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Original article

Patch-test Results Using Korean Standard Series: A 5-year Retrospective Review

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Running title: Patch-test results in Korea (2009 - 2014)

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Abstract

Background: There have been few studies regarding the results of the Korean standard patch test.

Objectives: The purpose of this study was to analyze the type and frequency of common contact allergens in Korea and to compare the results with those of previous reports.

Methods: From June 2009 to June 2014, 330 patients with suspected allergic contact dermatitis who visited our clinic were tested using the Korean standard patch test.

Results: The highest sensitization rate was found for nickel sulfate (47.58%). There was a significant gender difference in the prevalence of sensitization to nickel sulfate (OR=2.41, P=0.0004) and wool alcohol (OR=2.85, P=0.0358). Higher sensitization to nickel sulfate (OR=1.18, P=0.0159), 4-phenylenediamine (OR=1.23, P= 0.003), and tixocortol-21-pivalate (OR 1.48, P=0.0212) and lower sensitization to thimerosal (OR=0.77, P=0.0023) were associated with increasing age. Patients with allergic contact dermatitis on the scalp had a significantly higher risk of sensitization to 4-phenylenediamine (OR=3.07, P=0.0013). Patients with allergic contact dermatitis on the hands had significantly higher risks of sensitization to wool alcohol (OR=3.44, P=0.0083), formaldehyde (OR=2.52, P=0.0178), and colophony (OR=2.05, P=0.0499).

Conclusions: These results demonstrate trends in patch test results in Korea and the basis for the presumption of the route of allergen exposure.

Key words: Allergen, Allergic contact dermatitis, Patch test

Introduction

Contact dermatitis is an inflammation of the skin caused by contact with external agents. The first step in diagnosing allergic contact dermatitis is a careful history taking. However, in many cases, this step is not sufficient to detect the causative allergen (1). Since its introduction to medicine by Joseph Jadassohn in 1895, patch testing has been an important and useful method for the detection of such allergens in patients suspected to have allergic contact dermatitis (2).

To identify the most common causative allergens in patients suspected of having allergic contact dermatitis, most physicians use a standard series of allergens specifically chosen to test every patient undergoing patch testing. Therefore, a “standard series” represents the allergens that most commonly cause allergic contact dermatitis in the population being patch tested (3).

A number of countries have developed their own standard series of allergens used in patch testing, such as the North American Standard Series, British Standard Series, European Standard Series, Japanese Standard Series, Chinese Standard Series, Korean Standard Series, Belgium Standard Series, Finland Standard Series, Hungary Standard Series, Italy Standard Series, and Sweden Standard Series according to the differences in regional allergen exposure. The specific allergens used in the series and the number of allergens vary widely from series to series. For example, the Korean standard series (KOR-1000, Chemotechnique®, Sweden) uses 25 allergens, the TRUE-Test (Allerderm, Phoenix, Arizona, USA) uses 36 allergens, and the European Standard Series is composed of 28 allergens, whereas the North American Standard Series contains 65 allergens (3). The allergens used in a standard series are constantly changing according to the changing trends in the epidemiology of contact dermatitis in each region.

The Korean Standard Series has been available since the 1990s (4). There have been a number of reports regarding the results of patch testing using the Korean Standard Series during the periods of 2000 – 2006 (5), 2003 – 2008 (6), and 2009 – 2010 (7), however, these previous studies were reported only in the Korean language. We thought that it is time to analyze the results of Korean Standard Series compared to previous reports when a growing number of dermatology clinics have changed from Korean Standard Series (KOR-1000, Chemotechnique®, Sweden) to TRUE-Test panel 1 and 2 (Allerderm, Phoenix, Arizona, USA) for its convenience for a past decade.

To provide clinically relevant information on trends in patch-test results and allergen changes, we updated the patch-test results of previous reports and presented the frequency of sensitivity to allergens of the Korean Standard Series in 330 Korean patients with suspected contact dermatitis who were followed from 2009 to 2014. Furthermore, comparing the most common contact sensitizers in Korea with those of other countries can provide insight to the current trends in allergenicity of different countries and variations in patch test reactions among populations.

Materials and Methods

Patients

The study was conducted retrospectively after approval from the Institutional Review Board of Uijeongbu St. Mary's Hospital (IRB No. UC15RIS10029). Between June 2009 and June 2014, 330 patients with suspected contact dermatitis were patch tested for specified allergens and evaluated by dermatologists of Uijeongbu St. Mary's Hospital. Patient medical records containing clinical history, features and patch test results were reviewed and analyzed.

