Effect of Nickel Sulphate on Male Rats

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The skin is a very common route of absorption for the majority of chemicals. Nickel on regular contact, is known to cause dermatitis and other skin disorders (FISHER and SHAPIRO 1956, MASTROMATTEO 1967, BROWNING 1969, FEURMANN 1973). Cases of allergic eczymatous dermatitis and "nickel itch" have been reported among workers engaged in electroplating and refining of nickel. LAHIRI (1957) reported a higher incidence of dermatitis among nickel platers in India as compared to that in many other countries. Since nickel poisoning among occupational workers is more due to skin contact than any other route, we considered of interest to investigate the effects of dermal application of a nickel salt on vital organs such as liver, kidney and testis besides skin of the experimental animals and also whether they have any relationship to the concentration of the metal applied.

MATERIALS AND METHODS

Thirty two male albino rats of Industrial Toxicology Research Centre's colony (160 ± 10 g) were divided into four groups of 8 animals each. The hair on the lateroabdominal area of approximately 4x4 cm were clipped off by animal grooming clipper "OSTER" model 5 and cleaned with ethanol-acetone (1:1) mixture. The cleaned area of rats of group I, II and III were painted with 40, 60 and 100 mg Ni/kg, respectively in the form of $NiSO_4.6H_2O$ dissolved in 0.25 ml of normal saline daily for 30 days. An equal volume of saline was applied on the skin of group IV animals, which served as control. Four animals from each group were sacrificed after 15 and 30 days of nickel sulphate application, skin, liver, kidney and testis were removed and fixed in Bouin's fluid. After routine processing, the tissues were embedded in paraffin and sections of 6 µ thickness were cut and stained in haematoxylin - eosin for histopathological examination. The experiment was conducted at the room temperature (25 ± 2°C) with 60-70% relative humidity.

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RESULTS

Morbidity and Mortality

There was no clinical symptoms of poisoning or mortality among experimental animals due to the dermal application of nickel sulphate.

Macroscopic observations

No gross changes were noticed in the skin, liver, kidney or testis of rats painted with nickel sulphate. There was no liver enlargement and the weight of liver showed no significant difference from those of controls. The testis did not show any marked atrophy or hypertrophy. The colour and weight of testis did not differ significantly from those of controls.

Microscopic observations

The results of microscopic examination on skin, liver and testis of control animals and those of groups I, II and III after 15 and 30 days of exposure to nickel sulphate are summarised in table 1. However, no abnormality was observed in kidney of nickel sulphate treated rats.

DISCUSSION

The dermal application of three different concentrations of nickel sulphate for different periods induced some varied tissue damage in rats which indicate some absorption of the metal through intact skin. A variety of metallic salts are known to induce testicular changes in experimental animals (MACHLEOD et al. 1949, PARIZEK 1960). KAMBOJ and KAR (1964) observed that intratesticular and subcutaneous injections of nickel nitrate cause varied testicular damages. Similarly HOEY (1966) and WALTSCHEWA et al. (1973) showed that subcutaneous administration of nickel sulphate has an effect on spermatogenesis and interstitium of rat testis. Since dermal absorption is a common mode of occupational poisoning, the observation of testicular lesions in our study gains special significance over those reports where nickel was administered through other routes and also suggests an appreciable absorption of nickel sulphate through the skin.

The clinical picture of allergic contact dermatitis, after regular contact of workers with small amounts of nickel depends upon the source and quantity of the metal that gets deposited on the skin (FEUERMAN 1973). This seems reasonable as in our own study a higher con-

TABLE 1 - RESULTS OF MICROSCOPIC EXAMINATION OF TESTIS, SKIN AND LIVER OF RATS AFTER DERMAL APPLICATION OF NICKEL SULPHATE.

Tissue	Group	Dose mg Ni/kg	15 days	30 days
	I	40	Normal	Normal
Testis	II	60	Normal	Tubular damage; lumen filled with degenerated sperms and oedematous fluid.
	III	100	Normal	Increased tubular degeneration and oedema; epithelium of the seminiferous tubules distorted; testis of one of the rats showed necrotic tubules carrying a few giant cells (Fig. 2).
	IV	Saline only	Normal	Normal (Fig. 1)
Skin	I	40	Normal	Distorted epidermis with slight hyperkeratinization.
	II	60	Normal	Hydropic degeneration of basal layer; flattening of rete ridges; hyperkeratinization (Fig. 4).
	III	100	Distorted epidermis and dermis	Epidermis showing atrophy in some areas and acanthosis in other areas; disorder in the arrangement of epidermal cells; hyperkeratinization increased.
	IV	Saline only	Normal	Normal (Fig. 3)
Liver	I	40	Normal	Normal
	II	60	Hepatocytes swollen; feathery degeneration	Focal necrosis; congestion and dilatation of sinusoids; vacuolation; and feathery degeneration of the hepatocytes (Fig. 6).
	III	100	Changes as in group II	Changes as in group II
	IV	Saline only	Normal	Normal (Fig. 5)

