Changes in Some Testicular Biometric Parameters and Testicular Function in Cadmium Chloride Administered Wistar Rats

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Abstract: Recently there has been an increased association between environmental factors and male infertility. In the present study, the effect of changes in testicular biometric parameters (weight and volume) and testicular function (Sperm count, morphology, testosterone level) in Cadmium chloride administered Wistar rats was studied. Twenty male albino Wistar rats were randomized into four groups (n=5). Group A (control) received rat chow and water, while Group B, C and D received 15mg/ml, 20mg/ml and 25mg/ml of Cadmium chloride respectively for 6 weeks. The result showed a significant ($p<0.05$) and dose dependent decrease in testicular function parameters in the rats and a significant ($p<0.05$) and positive correlation between the biometric parameters and testicular function. The findings showed that Cadmium chloride has a deleterious effect on testicular function and biometric parameters of the testes may be important in the assessment of testicular function.

Keyword: Cadmium chloride, male infertility, testicular biometry

1.INTRODUCTION

Over the years, infertility has been on the increase in both males and females. The increase in male infertility has become a source of global concern (Berkley, 2004). According to the World Health Organization, 'infertility is the inability of a sexually active, non-contracepting couple to achieve pregnancy in one year' (WHO, 2000).

Currently, the etiology of suboptimal semen quality and male reproductive hormone is poorly understood, and many physiological and environmental factors have been implicated (Sharlip et al., 2002; Kenkel et al., 2001), factors such as smoking, use of restricted drugs, stress, and lack of exercise specifically have been implicated (Berkley, 2004).

Cadmium is one of environmental pollutants arising from electroplating, fertilizers, pigment and plastic manufactures. Therefore it easily contaminates the soil, plants, air and water (Ognjanovic et al., 2008). Humans and animals can easily be exposed to cadmium toxicity by consuming plants, water and air. Cadmium is absorbed and accumulates in various tissues (Casalino et al., 2002, Waisberg et al., 2003) even red blood cells (Kostic et al., 1993), the heart (Zikic et al., 1998) and the skeletal muscle of rats (Pavlovic et al., 2001).

Most animals with scrotal testes are susceptible to cadmium–induced testicular toxicity (King et al., 1999). Although, only about 1–2 % of acute cadmium dose is usually taken up by the testes, testicular toxicity is almost invariably evident. It has been reported that as low as 1-2 mg Cd/kg body weight can cause testicular damage without pathological changes to other organs (Prozialeck et al., 2006). Exposure to cadmium has been reported to reduce male fertility in both humans and rodents (Benoff et al., 2000), but the mechanism is still unknown.

Exposure to cadmium can negatively affect the male reproductive system via degenerative changes in testes, epididymis, and seminal vesicles (Ibrahim and Sameh 2002). Recently, Azoospermic persons were found to have higher serum and seminal plasma cadmium level compared with oligospermic ones (Oluyemi et al., 2006). Also positive relationship was found between cadmium exposure and asthenozoospermia in a rat model (Benoff et al., 2008).

The aim of the study is to establish an association between changes in some testicular biometric parameters and testicular function in Wistar rats induced with Cadmium chloride.

2. MATERIALS AND METHODS

2.1 Animals and Housing:

Twenty male albino Wistar rats weighing between 160- 180g and aged 12-14 weeks were used in this study. Animals were raised in the Animal House Unit in Faculty of Basic Medical Science, Delta State University, Abraka, Nigeria. They were maintained in wooden cages with stainless steel wire lids (bedded with wood shavings). Rat chow and water were supplied *ad libitum.* Rats were housed at a temperature of 28 ± 1ºC, 60 % humidity and under a 12 -hour - light: 12- hour- dark schedule.

2.2 Administration of Cadmium:

Cadmium Chloride ($CdCl_2$) in crystalline form was obtained from the Petroleum Training Institute (PTI), Warri and was dissolved in distilled water. The concentrations were 15mg/ml, 20mg/ml and 25mg/ml of the solution (Mervat, 2011). Male rats were randomly assigned to four groups of 5 animals each (control and experimental groups). Experimental male rats were provided access to drinking water containing $CdCl_2$ for 6 weeks. The control group received tap water only.

