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ORIGINAL ARTICLE

Occupational hand dermatitis among cement workers in Taiwan

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Background/Purpose: Occupational dermatitis among cement workers is a major occupational health concern. The two most important occupational hazards for cement workers are irritant and allergic cement contact dermatitis. The objective of this study was to investigate the severity of occupational cement contact dermatitis and the common allergens among cement workers in Taiwan.

Methods: A total of 97 cement workers from the Cement Workers' Association of Tainan City and County participated in this study. A structured questionnaire was used to evaluate the demographic data and work-related activities of these cement workers. A complete skin examination was conducted, and skin manifestations were assessed by a dermatologist. Allergens from European Standard Tray (Chemotechnique Diagnostic AB, Sweden) with a total of 25 substances were used for patch testing.

Results: Our results showed that 65 out of 97 cement workers were suffering from occupational cement hand contact dermatitis. The most affected skin area was the hand. Thickening of the dorsal surface of the hand, especially around the metacarpophalangeal joint area, and hyperkeratosis of the palm were the major skin manifestations. The results of the patch test showed that 24 out of 97 were allergic to potassium dichromate, nine were allergic to thiuram mix, nine were allergic to fragrance mix and seven were allergic to cobalt chloride. The final diagnosis, based on the results of the skin examination and the patch test, showed that 43 of 97 cement workers had irritant cement contact dermatitis and 22 had allergic cement contact dermatitis.

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Conclusion: We conclude that occupational cement hand dermatitis among cement workers is an important and severe issue in Taiwan, and the most common allergens among cement workers are potassium dichromate, thiuram mix, fragrance mix and cobalt chloride. The high positive rate of chromium hypersensitivity among cement workers reflects the urgency to regulate the addition of ferrous sulfate to cement in Taiwan.

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Introduction

Skin in contact with cement has been associated with irritant cement contact dermatitis and allergic cement contact dermatitis.¹ Cement contains the following substances: silicon dioxide (SiO₂), aluminium oxide (Al₂O₃), iron oxide (FeO₃), magnesium oxide (MgO), sulfur dioxide (SO₂) and calcium oxide (CaO). When calcium oxide comes into contact with water, it becomes calcium hydroxide (Ca(OH)₂), which is a highly alkaline substance, with a pH value of 11–13. It is a very strong irritant to the skin, and may sometimes produce skin erosion and even skin necrosis.¹ The common allergens affecting cement workers are: epoxy resin, colophony, formaldehyde, nickel, rubber gloves and cobalt, but the worst offender is hexavalent chromium.² Cement workers' hands are regularly in contact with cement, so once they suffer from hand contact dermatitis as a result of exposure to cement, they are susceptible to recurrence and complete recovery is very difficult,³ which may compromise their work efficiency. The necessity to frequently visit a physician makes them lose work time too.⁴ A previous study in Taiwan showed that 16.5% of male and 7.2% of female cement workers developed chromium hypersensitivity as a result of cement exposure.⁵ The objectives of our study were to investigate the severity of occupational cement contact dermatitis and the common allergens among cement workers in Taiwan.

Materials and methods

We studied members of the Cement Workers' Association of Tainan City and County and 97 cement workers were recruited. A complete skin examination was conducted and skin manifestations were assessed by a dermatologist through symptom questionnaire and physical examination. Photographs of hands were taken during the examination for further review. Dermatitis was diagnosed if erythema, maculopapules, hyperkeratosis, and/or skin thickening were present. The European Standard Tray (Chemo-technique Diagnostic AB, Sweden) with 25 substances, including potassium dichromate of 0.5% in petrolatum, was used. The testing agents were applied to Finn chambers (Epitest Ltd, Helsinki, Finland), which were fixed to the upper back with Scanpor tape then secured by 3 M tape. The patches were removed after 48 hours and the sites were examined for evidence of reaction. The sites were re-examined at 72 hours by the same dermatologist. The reading at 72 hours was considered positive if the skin reaction was equal to or greater than erythema and infiltration, possibly with papules and vesicles. All individuals

signed an informed consent form before undergoing the skin examination.