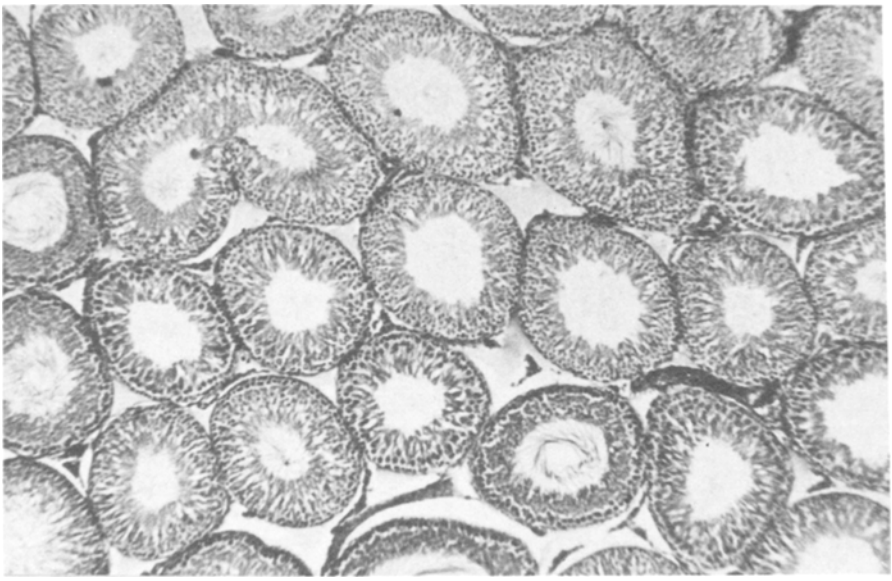

Fig. 1. Section of the rat testis after saline painting on skin for 30 days. Note normal histology, shape of the seminiferous tubules and interstitium. (X 80).

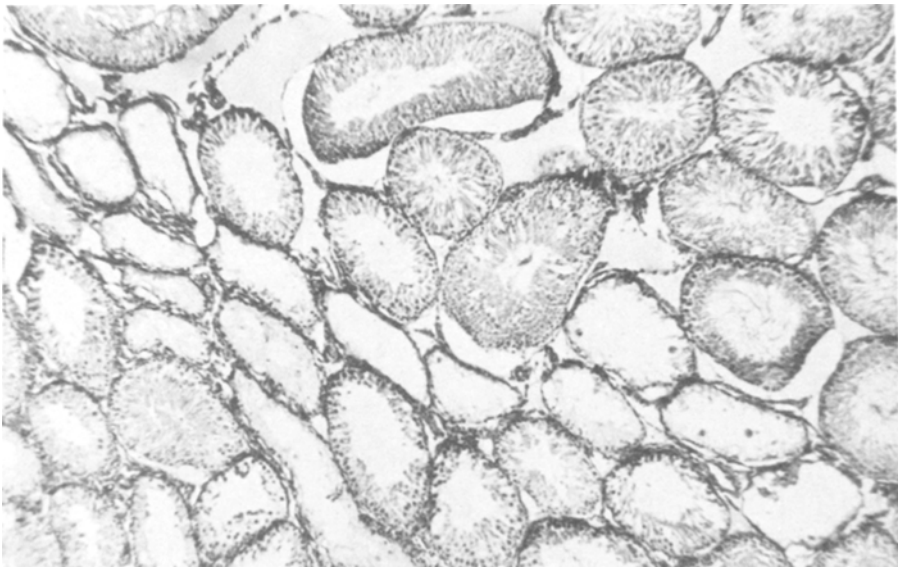

Fig. 2. Section of rat testis after nickel (100 mg Ni/kg/day) painting on skin for 30 days. Note seminiferous tubules, shrunken, necrosed and tubules devoid of spermatogenic cells. (X 80).