2.3 Experimental Design

A total of twenty (20) male albino Wistar rats were randomly divided into four groups of five rats each.

Group A: Control, fed with rat chow and water daily (n=5)

Group B: 15mg/ml Cadmium chloride solution treated rats (n=5)

Group C: 20mg/ml Cadmium chloride solution treated rats (n=5)

Group D: 25mg/ml Cadmium chloride solution treated rats (n=5)

2.4 Male fertility Assessment:

Sex Organ Weight and Volume

The rats were sacrificed from each group by decapitation at the end of experiment. The testes were dissected and weighed using a digital electronic weighing balance (EW, Germany) and recorded. The volume of the right testes was measured by first drying the surface of the right testes (using a filter paper), and then immersing it into a 10 ± 0.2 ml measuring cylinder containing 5ml physiological saline, and the volume of displaced fluid in the cylinder recorded.

2.4.1 Semen Quality Analysis:

Seminal content of epididymis was obtained by cutting of the cauda epididymis using surgical blades and squeezed in a sterile clean watch glass. This content was diluted 10 times with 2.9% sodium citrate dihydrate solution and thoroughly mixed to estimate the progressive motility and sperm count (Bearden and Fluquary, 1980). One drop of the suspension was smeared on a glass slide and stained by Eosin – nigrosin stain to determine the percentage of sperm cell morphology (Miller and Pass, 1952).

2.4.2 Testosterone Assay

Blood samples were collected directly from the heart, by cardiac puncture, in plain non-heparinized bottles and the serum was separated and frozen until hormonal assay was done. Testosterone was estimated in the serum as described by Ismail (1986).

2.5 Statistical Analysis

Values were expressed in mean ± SEM. SPSS version 17 was used for statistical analysis. Differences between groups were assessed by Student *t*-test and Pearson's product moment correlation. $P < 0.05$ was taken as significant.

3.0 RESULTS

Result showed the effect of cadmium chloride on testicular function and some testicular biometric parameters, it showed a dose dependent significant ($p<0.05$) reduction in the semen quality, serum testosterone, testicular weight/volume.

