



Effect of Atenolol (Beta Blocker) on Haematological and Biochemical Parameters in Male Wistar Rats

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ABSTRACT

Twelve male rats (120 – 140 g) were divided into control (distilled water) and atenolol-treated (1.43 mg/kg) groups (6 per group) for haematological and biochemical studies. The animals were orally treated on daily basis for 50 days. Red Blood Cell (RBC) count and Total White Blood Cell (TWBC) count were determined using haemocytometer. Activities of plasma Alanine Amino Transferase (ALT), Aspartate Amino Transferase (AST), Alkaline Phosphatase (ALP), as well as levels of total protein, globulin, albumin, creatinine and Blood Urea Nitrogen (BUN) were determined by spectrophotometry. Data were analysed using descriptive statistics and ANOVA at $p=0.05$. Treatment of rats with atenolol (1.43 mg/kg) caused significant ($p<0.05$) increments in TWBC and platelet values relative to their respective controls. It can therefore be concluded that atenolol probably has some beneficial effects on haematological function in male rats.

Keywords: Atenolol, Rats, Total white blood cell count, Red blood cell count, Total protein.

INTRODUCTION

Atenolol has been widely used in humans during the last 3–4 decades to treat various cardiovascular pathologies and has been classically considered a safe drug without significant side effects¹.

Atenolol is a cardioselective beta adrenoceptor blocking agent without intrinsic sympathomimetic activity. It has a markedly greater effect on cardiac than bronchial or vascular adrenoceptors^{2,3} and reduces blood pressure mainly by reducing cardiac output, in contrast to the nonselective 3-blockers that reduce blood pressure mainly by decreasing the peripheral vascular resistance⁴. Atenolol mainly causes its hypotensive effect by decreasing heart rate and cardiac contractility in both humans and experimental animals⁵.

Atenolol has been reported to have anxiolytic effect in human subjects⁶. It has also been reported to have antidepressant effect in mice⁷. Atenolol has been reported to cause decreased membrane fatty acid unsaturation and oxidative stress in heart and skeletal muscle mitochondria and improves immunity and behavior⁸ in mice. It has also been reported that pretreatment of rats with atenolol ameliorated the acute hemodynamic changes and prevented ZD6126-induced increases in both troponin T and myocardial necrosis⁹.

However, due to scarcity of information from literature on the effect of atenolol on haematological and biochemical parameters in male rats, this study therefore aims at investigating the effect of this antihypertensive agent on these aforementioned parameters in male rats.

MATERIALS AND METHODS

Experimental Animals

Adult male rats weighing between 120 g – 140 g bred in the Pre-Clinical Animal House of the College of Medicine and Health Sciences, Afe Babalola University were used. They were housed under standard laboratory conditions and had free access to feed and water; they were acclimatized for two weeks to laboratory conditions before the commencement of the experiments. All experiments were carried out in compliance with the recommendations of Afe Babalola University Ethics Committee on guiding principles on care and use of animals.

Drug

Beta blocker (atenolol) tablets (Bristol laboratories Ltd) were bought from Danax Pharmacy, Ibadan, Nigeria.

Atenolol (100 mg) was dissolved in 10 ml of distilled water to give a concentration of 10.0 mg/mL.

The dosage of atenolol used in this study was in accordance with that recommended by the manufacturer.

Experimental Design

Twelve male rats (120 – 140 g) were randomly divided into two groups, with each consisting of six animals. The two groups were subjected to the following oral treatments once a day for fifty (50) days:

Group I: received 0.5 mL/100 g of distilled water as control group.

Group II: received 1.43 mg/kg of atenolol.



Collection of blood samples

Twenty four hours (day 51) after the last dosing of all the groups, blood samples were collected from all the animals through the medial cantus with heparinized capillary tubes into EDTA bottles for hematological and plasma biochemical analyses. Before assays, the blood was centrifuged for 5 minutes using a bench top centrifuge (Centromix) and the plasma were used for the determination of the biochemical parameters.

Determination of Haematological Parameters

The red blood cells (RBC) and white blood cells (WBC) counts were determined by the Improved Neubauer haemocytometer method. The haemoglobin (Hb) concentration was determined according to ¹⁰ using the cyanomethaemoglobin method. The packed cell volume (PCV) was determined by the micro-haematocrit method according to ¹¹. Schilling method of differential leucocyte count was used to determine the distribution of the various white blood cells ¹². Mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) were computed according to ¹⁰.

