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Effect of Calcium Hypochlorite and Sodium Hypochlorite on the Proximal Tubules of Kidney of Mice.

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Abstract
The present study was used to elucidate the relationship between the levels of toxicity of chlorine salts exposure through drinking water and its damaging effect on the proximal tubules of the kidney of Swiss albino mice. Mice were given oral doses of chlorine salts calcium hypochlorite and sodium hypochlorite each in water. The doses of 100 ppm, 150 ppm and 200 ppm per kg of body weight per day for four months duration of both calcium hypochlorite as well as sodium hypochlorite were found to causesignificant increase in the diameter of the proximal tubules atP<0.05. Whereas, 200 ppm of sodium hypochlorite caused significant increase(at P< 0.05)in the diameter of the proximal tubules right after one month and three months as well.

Keywords: *calcium hypochlorite, sodium hypochlorite,kidney, proximal convoluted tubules.*

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I. Introduction

Water is used by people not only for drinking but also for washing, cooking, cleaning etc. Unfortunately, the freshwater which is so highly prized is afterwards returned to the environment dirty, smelly and discoloured which therefore, needs to be treated. In the developing nations,water borne diseases are major causes of illness.The provision of safe drinking water, therefore, to a large population is a massive enterprise.It may involve physical or chemical processes. Physical processes like reverse osmosis, boiling etc are not suitable for large supplies.Chemical processes like chlorination is of very common practice in many parts of the world including India.In chlorination usually chlorine or its compounds are added to water.Commonly the hypochlorite salts of water are used, such as calcium hypochlorite or sodium hypochlorite.When these are added to water free available chlorine is formed that has bactericidal and bacteriostatic properties.But the chlorine demand of water differs according to the source of water.Also, if organic impurities are present in water, these react to form harmful by-products which are mutagenic and carcinogenic.

Since, the kidney has diverse functions and small mass in relation to cardiac output that it handles, the kidney is a target both for chemicals that are pharmacologically active and for toxic materials.It is the major organ of excretion and homeostasis of water- soluble molecules.It can concentrate certain substances actively.But, this property also makes them susceptible to, and the target for such chemicals. Certain of these damages may be irreversible.The vulnerability of the kidney to toxicity from exposure to a particular drug or chemical is the product of several group of risk factors according to Khalil- Manesh et al(1992), who worked on these aspects of renal tubular injury. Makita et al (2000) have explained that the chemical substances that are ingested undergo detoxification, metabolism and excretion with the liver and kidneys being mainly involved. Even dietary phthalates are toxic according to Trasande et al (2014). It is evident that sodium hypochlorite is a toxic agent (Gatot et al, 1991; Gernhardt et al 2004). Even food additives or toxins in food cause severe kidney damage(Bao et al, 2008; Fahmy, 2017). Thus, the kidney is the second most important target for toxic chemicals after the liver.Therefore this study was undertaken to see the impact of calcium hypochlorite and sodium hypochlorite on the proximal tubules of the kidney of mice.

II. Methodology

Swiss albino mice were taken as the test animal. Male mice were taken in the age group of 3-4 months.Mice having average weight of 32±2.0 gm were selected. Two groups each having ten mice for each dose were selected. One group was given the oral dose of the chemical. Corresponding control group was maintained which were administered equal amount of distilled water. The chemicals selected were calcium hypochlorite ad sodium hypochlorite as these are chlorine salts used for water purification(Jolly, 1985). Doses of 50 ppm, 100 ppm, 150 ppm and 200 ppm of both calcium hypochlorite and sodium hypochlorite were given. Mice were sacrificed after one month, three months and four months to see the changes after different durations for the different doses. The kidneys were cut into small pieces and preserved in Bouin's fixative. Sections prepared from the blocks were studied. Diameter of the proximal convoluted tubules were taken with the help of ocular micrometer and stage micrometer after calibrations. Average of the twenty observations for each were calculated. The observations were taken at random. Standard deviation was calculated. The evaluation of the changes in the diameter of the proximal tubule was done taking its mean ± standard deviation. The data were subject to the student's t- test (of the differences of two means of independent samples. A 5% level of significance was used throughout the analysis.