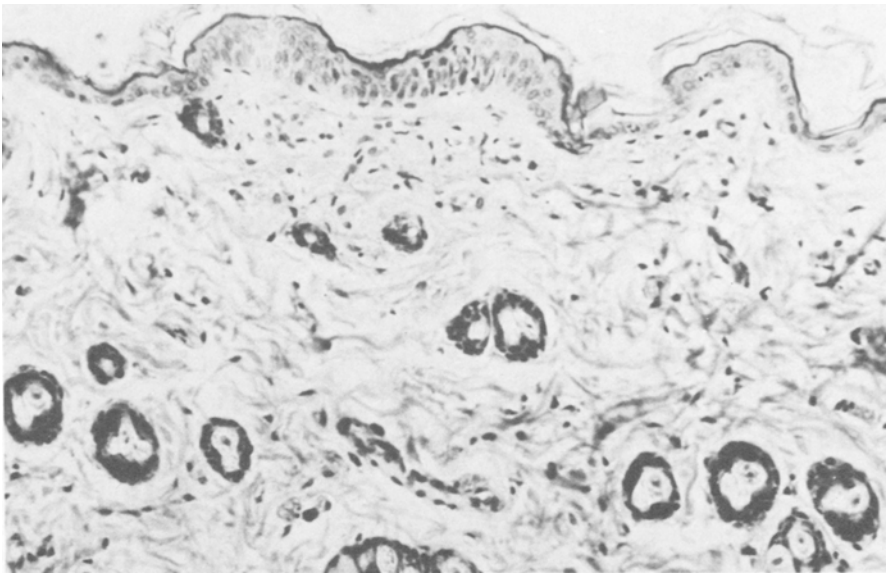

Fig. 3. Section of rat skin after saline treatment for 30 days. Note normal epidermis and dermis. (X 250).

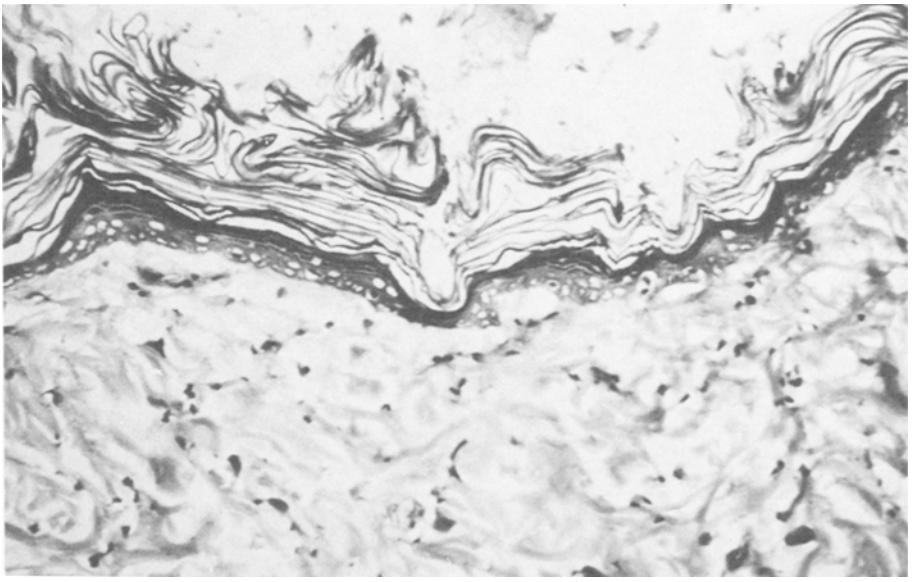

Fig. 4. Skin of rat after nickel painting (60 mg Ni/kg/day) for 30 days. Epidermal cells showing vacuolization and hyperkeratinization. (X 250).