Performing the patch-test and interpretation of the results

Patch testing with the Korean Standard Series (KOR-1000, Chemotechnique®, Sweden) was performed on the upper backs of patients using the Finn Chambers® (Epitest Ltd, Tuusula, Finland) on Scanpor® tape (Norgeplaster, Vennesia, Norway). The components of the Korean Standard Series include potassium dichromate 0.5%, 4-phenylenediamine base 1.0%, thiuram mix 1%, neomycin sulfate 20%, cobalt chloride 1.0%, mercury ammonium chloride 1.0%, nickel sulfate 5%, quinolone mix 6%, colophony 20%, paraben 12%, black rubber mix 0.1%, wool alcohol 30%, mercapto mix 2%, thimerosal 1.0%, balsam of Peru 25%, 4-t-butylphenol formaldehyde resin 1.0%, mercaptobenzothiazole 2%, formaldehyde 1.0%, fragrance mix 8%, imidiazolidinyl urea 2.0%, quaternium 15 1.0%, captan 0.5%, CI-Me-isothiazolinone 0.01%, budesonide, and tixocortol-21-pivalate. The Korean Standard Series are composed of 25 allergens, the Korean National Health Insurance system covers up to 25 allergens. Reactions were only evaluated 48 hours after the initial application, and interpretation of the results were conducted by dermatologists.

Reactions were graded as negative, 1+ (nonvesicular erythema, infiltration, or papules), 2+

(erythema, infiltration, papules and vesicles), or 3+ (erythema, infiltration and coalescent vesicles). Positive allergic patch test results were defined as those with 1+, 2+, or 3+ reactions to specific allergens.

Patient demographics, including gender and age, and localization of the body site of allergic contact dermatitis were retrospectively reviewed. Localization of the body site was categorized as scalp, face, neck, trunk, extremities except hands and feet, hands, feet, and genitalia.

Statistical analysis

Data from continuous variables are presented as means and standard deviation. Data from categorical variables are presented as percentages. Pearson's Chi-squared tests and Fisher's exact tests were used to compare percentages of sensitivity to specific allergens by gender difference. The odds ratios (OR) and corresponding 95% confidence intervals (95%CI) for risk of allergic contact dermatitis on specific body sites were calculated using weighted multivariate logistic regression analyses. All analyses were performed using SAS (Statistical Analysis System, Version 9.3, SAS Institute Inc., Cary, NC, USA). A P-value of 0.05 or less was considered to indicate statistical significance.

Results

Demographics and patch testing results

A total of 330 patients (range 3~82 years of age) underwent patch testing between June 2009 and June 2014. Two hundred thirty patients were female (69.7%) and 100 were male (30.3%). Mean age of total patients were 40.6 ± 16.2 years (41 ± 16 years in females and 39.6 ± 16.6 years in males, respectively). Thirty-eight patients among the 330 patients were less than 20 years of age and 43 patients were more than 60 years of age.

Of the 330 patients tested, 283 (85.8%) experienced at least one positive allergic reaction, while 14.2% showed all negative results on the patch test. Of all 283 patients with a positive result, 55 (16.7%) had a positive reaction to a single allergen, 44 (13.3%) patients had positive reactions to two allergens, and 184 (55.8%) patients showed positive reactions three or more allergens.

Allergen frequencies

The numbers of positive reactions to individual allergens are shown in Table 1. The three highest sensitization rates were found with nickel sulfate (47.6%, n=157), cobalt chloride (46.1%, n=152), and potassium dichromate (41.8%, n=111). In patients with 2+ or 3+ reactions, the highest sensitization rates were found with nickel sulfate (27.9%, n=92), cobalt chloride (14.2%, n=47), and 4-phenylenediamine (9.1%, n=30). In particular, more than half of the patients with 3+ reactions were sensitized to nickel sulfate (52.3%, n=45). Budesonide yielded the smallest amount of positive reactions (1.8%, n=6).

Gender

The five most common allergens varied between males and females. In females, the most commonly observed positive reactions were to nickel sulfate (54.3%), cobalt chloride (46.1%), potassium dichromate (41.3%), mercury ammonium chloride 1.0% (25.2%), thimerosal 1.0% (20%) and 4-phenylenediamine base (20%). In contrast, cobalt chloride (46%), potassium dichromate (43%), nickel sulfate (32%), mercury ammonium chloride (26%), and thimerosal (26%) were the most common allergens in males. Females showed significantly higher sensitization to nickel (OR=2.41, P=0.0004) and wool alcohol (OR=2.85, P=0.0358) compared to males. Increased odds ratios of positive reactions to mercaptobezothiazole 2.0% (OR= 2.26, P=0.0798) and fragrance mix 8% (OR=2.01, P=0.0622) were observed in females, however, the results were not statistically significant. The frequencies of positive patch test reactions and their distributions according to gender are shown in Table 2.