Four dermatitis terms used in this study were defined as: (1) Cement dermatitis: cement dermatitis was diagnosed if erythema, maculopapules, hyperkeratosis, and/or skin thickening were present; (2) Allergic cement contact dermatitis: cement dermatitis with a concomitant chromium hypersensitivity; (3) Irritant cement contact dermatitis: cement dermatitis without a concomitant chromium hypersensitivity; and (4) Chromium hypersensitivity: a positive patch test to potassium dichromate.¹

Results

A total of 97 cement workers completed the skin examination and patch test. The mean age of the cement workers was 47.0 for males, and 54.1 years for females; overall, 83.5% of the cement workers were over 40 years old. The mean duration of having been a cement worker was 26.9 years for the males, and 28.2 years for the females (Table 1). In addition, 27.8% of cement workers were smokers and 36.1% drank alcohol. Only 23% of the males always used protective gloves during work, while 38% used gloves occasionally or never. However, 86% of the females always used gloves during work while only 4% used gloves occasionally or never (data not showed). Skin examination showed that the hands were the most affected area. A total of 65 out of 97 cement workers had hand cement contact dermatitis, whereas the forearm (seven workers), wrist (five workers), nail (five workers) and other skin areas (10 workers) were affected less often. The skin examination highlighted two important results. There was thickening of the skin over the dorsal surface of the hand, especially near the metacarpophalangeal joint, and hyperkeratosis over the

Table 1 Demographic characteristics of cement workers.

Age groups (years)	No. of males (%)	No. of females (%)
20–29	7 (7.2%)	0 (0%)
30–39	9 (9.3%)	0 (0%)
40–49	23 (23.7%)	6 (6.2%)
50–59	19 (19.6%)	18 (18.6%)
60–69	11 (11.3%)	4 (4.1%)
Total	69 (71.1%)	28 (28.9%)
Age (mean ± SD)	47.0 ± 10.8	54.1 ± 6.3
Duration of being a cement worker (years)	26.9 ± 11.4	28.2 ± 9.3

Table 2 Skin manifestations of cement workers.

Symptoms	Positive (%)	Severity		
		(+)	(++)	(+++)
Thickened/lichenified	63 (64.9%)	32 (33.0%)	25 (25.8%)	6 (6.2%)
Hyperkeratosis	58 (59.8%)	32 (33.0%)	26 (26.8%)	
Scaling	34 (35.1%)	30 (30.9%)	4 (4.1%)	
Dryness	32 (33.0%)	29 (29.9%)	3 (3.1%)	
Erythema	25 (25.8%)	23 (23.7%)	2 (2.1%)	
Fissure	20 (20.6%)	14 (14.4%)	5 (5.2%)	1 (1.0%)
Pigmentation	14 (14.4%)	13 (13.4%)	1 (1.0%)	
Vesicles/papules	13 (13.4%)	8 (8.2%)	5 (5.2%)	
Itching	5 (5.2%)	2 (2.1%)	3 (3.1%)	
Scratch	3 (3.1%)	2 (2.1%)	1 (1.0%)	
Edema	2 (2.1%)	1 (1.0%)	1 (1.0%)	
Erosion	2 (2.1%)	1 (1.0%)	1 (1.0%)	
Ulceration	1 (1.0%)	1 (1.0%)		

palm. Other significant manifestations included erythema, scaling, dryness and hyperpigmentation (Table 2).

The patch test results showed that 24 out of 97 cement workers were allergic to potassium dichromate, nine were allergic to thiuram mix, nine were allergic to fragrance mix, and seven were allergic to cobalt chloride. Other minor allergens included nickel sulfate (four cement workers),

Vioform (two cement workers) and colophony (two cement workers) (Table 3).