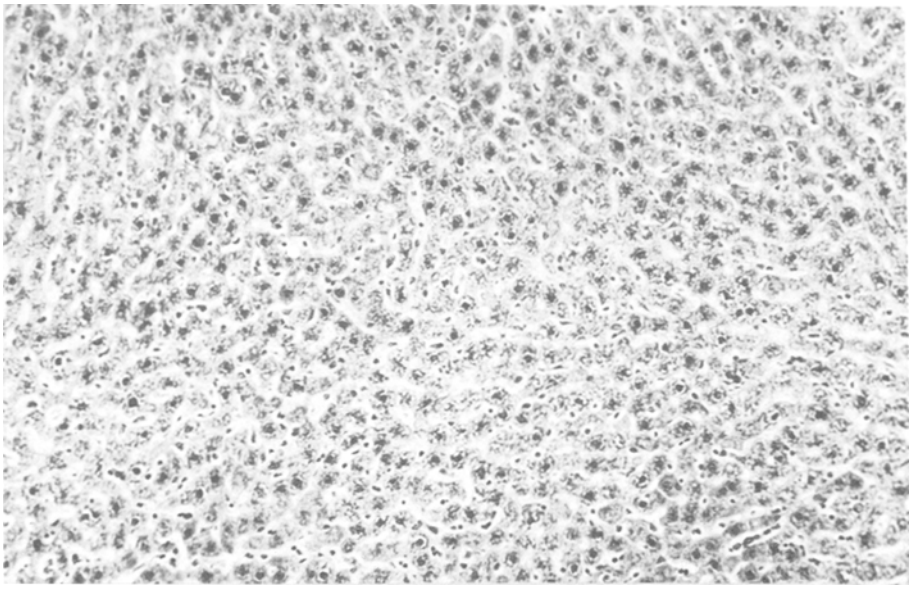

Fig. 5. Section of liver of the saline treated rats. Note normal hepatocytes and histology. (X 170).

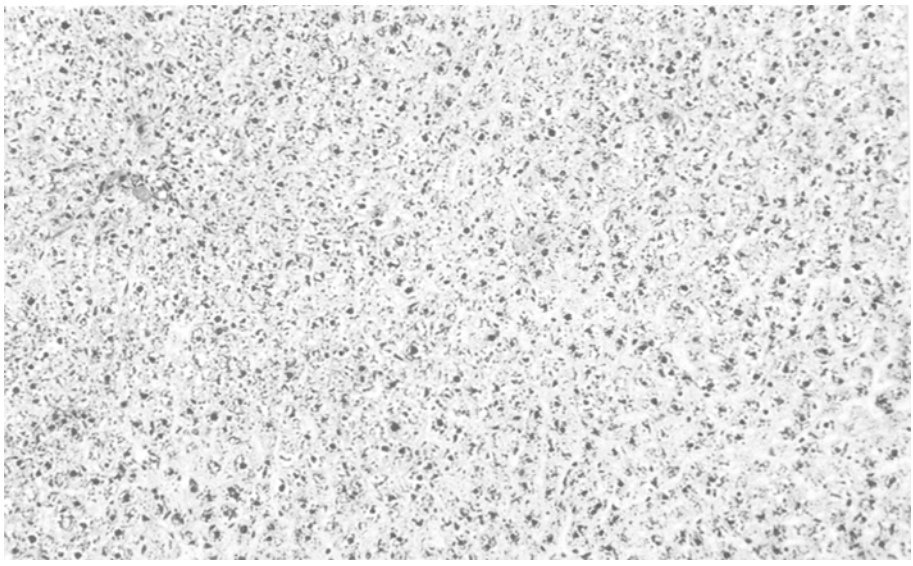

Fig. 6. Rat liver after nickel painting (60 mg Ni/ kg/day) for 30 days. Note focal necrosis congestion of sinusoids and vacuolization of hepatocytes. (X 170).

centration of nickel sulphate when applied to skin for a longer period produced more degenerative changes in skin, testis and liver than those resulted from the application of lower concentrations of the metal for the same period. Further, there was practically no tissue damage in animals treated for the shorter period even with the higher concentration. Thus the extent of tissue damage appears to be directly proportional to the concentration of the metal salt as well as to the duration of its application. The absence of any significant histopathological lesions in liver and practically no changes in kidney may probably be due to their involvement in the detoxification and excretion of the toxins.

The effect of temperature and moisture, the possible important contributing factors for the "nickel rash" (BULMER and MACKENZIE 1926) on the absorption of nickel through skin and subsequent damage to it or internal organs could not be understood from the present study which was conducted only at the room temperature and the normal relative humidity. However, it may be anticipated that workers at a nickel refinary at an elevated temperature or persons exposed to nickel during hot weather with increased sweating, the absorption of the metal may be higher followed by more severe damage to skin and possibly to the internal organs.

SUMMARY

Cytopathological and histopathological changes in skin, liver, kidney and testis of rats due to nickel sulphate have been studied experimentally. Skin of nickel sulphate painted rats showed hyperkeratinization, vacuolization, hydropic degeneration of basal layer and atrophy of epidermis. The testis showed degeneration and oedema of seminiferous tubules, while liver showed areas of focal necrosis, congestion and dilatation of sinusoids.

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