Determination of Plasma Biochemical Parameters

The total protein concentration was determined using the Biuret method ¹³ and the albumin concentration by the method of ¹⁴. The globulin concentration was calculated by subtracting the albumin concentration from the total protein concentration. Activities of plasma alanine transaminase (ALT) and aspartate transaminase (AST) were determined according to the method of ¹⁵. The levels of creatinine, urea and alkaline phosphatase were determined using the method of ¹⁶. All the above biochemical parameters were determined in the plasma using the Randox kits.

Statistical Analysis

The mean and standard error of mean (S.E.M.) were calculated for all values. Comparison between the control and experimental groups was done using one-way analysis of variance (ANOVA) with Duncan's Multiple Range Test. Differences were considered statistically significant at $p < 0.05$.

RESULTS

The effect of atenolol (1.43 mg/kg) on haematological and plasma biochemical parameters after treatment of rats for 50 days is shown in Tables 1 and 2 respectively.

Treatment of rats with atenolol (1.43 mg/kg) produced no significant ($p > 0.05$) changes in PCV, Hb, RBC, lymphocyte, neutrophil, monocyte, eosinophil, MCV, MCHC and MCH values relative to their respective controls.

Treatment of rats with atenolol (1.43 mg/kg) caused significant ($p < 0.05$) increments in TWBC and platelet values relative to their respective controls.

Table 1: Effect of 50 days treatment with atenolol on haematological parameters in male rats

Parameters	Control	Atenolol (1.43 mg/kg)
PCV (%)	43.40 ± 0.52	44.33 ± 0.91
Hb (g/dL)	14.38 ± 0.34	14.48 ± 0.43
RBC ($\times 10^6/\mu\text{L}$)	7.31 ± 0.32	7.31 ± 0.23
TWBC ($\times 10^3/\mu\text{L}$)	3.70 ± 0.21	6.01 ± 0.15*
Platelets ($\times 10^5/\mu\text{L}$)	1.39 ± 0.05	1.61 ± 0.05*
Lymphocytes (%)	71.00 ± 0.83	65.83 ± 0.86
Neutrophils (%)	25.40 ± 0.75	29.17 ± 0.81
Monocytes (%)	1.60 ± 0.11	2.33 ± 0.19
Eosinophils (%)	2.00 ± 0.16	2.67 ± 0.14
MCV (FL)	59.36 ± 0.55	60.70 ± 0.71
MCHC (g/dL)	33.12 ± 0.41	32.70 ± 0.24
MCH (pg)	19.67 ± 0.34	19.85 ± 0.57

(n=6, *p=0.05)

Treatment of rats with atenolol (1.43 mg/kg) produced no significant ($p > 0.05$) changes in total protein, albumin, globulin, ALT, AST, ALP, BUN and creatinine values relative to their respective controls.

Table 2: Effect of 50 days treatment with atenolol on plasma biochemical parameters in male rats

Parameters	Control	Atenolol (1.43 mg/kg)
Total Protein (g %)	6.80 ± 0.13	7.13 ± 0.18
Albumin (gm %)	2.66 ± 0.13	2.38 ± 0.12
Globulin (gm %)	4.14 ± 0.18	4.75 ± 0.21
AST (μL)	42.20 ± 0.87	40.00 ± 0.87
ALT (μL)	29.60 ± 0.74	29.33 ± 0.71
ALP (IU/L)	110.00 ± 1.71	112.67 ± 1.74
BUN (mg/dL)	15.96 ± 0.28	16.67 ± 0.22
Creatinine ($\mu\text{mol/L}$)	0.74 ± 0.02	0.82 ± 0.03

(n=6, *p=0.05)

DISCUSSION

The result of the haematological study has shown that atenolol caused no significant changes on the PCV, RBC and indices relating to it (Hb, MCV and MCHC). This could indicate that the drug does not have the potential to stimulate erythropoietin release from the kidneys which is the humoral regulator of RBC production ¹⁷. It could also indicate that there were no changes in the oxygen carrying capacity of the blood and the amount of oxygen delivered to the tissues since RBC and haemoglobin (Hb) are very important in transferring respiratory gases ¹⁸. It has been reported that values of RBC and associated



parameters lower than normal ranges are indicative of anaemic conditions while higher values are suggestive of polycythemia¹⁹; thus, the drug may not have the potential to induce anaemia or polycythemia. Also, the drug may not have adverse effects on the bone marrow, kidney and haemoglobin metabolism, since it has been reported that only substances which significantly affect the values of red blood cells and associated parameters would have effects on the bone marrow, kidney and haemoglobin metabolism²⁰.