The skin examination and patch test results showed that 43 out of 97 cement workers had irritant cement contact dermatitis and 22 had allergic cement contact dermatitis (Table 4), reflecting a severe occupation-related hazard among cement workers.

Table 3 Findings of the patch test for cement workers.

Allergens	No. of cement workers	97/69/28 (Total/M/F)	
		Positive case (Total/M/F)	Positive percentage (%) (Total/M/F)
1	Potassium dichromate (0.5% in petrolatum)	24/23/1	24.7/23.7/1.0
2	4-Phenylenediamine base	0	0.0/0/0.0
3	Thiuram mix	9/6/3	9.3/6.2/3.1
4	Neomycin sulfate	0	0.0/0/0.0
5	Cobalt chloride	7/5/2	7.2/5.2/2.1
6	Benzocaine	0	0.0/0/0.0
7	Nickel sulfate	4/0/4	4.1/0/4.1
8	Clioquinol (Chinoform, Vioform)	2/2/0	2.1/2.1/0
9	Colophony	2/0/2	2.1/0.0/2.1
10	Paraben mix	1/1/0	1.0/1.0/0.0
11	N-Isopropyl-N-phenyl-4-phenylenediamine	0	0.0/0/0.0
12	Wool alcohols	0	0.0/0/0.0
13	Mercapto mix	1/1/0	1.0/1.0/0
14	Epoxy resin	1/1/0	1.0/1.0/0
15	Balsam Peru	1/1/0	1.0/1.0/0
16	4-tert-Butylphenol formaldehyde resin	0	0.0/0/0.0
17	Mercaptobenzothiazole (MBT)	1/1/0	1.0/1.0/0
18	Formaldehyde	0	0.0/0/0.0
19	Fragrance mix	9/5/4	9.3/5.2/4.1
20	Sesquiterpene lactone mix	0	0.0/0/0.0
21	Quaternium 15 (Dowicil 200)	0	0.0/0/0.0
22	Primin	0	0.0/0/0.0
23	Cl+Me-isothiazolinone (Kathon CG, 100 ppm)	1/1/0	1.0/1.0/0
24	Budesonide	0	0.0/0/0.0
25	Tixocortol-21-pivalate	0	0.0/0/0.0

F = female; M = male.

Table 4 Skin diseases diagnosed among cement workers.

No. of cement workers	97/69/28 (Total/M/F)	
	Case (Total/M/F)	Percentage (%) (Total/M/F)
Irritant cement contact dermatitis	43/37/6	43.3/38.1/5.2
Allergic cement contact dermatitis	22/22/0	22.7/22.7/0.0
Allergic contact dermatitis (not related to cement)	2/1/1	2.1/1.0/1.0
Normal skin with positive patch reaction	11/2/9	12.4/2.1/10.3
Normal	19/7/12	19.6/7.2/12.4

F = female; M = male.

Discussion

In this study 83.5% of cement workers were over the age of 40 years (Table 1). The mean duration of being a cement worker was around 27 years, which is approximately 10 years longer than reported previously by Guo et al.⁵ The location of affected skin was predominantly the hand, which was strongly consistent with previous observations.⁵ The most common skin manifestation among cement workers was thickening of the skin over the dorsal surface of the hand (64.9%), as well as hyperkeratosis over the palm (59.8%) (Table 2). Further significant manifestations included scaling (35.1%), erythema (25.8%), dryness (33%), fissure (20.6%) and hyperpigmentation (14.4%).

Previous studies in Europe and the USA have shown that the prevalence rate of chromium hypersensitivity among cement workers is around 4–5%.^{6,7} However, some countries show a very high prevalence rate, for example Taiwan 13%,⁵ Poland 23%⁸ and Singapore 40%.⁹ In this study, the positive rate of chromium hypersensitivity among the cement workers was as high as 24.5% (Table 3). Participants who already suffered from hand cement contact dermatitis would have been eager to take part in this study, and this would seem to explain the higher positive rate of chromium hypersensitivity. Nonetheless, since our study showed that the majority of cement workers have remained in their profession, we expect that continuous long-term exposure may account for the higher positive rate of chromium hypersensitivity found.