Age

For analysis of age, the patient age was divided by ten to observe any increase in sensitization risk with a change in decade of lifetime. A lower frequency of contact sensitivity to thimerosal was associated with a 10-year increase in age (OR=0.77; 95% CI 0.65-0.91, P=0.0023). Higher frequencies of contact sensitivity to 4-phenylenediamine base (OR=1.23; 95%CI, 1.03-1.48, P=0.003), nickel sulfate (OR=1.18; 95%CI, 1.03-1.37, P=0.0159), and tixcortol-21-pivalate (OR=1.48; 95%CI, 1.06-2.06, P=0.0212) were associated with a 10-year increase in age. In contrast, a lower frequency of contact sensitivity to thimerosal was associated with a 10-year increase in age (OR=0.77; 95% CI 0.65-0.91, P=0.0023).

Localization

Patients experienced allergic contact dermatitis mainly localized on the face (45.5%) including eyelids, ears, and lips, followed by trunk (21.8%), and hands (21.5%) (Table 3). There was a gender difference in the prevalence of affected sites. In males, the most commonly affected sites were hands (31%) and trunk (24%). However, the face, including eyelids, ears and lips, was the most frequently affected site in females accounting for 51.7%, followed by trunk (19.6%) and hands (17.4%).

Nickel sulfate was the most frequent allergen on most of the areas except for the neck, foot, and genital region, where the most frequent allergen was cobalt chloride. Patients with allergic contact dermatitis on the scalp had a significantly higher risk of sensitization to 4-phenylenediamine base compared to other sites (OR=3.07; 95%CI 1.30-7.23, P=0.0013). Patients with allergic contact dermatitis on the arms or legs had a significant increased risk of sensitization to 4-t-butylphenol formaldehyde resin (OR=2.63; 95%CI: 1.13-6.15, P=0.0419) and a significantly lower risk of sensitization to fragrance mix 8% (OR=0.18; 95%CI: 0.04-0.76, P=0.0067) compared to patients with allergic contact dermatitis on other sites. Patients with allergic contact dermatitis on the hands showed significantly higher risks of sensitizations to wool alcohol (OR=3.44; 95%CI: 1.06-7.40, P=0.0083), formaldehyde (OR=2.52; 95%CI: 1.22-5.20, P=0.0178), and colophony (OR=2.05, 95%CI: 1.03-4.06, P=0.0499) compared to patients with allergic contact dermatitis on other body sites (Table 4).

Discussion

We here described our results and experience using patch testing at Uijeongbu-St. Mary's Hospital over a five-year period. Among the patients with allergic contact dermatitis in this study, more than two-thirds (69.7%) were female, which might be explained by the facts that female patients more frequently visit the dermatology clinic and are susceptible to allergic contact dermatitis due to the higher use of jewelry, fragrances, cosmetics, and hair dyes than males. In this study, 283 patients (85.8%) experienced at least one positive allergic reaction in the patch test. One hundred eighty four patients (55.3%) showed polysensitization, which refers to three or more contact allergies to environmental substances detected by patch testing (8) and is considered to be associated with increased sensitization to further allergens (9). In the present study, the rate of polysensitized patients was relatively high compared with a previous Korean report (27.7%) (10). The most common allergens were metals such as nickel sulfate, cobalt chloride and potassium dichromate, in that order.

Nickel is the most frequently detected allergen in patch test populations worldwide (11). Nickel is ubiquitous, found in drinking water, food, jewelry, coins, dental fillings, prostheses, buttons, zippers, tools, alkaline batteries, insecticides, fuels additives, dyes, pigments, and nickel-plated items (11). In a previous study, it was explained that the high rate of cell phone use and a comparatively higher dietary intake of nickel among Korean people are some of the reasons for high nickel sensitivity in Korea (7). Kimchi (Celery cabbage pickles; 6.38 mg/kg, sliced white-radish Kimchi; 4.95mg/kg of nickel content)(12), a Korean traditional food, and green tea (Green tea bag; 235.57mg/kg)(12) have been shown to contain high levels of nickel (7). In our study, nickel sensitivity was found in 54.3% of female patients, and 32% of male patients (OR=2.41, $P<0.0004$), in accordance with the results of other recent studies. Nickel sensitivity has been reported to be 2–10 times more common in females than in males (13)

possibly due to greater use of jewelry and frequent housework. On the other hand, metal exposure, such as that from belts or watches, and occupational exposure seem to be risk factors to sensitization to nickel for men.

