Journal of Pakistan Association of Dermatologists. 2015;**25 (3)**:169-176.

Original Article

Clinico-epidemiological study on metal-induced contact dermatitis from North India

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Abstract

Objective To determine the prevalence of metal sensitization and different clinical patterns in suspected patients of metal induced contact dermatitis.

Methods This was an epidemiological study during which a total of 100 patients suspected and provisionally diagnosed as having contact dermatitis to metals were subjected to a patch test with Indian Standard Battery developed by CODFI (Contact and Occupational Dermatoses Forum of India). Results were read after 48hrs of application and a second reading, if required, was taken after 72-96hrs.

Results Most of the patients in this series presented with hand eczema (40%), which was followed by dermatitis localized to site of contact with metal (20%) and facial dermatitis including eyelid dermatitis (15%). Twenty-seven patients showed positive reactions to metal allergens. Cross-sensitivity was low and three patients or 11.11% showed sensitization to two metal allergens. No patient showed sensitization to all the three metals.

Conclusion Nickel was the commonest metal allergen identified and it was relevant in 100% of the cases. It showed a strong female preponderance. Patch testing is hence a helpful diagnostic aid in identifying the agents responsible for contact dermatitis and a sincere effort should be made to determine clinical relevance of the test results in every case.

Keywords
Contact dermatitis, metal, clinico-epidemiological study.

Introduction

Contact dermatitis is an inflammatory response of the skin as a result of exposure to an exogenous agent and the agent, which produces this type of dermatitis, is called the contact allergen or contactant. It is a common problem accounting for 4-7% of all dermatological consultations.[1] Metals, as a group, are the most common contact allergens and nickel ranks as the most common of all screening agents.[2-4] It has been rightly said by the International Nickel Company in a brochure titled "The Romance of Nickel" that "Nickel is with you and does things for you from the time you get up in the morning until you go to sleep at night". On account of its significant public health importance, the American Contact Dermatitis Society (ACDS) named nickel as the "Contact Allergen of the Year" in 2008.[5] It is commonly found in consumer articles like jewellery, cutlery, kitchen equipment, hardware, sporting goods, wire screens, electrical equipment, metallic buttons, make-up products etc.[6-8] Occupational exposure

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to nickel is common in metal plating industries, cashiers, kitchen workers, seamstresses, restaurant workers, and hairdressers.

Other metal allergens widely used in patch test screening kits are cobalt and potassium dichromate. Since cobalt coexists with nickel in nature, nickel based alloys used in consumer products also contain cobalt, resulting in concomitant exposure and sensitization to both the metals. Cobalt is used to produce jewellery,[9] spectacle frames and wristwatches.[10] People may also be exposed to cobalt in certain nonmetallic products, for example, detergents and pigments used in paint, tattoos, and shoes.[11] The main source of chromium is cement, although the content varies widely depending upon the manufacturer. Construction workers, artists and do-it-yourself homebuilders are exposed to cement and the hazards of cement dermatitis. Occupational contact dermatitis clinics in Germany conducted patch tests on construction workers, which showed that potassium dichromate was the commonest allergen (31.9%) among them whereas chromate sensitivity was found in less than 2% of patients attending the general patch test clinic.[12]

The present study was conducted with an aim to determine the prevalence of metal sensitization and different clinical patterns in suspected patients of metal induced contact dermatitis.

Methods

This was an epidemiological study conducted from January 2013 to December 2014. A total of 100 patients suspected and provisionally diagnosed, as having contact dermatitis to metals and attending the dermatology OPD at DMC&H Ludhiana were selected for the study. Detailed clinical history and cutaneous examination with special reference to pattern and morphology of dermatitis, exacerbating factors, sites involved and other suspected allergies was performed in each case. Particular attention was paid to risk factors in the form of ear piercing, occupational triggers like jewellery related profession, industrial workers and other miscellaneous professions related to metal work. Patients presenting with acute dermatitis, those on steroids and other immunosuppressants were excluded from the study. The patients were then subjected to a patch test with Indian Standard Battery developed by CODFI (Contact and Occupational Dermatoses Forum of India). Metal allergens in the testing kit included potassium dichromate, nickel sulphate and cobalt sulphate.

The results were read after 48 hours of application. First reading was taken 45-60 minutes after removing patches allowing adequate time for erythema due to stripping of tape to settle down. Second reading was taken, if required, after 72 or 96 hours to confirm the presence of allergic reaction that persisted or increased while irritant reaction decreased. In all the patients, clinical relevance of positive allergens was determined based upon the history and examination to isolate all the probable contactants.

