\mu\text{g}$  / kg and 100  $\mu\text{g}$  / kg). Similar letters on the bars indicate no significant differences. Different letters indicate significant differences.



**Figure 9:** The mean platelets count in the blood of control and growth hormone (50  $\mu\text{g}$  / kg and 100  $\mu\text{g}$  / kg) treated rabbits. Similar letters on the bars indicate no significant differences. Different letters indicate significant differences.

### Discussion:

The effect of GH on RBC count was studied and the results showed an increase in the RBC count in a dose-dependent manner. In previous study investigated the effect of growth hormone therapeutic supplementation on hematopoietic stem / progenitor cells in children with growth hormone deficiency, it was found that GH-replacement therapy stimulated increases in clonogenic growth of erythroid lineage and RBC counts as well as significant up-regulation of cell cycle propagating genes (10). Other reports observed an increase in RBC count in growth hormone deficient children and normal children treated with growth hormone (11-13). In adults with GH deficiency, GH therapy was also found to increase RBC count (erythropoiesis) (14). GH and IGF-I have been demonstrated to stimulate erythropoiesis under various conditions *in vitro* (15, 16) and in children with short stature (17). In study on hypo-physectomized rats, both human GH and human IGF-I stimulated erythropoiesis and increased serum erythropoietin concentration (18). However, the stimulatory effect on erythropoiesis occurred before the serum erythropoietin levels had increased (18). Furthermore, administration of IGF-I to neonatal rats led to accelerated red blood cell production (19). An intriguing study shows that after one year of GH treatment in non-GHD children, erythropoietin (Epo) plasma levels significantly decreased and granulocyte-colony stimulating factor (G-CSF) levels increased from basal to 12 months of therapy, whereas in GHD children, they did not change significantly. Circulating levels of G-CSF are significantly lower in GHD than in non-GHD children. In non-GHD children, the number of red blood cells, hemoglobin (HG), and HCT values significantly increased after one year of GH treatment. GH therapy influences Epo and G-CSF levels in short non-GHD children, while it shows no effects in GHD children (20). These findings need further clarification, since GH increases plasma Epo levels and Hb in adult GHD patients (21) and increases plasma G-CSF levels and neutrophil counts in adult GHD patients (22). Another study carried out in GHD patients treated with GH showed that the replacement therapy exerted a beneficial effect leading to a significant increase of erythrocyte parameters and recovery from anemia (typical of GHD patients during childhood), without affecting the number of leukocytes or platelets (23). In all, these data indicate that GH exerts a positive role on the hematopoietic system, similar to that played by G-CSF (24). In this

study the percent HCT and the HG concentration were also found to increase in a dose-dependent manner in the GH- treated rabbits. Since there was an increase in the number of RBC, one would expect an increase in the HG concentration and the percent HCT. In patients with adult-onset GH deficiency, treatment with recombinant human GH resulted in a significant increase in individual HG concentrations, especially in the male patients (25). In children with short stature treatment with GH accelerated growth and elevated the concentrations of HG and IGF-I (17). In another study GH treatment had caused a non-significant increase in HG concentration in adults with GH deficiency, even though the number of RBC was significantly increased (14). Previous study reported an increase in the HCT of GH deficient children after GH- treatment (13). The increase in RBC count, HG, and HCT in observed in these children during GH treatment confirmed the *in vivo* erythropoietic growth- promoting effects of GH (13). GH at a dose of 0.4U/kg/week for 9 months was found to increase RBC count, HG concentration, and HCT in a group of eight subjects with GH deficiency (26).

GH injection had no significant effect on the values of MCV, MCH, and MCHC. The value of MCV in this study was within the normal range (27). This normal value indicates normocytic cells. MCH and MCHC were within normal range for rabbits. This indicates that HG production and iron metabolism in the RBC of these rabbits are normal, which means that the increases in HG and HCT are due to increase in RBC production. However the study by (14) reported that the values of MCV, MCH and MCHC were significantly reduced even though the RBC count significantly increased in GH-deficient adults treated with GH. They explain that this is in keeping with a GH-induced increase in the erythrocyte production rate, leading to an increased demand for iron.

The WBC numbers were found to increase in a dose-dependent manner with the increase in GH concentration. The effect of GH on leukopoiesis *in vivo* and *in vitro* in rats shown effects on myeloid progenitor cells and the hemopoietic microenvironment simultaneously, resulting in an increase in leukocytes (28). But in the other studies with GH- deficient patients, treatment with GH showed that replacement therapy caused an increase in erythrocyte parameters without affecting the number of leukocytes (23, 25).

In this study, the platelets count was also found to increase in a dose-dependent manner with the increase in GH concentration. This is possible since, it has been shown that human GH has a distinct capacity to promote the differentiation of human primary megakaryocytes derived from umbilical cord blood CD34 cells. In particular, human GH was found to be potent in facilitating pro-platelet formation and platelet production from cultured megakaryocytes (29). Recombinant human growth hormone (rhGH) administered to mice after syngeneic bone marrow transplantation was found to cause significant increases in total hematopoietic progenitor cell content in both bone marrow and spleen (30). Erythroid cell progenitor content was also significantly increased after rhGH treatment. And analysis of peripheral blood indicated that administration of rhGH resulted in significant increase in the rate of WBC and platelet recovery. But the studies by (23, 25) reported that GH had no significant effect on platelets count.