In addition, the previous study⁵ reported the sensitization rate to thiuram mix to be only 2.1%, and fragrance mix 6.6%. Our study, however, showed the sensitization rates of thiuram mix and fragrance mix to have increased to 9.2%. When cement workers suffer from hand cement contact dermatitis, they are motivated to begin wearing protective rubber gloves while at work. Unfortunately, these gloves contain thiuram mix which will induce allergic hand contact dermatitis. Therefore, we suggest only gloves free from thiuram mix should be worn. Another unique finding is that cement workers have a higher sensitivity to fragrance mix. Fragrance mix includes eight ingredients: cinnamic alcohol, cinnamic aldehyde, hydroxycitronellal, amylcinnam aldehyde, geranyl, eugenol, isoeugenol and oakmoss absolute.

All of these fragrances might be contained in hand-cleaning agents or protective hand creams. Cement workers are encouraged to use protective hand creams to prevent their hands from damage. However, because of the high prevalence of fragrance mix allergy in our findings, only fragrance-free hand-cleaning agents and protective hand creams are recommended. Our study also showed that cement workers with chromium hypersensitivity were predisposed to exhibit allergic reactions to cobalt chloride. This finding was consistent with previous studies.^{5,10}

The prevalence of chromium hypersensitivity in the general population is on average less than 1%.^{6,11} This means that the prevalence of chromium hypersensitivity among cement workers in Taiwan is 10–20 times more than that of the general population. So it is urgent and important to find effective preventative methods or regulations to reduce the high prevalence of chromium hypersensitivity among cement workers in Taiwan. Many strategies have been proposed to prevent chromium hypersensitivity in cement workers, including the use of protective gloves to prevent direct hand contact with cement,¹⁰ the use of protective barrier cream, such as ascorbic acid cream¹² and the addition of ferrous sulfate to cement.¹³ The addition of ferrous sulfate to cement was proven to be an effective way to reduce chromium hypersensitivity.¹⁴ It was found that in most countries the soluble hexavalent chromium concentration in cement was 10–20 ppm.¹⁵ In a previous study in Taiwan, the soluble hexavalent chromium concentration in cement was 0.04–19.5 mg/g, and 78% of cement samples contained a concentration of hexavalent chromium higher than 2 mg/g.¹⁶ This concentration is much higher than the minimum amount required to induce chromium hypersensitivity. A previous study has shown that reducing the hexavalent chromium level of cement to below 2 ppm can effectively prevent the induction of chromium hypersensitivity.¹⁴ Another study showed that the addition of ferrous sulfate to cement can reduce the hexavalent chromium level of cement to below 2 ppm,¹³ thus effectively preventing the induction of chromium hypersensitivity.¹⁴ However, there is no such regulation in Taiwan. We would strongly recommend that this important regulation be established urgently in Taiwan to protect cement workers from chromium hypersensitivity.

Selection bias is difficult to avoid in these types of field studies. The only selection criterion in this study was that volunteers be members of the Cement Worker's Association of Tainan City and County. While it is understandable that those already experiencing skin problems are more eager to volunteer for this study compared to those with no skin problems, another important factor for consideration is the healthy worker effect, where severe skin illness could cause cement workers to quit their job. Our data showed that only 16.5% of cement workers were under the age of 40 years. This suggested that the younger cement workers with skin problems had probably given up the occupation. So, although selection bias can occur, this study reflected the severity of occupational cement contact dermatitis and high positive rate of chromium hypersensitivity in cement workers in Taiwan.

We conclude that occupational cement hand dermatitis among cement workers is an important and severe issue in Taiwan and the most common allergens are potassium dichromate, thiuram mix, fragrance mix and cobalt

chloride. We recommend the addition of ferrous sulfate to cement, and the use of gloves without thiuram mix, to prevent occupational hand dermatitis in cement workers.

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