Results

In the series, 35 females tested positive as compared to 20 males. Overall, 55 of the 100 tested patients had a positive patch test reaction. The age group with the most patch test positive patients was 40-49 years (15 patients). Age and sex distribution of these patients is outlined in **Table 1**.

Twenty-seven patients showed positive reactions to metal allergens. 24 patients among these i.e. 88.29% showed a positive reaction to single metal allergen. Cross sensitivity was low and three patients or 11.11% showed sensitization to

Table 1 Age and sex distribution.

Age (years)	*Males*			*Females*			*Total*		
	No. of cases tested	*Positive cases*	*%*	*No. of cases tested*	*Positive cases*	*%*	*No. of cases tested*	*Positive cases*	*%*
10-19	3	2	66.67%	5	4	80.00%	8	6	75.00%
20-29	5	4	80.00%	19	7	36.84%	24	11	45.83%
30-39	9	3	33.33%	14	8	57.14%	23	11	47.83%
40-49	6	2	33.33%	19	13	68.42%	25	15	60.00%
50-59	13	7	53.85%	5	3	60.00%	18	10	55.56%
≥60	2	2	100.00%	0	0	0.00%	2	2	100.00%
Total	38	20	52.63%	62	35	56.45%	100	55	55.00%

Table 2 Distribution of patients according to clinical patterns

Clinical pattern	*No. of cases tested*	*Patients with positive results*		*Patients with positive results to probable contactants (relevant)*	
		No.	*%*	*No.*	*%*
Localized (to area of contact)	20	16	29.09%	14	35.90%
Face	15	9	16.36%	8	20.51%
Hand	40	18	32.73%	7	17.95%
Mixed	5	4	7.27%	4	10.26%
Foot	10	3	5.45%	3	7.69%
ABCD	2	2	3.64%	1	2.56%
Acrofacial	1	1	1.82%	1	2.56%
Palmoplantar	7	2	3.64%	1	2.56%
Total	100	55	100.00%	39	100.00%

ABCD = air-borne contact dermatitis

Table 3 Correlation of positive patch test results with occupation

Occupation	*No. of cases tested*	*Patients with positive results*		*Patients with positive results to probable contactants (relevant)*	
		No.	*%*	*No.*	*%*
Housewife	42	24	43.64%	17	43.59%
Student	15	9	16.36%	5	12.82%
Farmer	10	6	10.91%	4	10.26%
Teacher	6	3	5.45%	3	7.69%
Construction worker	3	3	5.45%	2	5.13%
Medical/Paramedical staff	4	2	3.64%	2	5.13%
Service/clerical work	4	2	3.64%	2	5.13%
Businessman/ shopkeeper	7	2	3.64%	1	2.56%
Mechanic	2	1	1.82%	1	2.56%
Police	1	1	1.82%	1	2.56%
Retired	2	2	3.64%	1	2.56%
Chemical engineer	1	0	0.00%	0	0.00%
Gardener	1	0	0.00%	0	0.00%
IT Engineer	1	0	0.00%	0	0.00%
Tailor	1	0	0.00%	0	0.00%
Total	100	55	100.00%	39	100.00%

two metal allergens. Among them, two patients had a positive reaction to nickel and cobalt both while one patient had a positive reaction to nickel and chromate. No patient showed sensitization to all the three metals. Cross sensitization was not seen in males. The highest