### Conclusion

In conclusion, these results clearly indicate that GH hormone has dramatic effect on the blood picture of the animal. Especially an increase in the number of red blood cells, which can lead to increase in RBC count could have serious cardiovascular problems.

### References

1. M. Wallis, in *New Comprehensive Biochemistry*. (Elsevier, 1988), vol. 18, pp. 265-294.
2. A. C. Guyton, J. E. Hall, *Textbook of medical physiology*. (Saunders Philadelphia, 1986), vol. 548.
3. O. G. Isaksson, A. Lindahl, A. Nilsson, J. Isgaard, Mechanism of the stimulatory effect of growth hormone on longitudinal bone growth. *Endocrine reviews* **8**, 426 (1987).
4. N. Møller, J. O. L. Jørgensen, Effects of growth hormone on glucose, lipid, and protein metabolism in human subjects. *Endocrine reviews* **30**, 152.(2009)
5. P. V. Carroll, B. A. Bengtsson, L. Carlsson, J. Christiansen, D. Clemmons, R. Hintz, Growth hormone deficiency in adulthood and the effects of growth hormone replacement: a review. *The Journal of Clinical Endocrinology & Metabolism* **83**, 382 (1998).

6. H. de Boer, G.-J. Blok, E. A. van der Veen, Clinical aspects of growth hormone deficiency in adults. *Endocrine reviews* **16**, 63 (1995).
7. M. Saugy, N. Robinson, C. Saudan, N. Baume, L. Avois, P. Mangin Human growth hormone doping in sport. *British journal of sports medicine* **40**, i35 (2006).
8. D. M. Crist, G. T. Peake, R. B. Loftfield, J. C. Kraner, P. A. Egan, Supplemental growth hormone alters body composition, muscle protein metabolism and serum lipids in fit adults: characterization of dose-dependent and response-recovery effects. *Mechanisms of ageing and development* **58**, 191 (1991).
9. R. Deysig, H. Frisch, W. F. Blum, T. Waldhör, Effect of growth hormone treatment on hormonal parameters, body composition and strength in athletes. *European Journal of Endocrinology* **128**, 313 (1993).
10. M. Kawa, I. Stecewicz, K. Piecyk, E. Pius-Sadowska, E. Paczkowska D. Rogińska, Effects of growth hormone therapeutic supplementation on hematopoietic stem/progenitor cells in children with growth hormone deficiency: focus on proliferation and differentiation capabilities. *Endocrine* **50**, 162 (2015).
11. M. Pankratova, A. Yusipovich, M. Vorontsova, E. Parshina, S. Bochkareva, A. Cherkashin, One-year recombinant growth hormone therapy does not improve hemoglobin state and morphology of erythrocytes in growth hormone deficient children. *Pathophysiology* **25**, 13 (2018).
12. N. Stahnke, W. Blunck, W. Schröter, Action of growth hormone on erythropoiesis: changes in red blood cell enzyme activities in growth-retarded patients with and without growth hormone deficiency. *Pediatric Research* **10**, 802 (1976).
13. G. Valerio, S. DiMaio, M. Salemo, A. Argenziano, R. Badolato, A. Tenore, Assessment of red blood cell indices in growth-hormone-treated children. *Hormone Research in Paediatrics* **47**, 62 (1997).
14. E. Christ, M. Cummings, N. Westwood, B. Sawyer, T. Pearson, P. Sonksen, The importance of growth hormone in the regulation of erythropoiesis, red cell mass, and plasma volume in adults with growth hormone deficiency. *The Journal of Clinical Endocrinology & Metabolism* **82**, 2985 (1997).