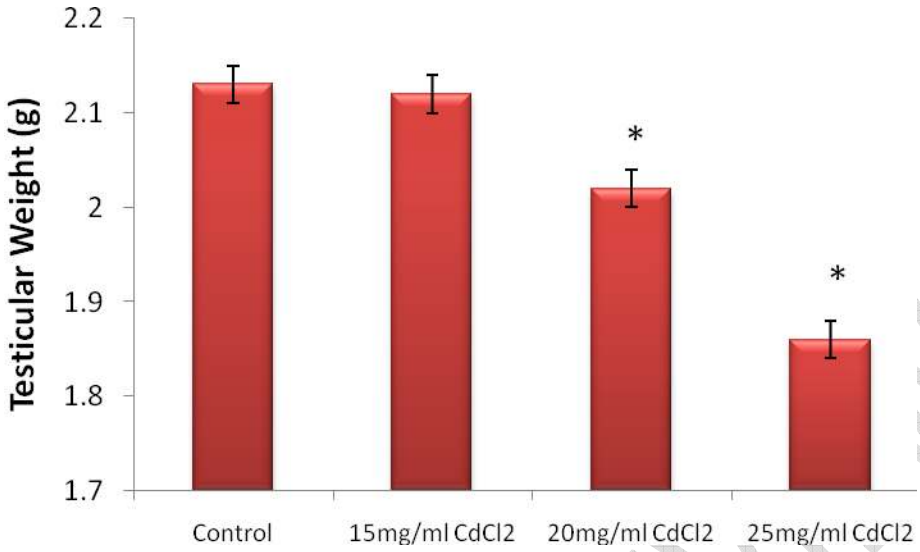

Fig 1: Effect of Cadmium Chloride on Testicular Weight

** p<0.05 compared with the Group 1(control); (n=5)*

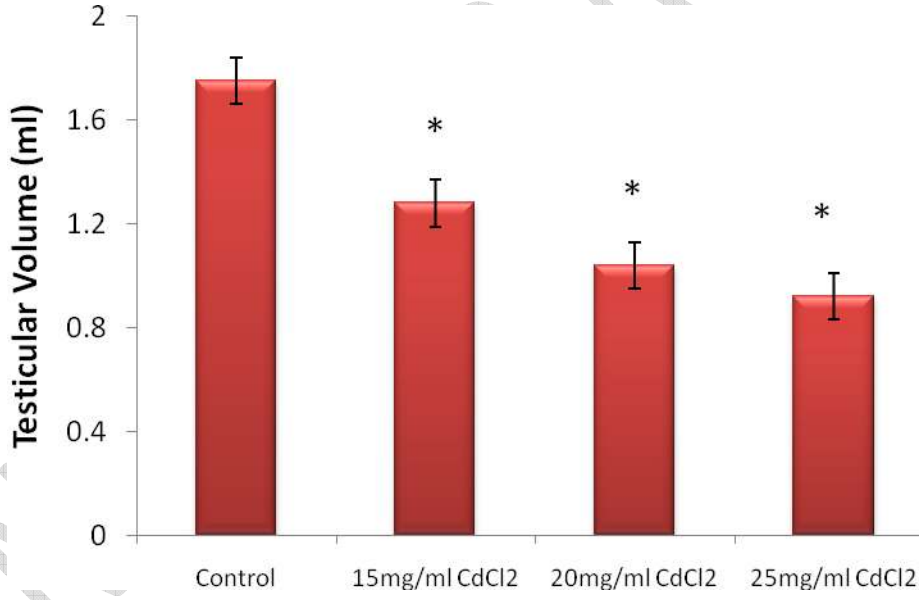

Fig 2: Effect of Cadmium Chloride on Testicular Volume

** p<0.05 compared with the Group 1(control); (n=5)*

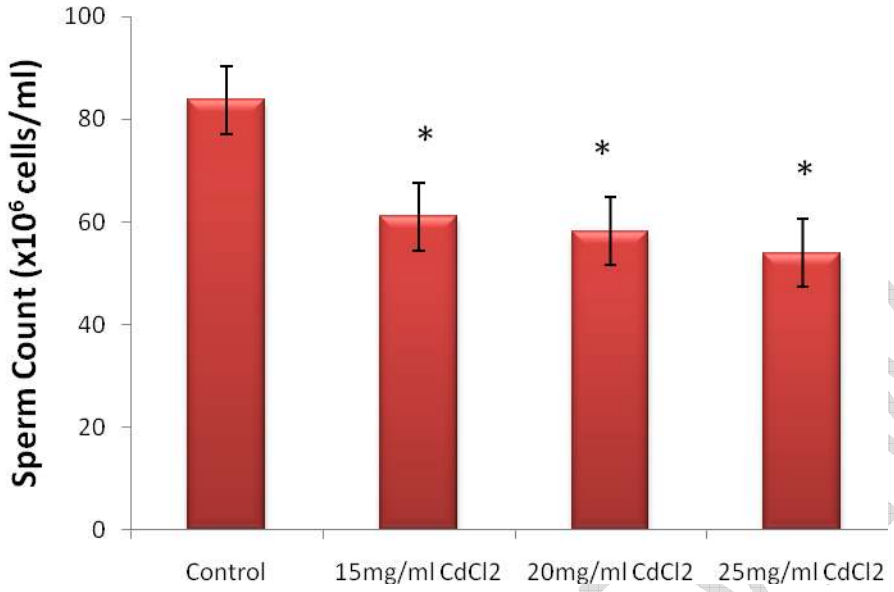

Fig 3: Effect of Cadmium Chloride on Sperm Count

** p<0.05 compared with the Group 1(control); (n=5)*

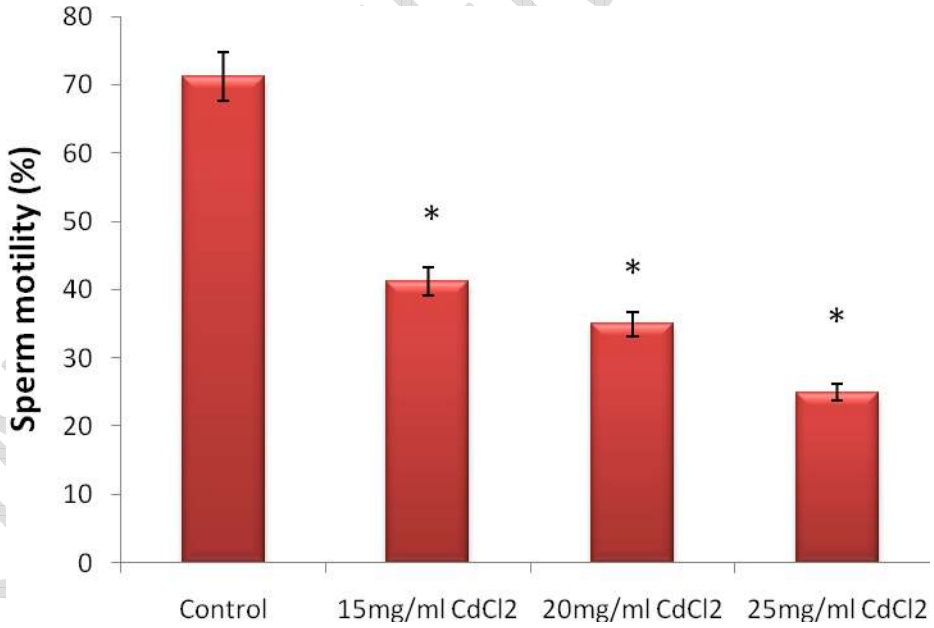

Fig 4: Effect of Cadmium Chloride on Sperm motility

** p<0.05 compared with the Group 1(control); (n=5)*

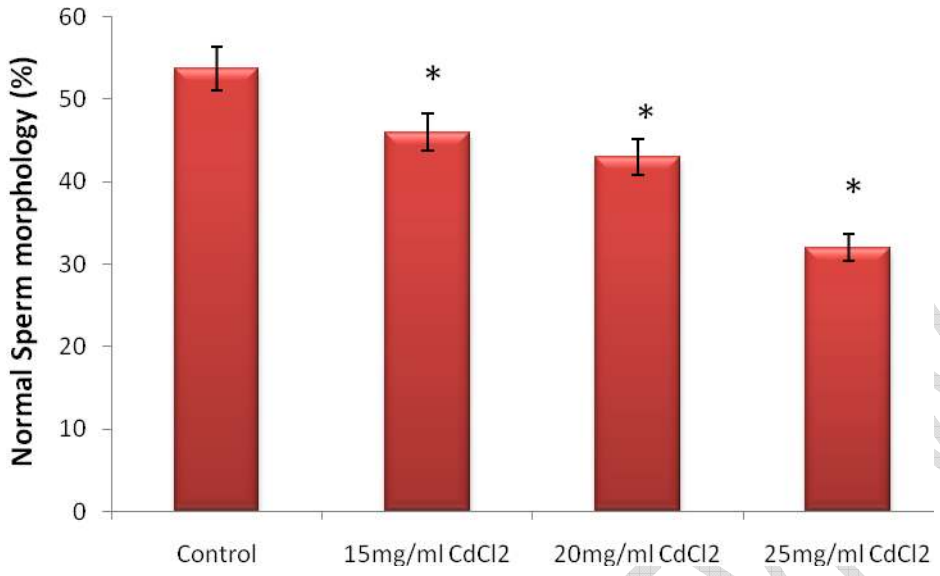

Fig 5: Effect of Cadmium Chloride on Sperm morphology

** p<0.05 compared with the Group 1(control); (n=5)*

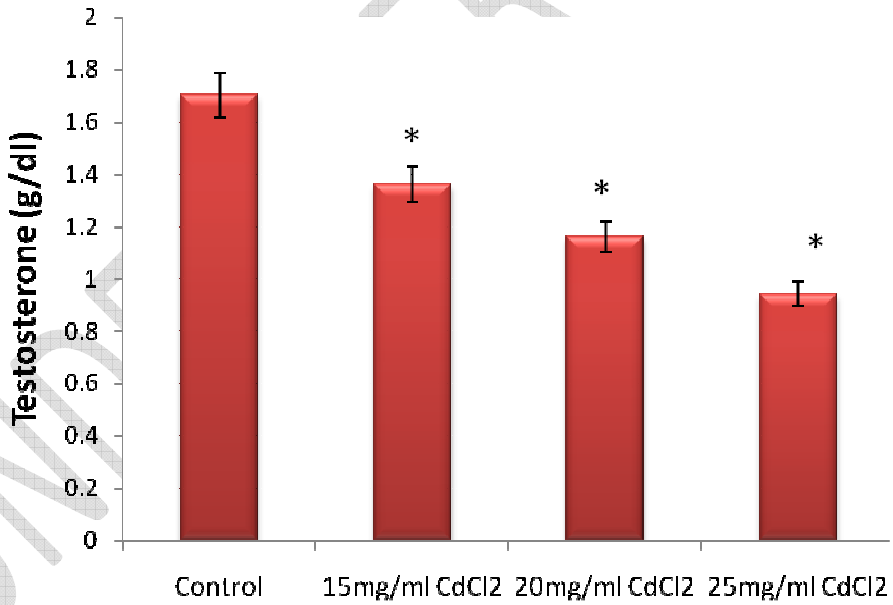

Fig 6: Effect of Cadmium Chloride on Testosterone

** p<0.05 compared with the Group 1(control); (n=5)*

The relationship between the testicular weight and/or volume with the semen quality and serum testosterone level, following cadmium chloride treatment was ascertained on the basis of

correlation coefficient. This was done to establish a possible relationship between the testicular weight or volume with semen quality and serum testosterone level.

Table 1: Relationship between the Testicular Weight and Volume with Semen Quality and Serum Testosterone Level after Cadmium Chloride Treatment.