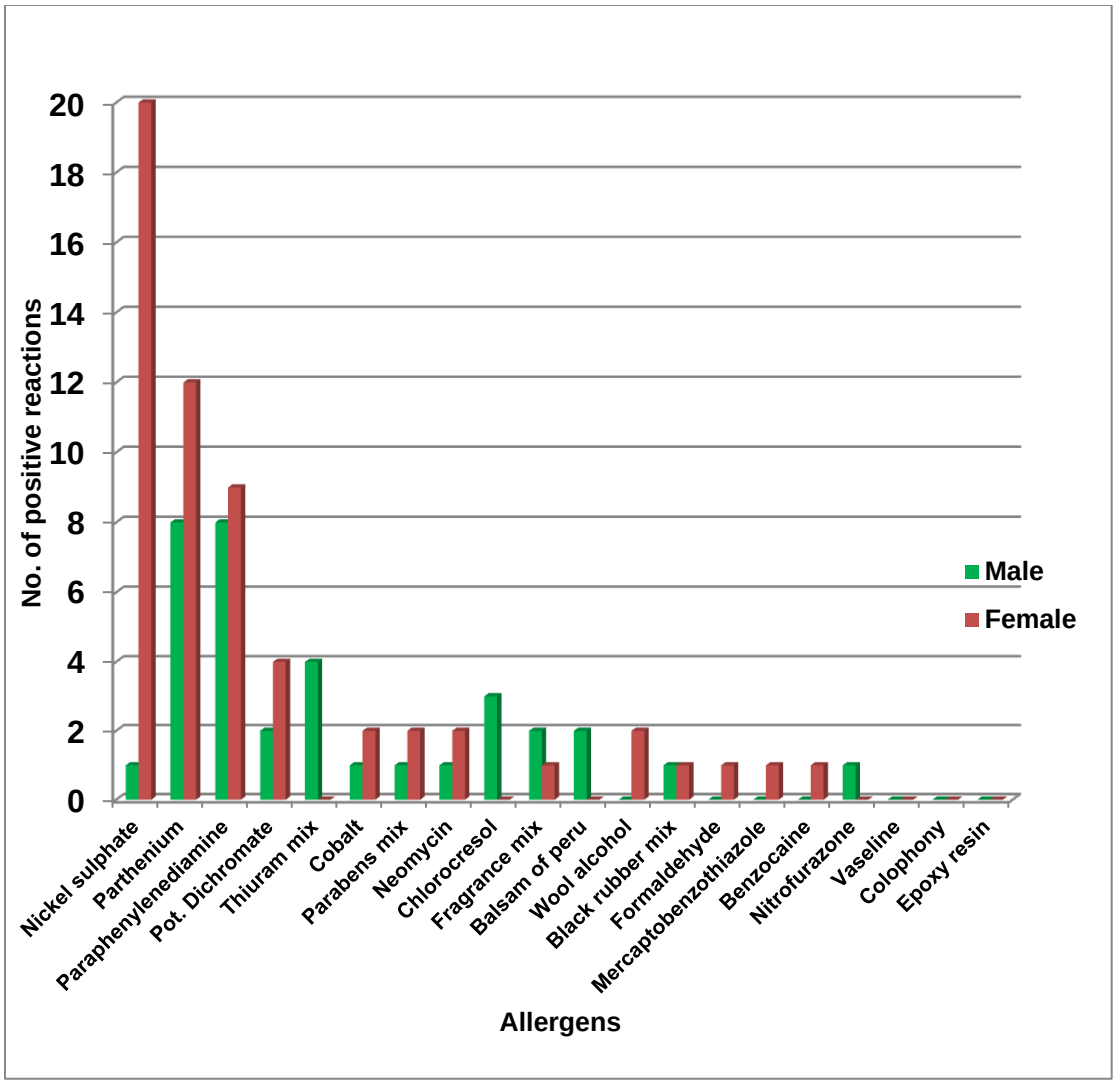

Figure 1 Etiological profile of various allergens established by patch testing

Figure 1 Dermatitis at site of contact with belt buckle.

number of positive responses was seen to nickel sulphate (21%). Details of the results obtained after testing with the twenty allergens in the kit are shown in **Figure 1**. **Figure 2** and **3** show examples of the clinical presentations showing positive reactions to metal allergens.

Figure 2 Earlobe dermatitis due to earrings

Clinically relevant reactions or positivity to probable allergens was observed in 39% of the cases while 16% showed a positive reaction to an unrelated or irrelevant allergen.

The clinical involvement observed in the patients was grouped into eight clinical patterns according to the sites involved.

- Hand eczema
- Foot eczema
- Palmoplantar eczema
- Facial dermatitis (including eyelid dermatitis)
- Acrofacial dermatitis (involving hands and face)
- Dermatitis localized to area of contact with metal, such as involvement of earlobes due to earrings
- Airborne contact dermatitis like pattern (ABCD)
- Mixed pattern or generalized (involving two or more of the clinical patterns described above).

Distribution of positive reactions in these groups is depicted in **Table 2**. Occupational history of the patients formed an important part of their evaluation and this was correlated with their respective patch tests results (**Table 3**).

Discussion

In the present study, 27 patients (27%) tested positive to metal allergens. Nickel had the highest incidence of positivity (21 patients or 21%). Hence, incidence of nickel hypersensitivity in metal reactors was found to be 77.78%. Cobalt and chromium were positive in three and six patients each. Clinical relevance for nickel, cobalt and chromium was present in 100%, 33.33% and 66.67% of the patients respectively. On reviewing the literature, nickel has been reported as the most allergen in many studies (**Table 4**).

Some European studies have reported decreasing prevalence of nickel allergy following the European Union Nickel Directive, according to which nickel content and release rates have been limited to <0.5 μg/cm^2/week for products intended to come into direct and prolonged contact with the skin. Johansen et al showed that the prevalence of nickel allergy decreased significantly from 24.8% in 1985-1986 to 9.2% in 1997-1998 in Danish children aged 0-18 years.[25] In Poland, the prevalence of nickel allergy decreased from 15.9% in 1995 to 10.0% in 2004 in female dermatitis patients aged under 20 years.[26] To the best of our knowledge, no such regulation has been made in India so far.