15. M. Claustres, P. Chatelain, C. Sultan, Insulin-like growth factor I stimulates human erythroid colony formation in vitro. *The Journal of Clinical Endocrinology & Metabolism* **65**, 78 (1987).
16. D. W. Golde, N. Bersch, C. H. Li, Growth hormone: species-specific stimulation of erythropoiesis in vitro. *Science* **196**, 1112 (1977).
17. E. Vihervuori, M. Virtanen, H. Koistinen, R. Koistinen, M. Seppala, M. A. Siimes, Hemoglobin level is linked to growth hormone-dependent proteins in short children. *Blood*. **87**, 2075 (1996).
18. A. Kurtz, J. Zapf, K. U. Eckardt, G. Clemons, E. R. Froesch, C. Bauer Insulin-like growth factor I stimulates erythropoiesis in hypophysectomized rats. *Proceedings of the National Academy of Sciences* **85**, 7825 (1988).
19. A. F. Philipps, B. Persson, K. Hall, M. Lake, A. Skottner, T. Sanengen, The effects of biosynthetic insulin-like growth factor-1 supplementation on somatic growth, maturation, and erythropoiesis on the neonatal rat. *Pediatric research* **23**, 298 (1988).
20. C. Meazza, I. Bonomelli, S. Pagani, P. Travaglino, K. Laarej, F. Cantoni, Effect of human recombinant growth hormone therapy on circulating levels of erythropoietin and granulocyte-colony stimulating factor in short children. *Journal of Pediatric Endocrinology and Metabolism* **22**, 837 (2009).
21. M. Sohmiya, Y. Kato, Effect of long- term administration of recombinant human growth hormone (rhGH) on plasma erythropoietin (EPO) and haemoglobin levels in anaemic patients with adult GH deficiency. *Clinical Endocrinology* **55**, 749.(2001)
22. M. Sohmiya, I. Kanazawa, Y. Kato, Effect of recombinant human GH on circulating granulocyte colony-stimulating factor and neutrophils in patients with adult GH deficiency. *European journal of endocrinology* **152**, 211 (2005).
23. A. Esposito, D. Capalbo, L. De Martino, M. Rezzuto, R. Di Mase, C. Pignata, Long-term effects of growth hormone (GH) replacement therapy on hematopoiesis in a large cohort of children with GH deficiency. *Endocrine* **53**, 192 (2016).
24. C. Carlo-Stella, M. Di Nicola, R. Milani, P. Longoni, M. Milanese, C. Bifulco, Age-and irradiation-associated loss of bone marrow hematopoietic function in mice is reversed by recombinant human growth hormone. *Experimental hematology* **32**, 171 (2004).

25. S. Ten Have, A. Van der Lely, S. Lamberts, Increase in haemoglobin concentrations in growth hormone deficient adults during human recombinant growth hormone replacement therapy. *Clinical endocrinology* **47**, 565 (1997).
26. A. Ardizzi, G. Guzzaloni, G. Grugni, D. Moro, G. Calo, G. Mazzilli, The effect of GH on erythropoiesis in vivo. *Minerva Endocrinologica* **18**, 83 (1993).
27. K. L. Marshall, Rabbit hematology. *Veterinary clinics of North America: exotic animal practice* **11**, 551 (2008)
28. Y. Miyashita, The effect of growth hormone on leukopoiesis: in vivo and in vitro studies. *Nihon Naibunpi Gakkai Zasshi* **67**, 785 (1991).
29. Y. Xu, S. Wang, M. Shen, Z. Zhang, S. Chen, F. Chen, hGH promotes megakaryocyte differentiation and exerts a complementary effect with c-Mpl ligands on thrombopoiesis. *Blood, The Journal of the American Society of Hematology* **123**, 2250 (2014).
30. Z.-G. Tian, M. A. Woody, R. Sun, L. A. Welniak, A. Raziuddin. S. Funakoshi, Recombinant human growth hormone promotes hematopoietic reconstitution after syngeneic bone marrow transplantation in mice. *Stem Cells* **16**, 193 (1998).

## تأثير هرمون النمو البشري علي صورة الدم في ذكور الارانب

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### المستخلص العربي

في السنوات الاخيرة القريبة تم ملاحظة الاستعمال المتزايد لهرمون النمو من قبل العديد من الأشخاص من اجل تحسين البنية الجسدية و القدرة الرياضية ومن اجل الشعور بالنشاط الحيوي. لكن لا توجد دراسات عديدة علي الحيوانات لاختبار الاعراض الجانبية الناجمة عن استعمال هرمون النمو وخصوصا بجرع مرتفعة لأغراض غير طبية. وبالتالي فإن الهدف من هذه الدراسة هو التحقق من تأثير جرعتين مرتفعتين ومختلفتين من هرمون النمو البشري (rhGH) علي صورة الدم في ذكور الأرانب. تم استعمال 15 أرنب من ذكور الأرانب النيوزيلندية البيضاء وتم وزنها وتقسيما عشوائيا الي 3 مجموعات: المجموعة الضابطة و المجموعة منخفضة الجرعة و مجموعة مرتفعة الجرعة. لقد تم حقن الأرانب تحت الجلد 3مرات في الاسبوع لمدة 6 اسابيع بعد الانتهاء من مدة الحقن تم وزنها وذبها وتجميع عينات من الدم لتحليلها. حقن الهرمون ادي الي زيادة في معدل الهرمون في مصل الأرانب المعاملة. حقن الهرمون ادي الي زيادة معنوية في عدد كريات الدم الحمراء وتركيز الهيموجلوبين ونسبة الهيماتوكريت وعدد خلايا الدم البيضاء والصفائح الدموية, ولكن لم يكن للهرمون أي تأثير معنوي علي كلا من متوسط حجم كريات الدم الحمراء (MCV) ومتوسط كمية الهيموجلوبين في كرية الدم (MCH) ومتوسط تركيز الهيموجلوبين في كرية الدم (MCHC) هذه النتائج تبين بشكل واضح ان لهرمون النمو تأثير كبير علي صورة الدم في الحيوانات. ان الزيادة في عدد كريات الدم الحمراء قد تؤدي الي مشاكل في الجهاز الوعائي القلبي.

**الكلمات المفتاحية:** هرمون النمو البشري, صورة الدم, ذكور الأرانب