	Correlation	
	Testicular Weight (g)	**Testicular Volume (ml)**
Sperm count (x10^6 cells/ml)	0.67*	0.60*
Sperm motility (%)	0.56*	0.69*
Sperm morphology (%)	0.75*	0.68*
Testosterone (ng/ml)	0.58*	0.61*

* Correlation is significant at the $p<0.05$ level (2-tailed); (n=20)

In the above table, the testicular volume was positively and significantly correlated with the sperm count, sperm motility, percentage of sperm with normal morphology and serum testosterone levels. Similarly, the testicular weight of the rats were positively and significantly correlated with the sperm count, progressive sperm motility, percentage of sperm with normal morphology and serum testosterone level.

4.0 DISCUSSION

In this study, effects of administration of $CdCl_2$ in the drinking water of adult male rat on semen quality, testosterone and some testicular biometric parameters were investigated. Cadmium has been found to produce wide range of biochemical and physiological dysfunctions in humans and laboratory animals (Santos et al., 2004) and such target organs as the testes have been affected (Oteiza et al., 1999).

From the study there are evidences that exposure to cadmium chloride can interfere with male fertility. At the various dose of administration, Cadmium Chloride adversely affected ($p<0.05$) the semen quality parameters and testosterone, to the extent that it may impair fertility in the male Wistar rat used for the study. Waisberg et al. (2003) explained that through increase in oxidative stress, cadmium chloride causes testicular damage, and impairs male fertility. In line with the above, Neeven et al. (2007), Benoff et al. (2008), Bench et al. (1999) and Babara et al. (2008) have shown that cadmium chloride administration would interfere with male fertility, especially by its detrimental effect on testicular function.

Cadmium chloride also significantly ($p<0.05$) decreased the testicular weight and volume, this could be understandable after reports from Redkha et al (2011) show derangement in some testicular structures such as seminiferous tubules and leydig cells that consist 70% to 80% of testicular mass (Setchell et al., 1998).

According to Bailey *et al*. (1998), testicular volume and weight are highly correlated. Also, Arai *et al*. (1998) have suggested a possible correlation between testicular volume and testicular function which was also observed in this present study.

5.0 CONCLUSION

The exposure of rats to cadmium chloride induces biochemical effects in the testes. Cadmium chloride decreased some testicular biometric parameters, semen quality and testosterone and these changes in the testicular function and testicular biometric parameters are positively correlated.

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