In the present study, twenty six females tested positive to a metal allergen as compared to four males (male:female ratio= 2:13). Among the twenty-one positive patients, females again outnumbered males by 20:1 and this difference was significant (p =0.000). Higher incidence of nickel hypersensitivity in females has been reported in various other studies. A German study conducted by Uter *et al*.[27] utilizing patch test data from 74,940 patients showed a strong association between female gender and nickel allergy with a prevalence ratio of 3.74. Thyssen *et al*.[28] showed that the median prevalence of nickel allergy was higher among women than men (17.1%). Calnan[29] and Gaul[30] individually described that nickel allergy was much more common in female patients due to nickel in suspenders and jewellery. However, in 1969, Kanan reported that prevalence of nickel allergy was higher in male Kuwaiti dermatitis patients, mainly due to nickel in wristwatches and press-studs in underpants.[31] Overall, the higher prevalence of nickel allergy in women can be explained by the higher prevalence of ear and body piercing and exposure to costume jewellery in women than in men.

Table 4 Most common metal allergen in published literature

Authors	*Year of publication*	*Most common metal allergen*
Davis *et al.*[13]	2011	Nickel (22.5%)
García-Rabasco *et al.*[14]	2014	Nickel (24.2%)
Khatami *et al.*[15]	2013	Nickel (20%)
Akyol *et al.*[16]	2005	Nickel (17.6%)
Goon *et al.*[17]	2005	Nickel (19.9%)
Cheng *et al.*[18]	2008	Nickel (17.7%)
Fransway *et al.*[19]	2013	Nickel (19.5%)
Warshaw *et al.*[20]	2013	Nickel (15.5%)
Dou *et al.*[21]	2011	Nickel (25.7%)
Handa *et al.*[22]	2011	Potassium dichromate (12.3%)
Hassan *et al.*[23]	2013	Nickel (16.1%) Potassium dichromate (16.1%)
Majid[24]	2014	Nickel (12.8%)
Present study	2014	Nickel (21%)

Most of the patients in this series presented with hand eczema (40%), which was followed by dermatitis localized to site of contact with metal (20%) and facial dermatitis including eyelid dermatitis (15%). On further investigation with patch testing highest frequency of nickel positivity was seen in localized pattern (61.90% of nickel sensitive patients) followed by hand eczema (28.57%). Hand eczema was also the most common presenting dermatitis in a study conducted by Fransway *et al.*[19] and Ruff *et al.*[32] while airborne contact dermatitis (ABCD) affecting face, neck, flexures of arms, and legs was the most common pattern, followed by localized allergic contact dermatitis, hand dermatitis and footwear dermatitis in a study conducted by Handa *et al.*[22] Our findings differ from those obtained by Cheng *et al.*[18] Among the metal-sensitized individuals, common sites of dermatitis were the upper extremities, face, and hands in decreasing order. Those patients who were nickel positive showed a predilection for face (37.6%), upper extremities (36.6%) and hands (17.9%). One explanation for this difference could be the fact that our study, all the patients presenting with dermatitis of limbs, abdomen etc. were clubbed together as a single group of patients i.e. localized dermatitis.

Potassium dichromate was the most common metal allergen reported from a contact dermatitis clinic in North India,[22] in which 12.3% patients showed a positive reaction to potassium dichromate followed by 11.9% to nickel sulphate. However, in their study males (54.1%) outnumbered females (45.9%) and this could account for higher positivity to chromate since chromate sensitivity is more common in males while nickel sensitivity is commoner in females. This difference could also be partly attributed to the fact that chromium sensitivity is primarily seen in construction workers who constituted only a minority of the patients in our study (3 patients).

Conclusion

Metal induced contact dermatitis is a frequently encountered problem in dermatology clinics and it can manifest in different clinical patterns. The main limitation in our study was that dimethylglyoxime test was not incorporated into the study, hence, source of exposure or evidence of nickel release from the patients' own objects could not be identified. The representation of metal workers (mechanics, plating industry workers etc.) was less. This was probably due to the fact that they comprise a lower income group and prefer going to government hospitals. Nickel was the commonest metal allergen identified and it was relevant in 100% of the cases. Nickel hypersensitivity showed a strong female

preponderance. Patch testing is hence a helpful diagnostic aid in identifying the agents responsible for contact dermatitis and a sincere effort should be made to determine clinical relevance of the test results in every case.

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