Atenolol caused significant increase in TWBC value, which probably indicates an enhancement in the ability of the body to defend against invading organisms²¹. Similar result was reported by²² in *Viscum album* extract treated rats.

Atenolol caused significant increase in the platelet value, which probably indicates an enhancement on the haemostatic function of the body. Similar result was reported by²³ in *Fadogia agrestis* extract treated rats.

Atenolol caused no significant change in lymphocyte value, which probably indicates that it has no effect on the acquired immune response of the body. Similar result was reported by²⁴ in isolated ergosterol treated rats.

Atenolol caused no significant increase in the neutrophil count, which probably indicates it has no effect on the ability of the body to attack and destroy invading bacteria, viruses and other injurious agents (phagocytosis). Contrary result was reported²⁵ in *Dennettia tripetala* extract treated rats.

Atenolol caused no significant change in the monocyte value, which probably indicates that it has no effect on the phagocytic function of the body²⁶. Contrary result was reported by²⁷ in *Saccharomyces cerevisiae* extract fed hens.

Atenolol caused no significant change in eosinophil value, which could indicate that it has no effect on the anti-allergic and anti-parasitic infectious responses of the body. Contrary result was reported by²⁸ in *Arctotis acrotoides* extract treated rats and mice.

Atenolol caused insignificant changes in the MCV and MCH values which probably indicate it has no effect on induction of macrocytic anaemia, since increased MCV and MCH values are known to be indicative of macrocytic anaemia²⁹. Similar result was reported by³⁰ in *Jatropha gossypifolia* extract treated rats. The insignificant change in the MCHC value caused by lisinopril probably indicates that it has no effect on induction of hereditary spherocytosis, since MCHC values are known to be elevated in hereditary spherocytosis. Similar result was reported by³⁰ in *Jatropha gossypifolia* extract treated rats.

The result of the plasma biochemical study has shown that treatment of rats with atenolol caused insignificant change in total protein level. This might indicate that the drug has no effect on the buffering capacity of the blood

as well as having no effect on colloid osmotic pressure, since plasma proteins have been reported to be responsible for 15% of buffering capacity of blood²¹ and that osmotic pressure caused by the plasma proteins (called colloid osmotic pressure) tends to cause fluid movement by osmosis. Contrary result was reported by³¹ in *Euphorbia heterophylla* extract treated rats.

Atenolol caused no significant change in albumin level, which probably indicates that it has no effect on the plasma levels of metals, ions, fatty acids, amino acids, bilirubin and enzymes; since it has been reported that albumin serves as a carrier for metals, ions, fatty acids, amino acids, bilirubin, enzymes and drugs²¹. Contrary result was reported by³² in *Enicostemma axillare* extract treated rats.

Atenolol produced no significant change in globulin level, which probably indicates that it has no effect on both the natural and acquired immunity of the body against invading organisms, since it has been reported that globulins are principally responsible for the body's both natural and acquired immunity against invading organisms²⁶. Similar result was reported by³³ in *Portulaca oleracea* extracts treated rats.

The insignificant change in the activity of AST caused by the drug could indicate it has no effect on induction of tissue necrosis, since it has been reported that elevation in the activity of AST can be associated with cell necrosis of many tissues, which allows leakage of large amounts of this enzyme into the blood³⁴. Contrary result was reported by³⁵ in *Sida rhombifolia* extract treated mice and rats.

Atenolol caused an insignificant change in the activity of ALT, which probably indicates it has no effects on induction of hepatic damage, since it has been reported that ALT is present in the liver and other cells and is particularly useful in measuring hepatic necrosis, especially in small animals³⁶. Contrary result was reported by³⁷ in *Moringa oleifera* extract treated rats.

Atenolol caused no significant change in ALP level, this probably indicates the absence of cholestasis, since ALP has been reported to be a marker of cholestasis³⁸. Similar result was reported by³⁰ in *Jatropha gossypifolia* extract treated rats.

Atenolol induced insignificant changes in urea and creatinine levels. This probably indicates absence of nephrotoxicism (renal impairment), since high plasma levels of urea and creatinine are markers of kidney dysfunctions. Contrary result was reported by³⁹ in *Passiflora edulis* extract treated rats.

CONCLUSION

In conclusion, this study has shown that atenolol has some beneficial effects on the haematological function in male rats. However, the effect of this antihypertensive agent on human haematological function and blood chemistry are unknown; nevertheless, considering these



findings in animal model, it is recommended that patients should strictly comply with the dosage regimen as recommended by their physicians.

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