

Nickel penetration through rubber gloves

LEON M. WALL

St. John's Hospital for Diseases of the Skin, London, England

Positive patch tests confirm nickel penetration through rubber gloves. Dimethylglyoxime (DMG) results indicate that nickel reactivity may occur where DMG testing is negative.

Key words: Dimethylglyoxime – nickel penetration – rubber gloves.

Received for publication April 9, 1980

Mouridsen & Faber (1973) showed that positive patch tests to nickel sulphate (2.5 % pet) could be obtained even when the allergen was separated from nickel-sensitive skin by a segment of rubber glove material. Similar tests using polyvinyl chloride (PVC) material instead of rubber proved negative.

During a recent investigation of an outbreak of nickel dermatitis in an electroforming factory (Wall & Calnan 1980), it was found that the inside lining of the fingertips of the operators' used rubber gloves was dimethylglyoxime (DMG) positive.

This could possibly have been due to spillage of nickel solution into the glove or to absorption of nickel through the glove fabric.

The following investigations were carried out to elucidate this point.

Methods

Patch tests were done on five nickel-sensitive subjects using nickel sulphate, nickel chloride and nickel sulphamate (all 5 % pet). The allergens were placed in a Finn chamber and separated from the subject's skin by 3.0 cm squares of rubber glove and

PVC glove material, respectively. The patches were removed at 2 days and read 20 min later and again at 4 days. Patch tests with the glove material alone were also carried out. At 2 days, DMG tests were carried out (Fisher 1973) on the skin at the patch test site, the inner aspect of the glove material directly opposite the Finn chamber, and on the outer aspect of the glove surrounding the Finn chamber. DMG tests were also made on serial dilutions (1, 0.1, 0.05, 0.025 and 0.01 %) of aqueous nickel sulphate solution.

Discussion

There seems little doubt that nickel salts penetrate rubber but not PVC glove material. The positive patch tests were always directly opposite the Finn chamber and rounded in shape. Negative DMG results away from the chamber edge indicate that the nickel allergen had not 'crept' around the edge of the glove segment square. The negative results with the glove materials exclude these as a possible cause of the positive patch tests.

The DMG studies indicate that concentra-

Results

1. Patch tests using glove material

Patients	Glove materials	Nickel sulphate	Nickel chloride	Nickel sulphamate	Rubber glove	PVC glove
B.B.	Rubber	—	++	++	—	—
	PVC	—	—	—	—	—
S.D.	Rubber	++	++	++	—	—
	PVC	—	—	—	—	—
H.C.	Rubber	—	++	++	—	—
	PVC	—	—	—	—	—
B.C.	Rubber	++	++	++	—	—
	PVC	—	—	—	—	—
R.D.	Rubber	++	++	++	—	—
	PVC	—	—	—	—	—

2. DMG tests

- a) On the skin at patch test sites all negative
- b) On inner aspect of gloves at patch test sites all negative
- c) On outer aspect of glove — adjacent to Finn chamber all positive
- On outer aspect of glove — at 3 mm from chamber edge all negative

3. DMG tests on nickel solution

- 1.0 % +ve
- 0.1 % +ve
- 0.05 % +ve
- 0.025 % —ve
- 0.01 % —ve

trations of nickel ions less than 0.05 % in solution are sufficient to cause positive patch tests in sensitive subjects when there is the added influence of rubber occlusion. This could possibly be due to increased absorption of nickel through occluded skin.

Marzulli & Maibach (1974) stated that sweating skin enhanced solubilization of nickel, favouring skin penetration and ultimately sensitization. This is perhaps not surprising in view of Wells' (1956) elegant studies which showed that most nickel applied to the skin is held in the outer layers of the stratum corneum, and deeper penetration under normal conditions occurred only at sweat duct and hair follicle openings.

Nickel sulphate (0.05 %) solution is equal to approximately 25 $\mu\text{m/l}$ which is slightly above Malten & Spruit's (1969) threshold concentration at which not even the most sensitized patient showed a reaction in a 6-h cup test (10 $\mu\text{m/l}$). Malten felt that the cup test was a better imitation of real life circumstance than the patch test.

It may be wrong to equate these concentrations with the levels of nickel needed to produce clinical eruptions in sensitive patients. However, in the electroforming works it appeared that rubber gloves may have not only allowed absorption of nickel ions but also, via an occlusive effect, enhanced the absorption of nickel ions into the der-

mis, thus increasing the chances of development of sensitization and/or clinical reactions.

These studies repeatedly show positive patch test reactions to nickel concentrations below the level needed to produce a positive DMG reaction. Perhaps there are some clinical situations, e.g. occlusion under a watch or ring plus sweating, which could simulate these patch test conditions. However, the majority of clinical situations relevant to a nickel-sensitive object would still be expected to produce positive DMG reactions.

Acknowledgment

The assistance of Drs. C. D. Calnan, Etain Cronin and R. J. G. Rycroft of the Industrial Dermatoses Clinic, St. John's Hospital for Diseases of the Skin, London in carrying out this study is gratefully acknowledged.

References

- Fisher, A. A. (1973) *Contact Dermatitis*, 2nd ed., p. 98. Philadelphia: Lea and Febiger.
- Malten, K. E. & Spruit, D. (1969) The relative importance of various environmental exposures to nickel in causing contact hypersensitivity. *Acta Dermato-venereologica* 49, 14-19.
- Marzulli, F. N. & Maibach, H. I. (1974) The use of graded concentrations in studying skin sensitizers. Experimental contact sensitization in man. *Food and Cosmetic Toxicology* 12, 219-227.
- Mouridsen, H. T. & Faber, O. (1973) Penetration of protective gloves by allergens and irritants. *Transactions of the St. John's Hospital Dermatological Society* 59, 230-234.
- Wall, L. M. & Calnan, C. D. (1980) *Contact Dermatitis*. Accepted for publication.
- Wells, G. C. (1956) Effects of nickel on the skin. *British Journal of Dermatology* 68, 237-242.

Address:

Dr. L. Wall
Queen Elizabeth Medical Centre
Perth
Western Australia

PVC
glove

—

—

—

—

—

negative
negative
positive
negative

) solution is equal
which is slightly
(1969) threshold
at even the most
a reaction in a
often felt that the
ation of real life
ch test.
ate these concen-
nickel needed to
in sensitive pa-
troforming works
gloves may have
on of nickel ions
effect, enhanced
ons into the der-