III. Results And Discussion

Chemical insult to the kidney may result in a spectrum of nephropathies. But the tubules are greatly susceptible to damage by most of the chemicals. In this case the changes in the proximal convoluted tubule were observed. It was as follows:

Table 1. Showing the diameter of Proximal Convoluted Tubule (in mm) of kidney of mice treated with calcium hypochlorite and sodium hypochlorite:

Duration→	**1 month**	**3 months**	**4 months**
Dose ↓			
Control	0.0318719 ±0.0013416	0.03254525 ±0.003376	0.0363609 ±0.0013416
50 ppm Calcium hypochlorite	0.0354631 ±0.00313	0.0372587 ±0.0053197	0.0395064* ±0.003346
100 ppm Calcium hypochlorite	0.0363609 ±0.0042308	0.0426454 ±0.008087	0.0381565* ±0.0045934
150 ppm Calcium hypochlorite	0.0372587 ±0.003656	0.040401 ±0.007717	0.040401* ±0.0069498
200 ppm Calcium hypochlorite	0.0390543 ±0.0080374	0.0408499* ±0.011606	0.045788* 0.0141633
50 ppm Sodium hypochlorite	0.0346881 ±0.0028635	0.0377076 ±0.00573	0.0430944 ±0.0072869
100 ppm Sodium hypochlorite	0.0350142 ±0.002683	0.0381565 ±0.0045934	0.0393543* ±0.006556
150 ppm Sodium hypochlorite	0.0377076 ±0.0053758	0.0368098* ±0.0059497	0.043543* ±0.0077846
200 ppm Sodium hypochlorite	0.0386054* ±0.010069	0.0412988* ±0.0141633	0.0462367* 0.014057

*P<0.05

Thus, the proximal convoluted tubule of the kidney showed increase in diameter as compared to the control ones. This clearly indicates the effect of calcium hypochlorite and sodium hypochlorite on the kidney of mice. All the doses of 50 ppm, 100 ppm, 150 ppm and 200 ppm of calcium hypochlorite for four months and 200 ppm for three months only caused significant increase in the diameter of the proximal convoluted tubule. Sodium hypochlorite induced still greater changes in the diameter of the proximal convoluted tubule. Significant changes were caused by 100 ppm after four months and by 150 ppm after both three and four months. But 200 ppm induced significant changes after one month, three months and four months i.e.after all the durations of treatment. Dilatation of the tubules is one of the major aspects of renal injury. Even Ibrahim et al have shown dilatation of tubules as pathological changes in mice exposed to gold nanoparticles.The kidney is susceptible to chemicals in food and drinking water. Since the proximal tubules are involved in selective reabsorption of electrolytes, therefore, the chances of injury to these tubules are profound. Mitsumori et al (1998) have reported that the degeneration of the proximal tubular epithelia was quite prominent after four months of treatment with cadmium chloride. Male albino rats treated with antimony trisulfide in drinking water daily for 12 weeks showed pleomorphic vacuoles in the proximal tubule(Rashedy et al 2013).This may explain the renal injury and the possible factors leading to increase in diameter of the proximal tubule as it has been seen in the present study.The incidence of renal tumours in F344 rats administered potassium bromate in water was shown by Kurokawa et al (1986). The effect of sodium hypochlorite was greater as compared to calcium hypochlorite. This may be because sodium hypochlorite causes soft tissue damage as pointed by Witton et al (2005). According to Estrela et al (2002) sodium hypochlorite combines with water to generate hypochlorous acid which in turn generates superoxide radicals resulting in oxidative injury. That the hypochlorite's potential to cause toxicity is related to its oxidizing capacity has been put forward in the reviews of Slaughter et al (2019).Malle et al (1997) have opined that oxidation of proteins might be a leading event in tubular injury. As for calcium hypochlorite,from the studies of Ashby et al (1987) it has been reported that calcium hypochlorite is clastogenic in vitro but not in vivo. Thus the changes in diameter of the tubules are indicative of the damage induced by the two chemicals. But both the chemicals induce damage to the proximal tubules of the kidney. The nature of normal renal function in itself contributes to the vulnerability of the kidney to the toxins.

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CONFLICT OF INTEREST

Authors declare no conflict of interest regarding publication or any other activity related to this article.

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