In the present study, sensitization rates to cobalt chloride and potassium dichromate were higher than those in previous studies. Our study noted multiple positive patch test reactions to nickel sulfate, cobalt chloride and potassium dichromate. Care should be exerted when evaluating the patch test results of these metals as false-positive irritant reactions are common with these metal salts, especially in atopic patients (14). In the present study, the most frequently associated metal allergens were nickel sulfate and cobalt chloride, a combined allergy to which was seen in 94 patients, followed by potassium dichromate and cobalt chloride in 91 patients. This is a well-known finding since many metal products are made of various combinations of these metals. Therefore, when nickel sensitivity is found, one should consider corresponding heavy contact with other metals (15-17). High rates of potassium dichromate and cobalt chloride sensitivity may be due to sensitization to cement in the construction industry (14). An effort may be needed to reduce the sensitization rates to metals in Korea. For example, in certain European countries, chromate sensitivity has decreased with the addition of ferrous sulfate to cement, which changes the water solubility of chromium (18).

After metals (nickel sulfate, cobalt chloride, and potassium dichromate), the top 10 most frequently positive allergens were mercury ammonium, thimerosal, 4-phenylenediamine base, parabens, fragrance mix, CI-Me-isothiazolinone, and colophony. This list is similar to one established using data from 2003 to 2008 in Korea (7), except that thimerosal moved from position 8 to 4; fragrance mix moved from 7 to 8; 4-phenylenediamine base moved down from 5 to 6; and parabens, CI-Me-isothiazolinone, and colophony were not included in the previous report's top 10 allergens list (7). High sensitivity rates to preservatives (mercury

ammonium, thimerosal, parabens, and CI-Me-isothiazolinone), fragrance mix and colophony suggest frequent use of perfumed products and cosmetics in Korea.

In this study, wool alcohol was significantly sensitized in females (OR=2.85, P=0.0358). The increased sensitivity to wool alcohol has been previously reported (19). Wool alcohols are the principle component of lanolin and are found in many pharmaceutical preparations, cosmetics, and toiletries. They are also used in the industrial field, such as for print ink, furniture and shoe polisher, textile finishers, and leather. Many moisturizers contain wool alcohol, and the use of various types of cosmetics in females contributes to the increased risk of sensitivity to wool alcohol. In females, the most frequent body site of allergic contact dermatitis was the face (45.45%), which could be explained by the increased exposure to wool alcohol in this area and the resulting sensitivity.

A higher frequency of contact sensitivity with increasing age was found to 4-phenylenediamine base (OR=1.23 with a 10-year increase in age, P=0.003) and nickel sulfate (OR=1.18 with a 10-year increase in age, P=0.0159). These increases in sensitivity rates may be due to the increasing use of hair dyes in older people since 4-phenylenediamine is the main ingredient found in most hair dyes (20). The results of significant sensitization rates of 4-phenylenediamine base on the scalp also support the increased sensitization to 4-phenylenediamine in Korean older patients. This finding is in contrast to that of thimerosal, which was a more frequent cause of sensitization in young patients. Though this conclusion is speculative, this result could be due to the increased use of recommended routine vaccinations for young children in Korea. Thimerosal is a preservative used in solutions for contact lenses, mascaras, and vaccines. It has been suggested that patch test reactions to thimerosal can be attributed to sensitization to thimerosal-containing vaccines (21).

As can be seen in Table 5, differences in the five most frequent allergens exist among

countries. This dissimilarity is likely caused by differences in patient populations, and different environmental exposures to allergens among countries (22, 23).

There are several limitations to this study. First, our data does not reflect the general population since it was acquired at a single center and included only highly selected allergic contact dermatitis patients undergoing patch testing. Second, we cannot ensure uniformity in the process of patch testing since the nurses executing the patch tests changed over the five years, and there were more than five physicians who ordered and interpreted the test results. Third, the reactions were read only 48 hours after the application of the allergens. After the 48-hour patch test reading, additional readings at 3 to 4 days and, in some cases, 7 days after the original application of the patch yield the best overall reading reliability. About one-third of relevant allergens that are negative at the 48-hour reading become positive after 72 to 96 hours, and irritant reactions tend to disappear by 96 hours. In the present study, the second reading was not practically available in all patients. Despite considering the missing positivity rate of sensitized allergen by not doing a delayed reading in the present study, the positivity rate and polysensitization rate were relatively high comparing the previous reports. Fourth, there are some statistical limitations in that multiple comparison tests were not analyzed.

Despite these limitations, this study outlines data on important allergens in the etiology of allergic contact dermatitis in Korea, and this data may help with a public health initiative to decrease exposure to allergens by providing targets. Patch testing remains a critical diagnostic tool for evaluation of patients with suspected allergic contact dermatitis and we concluded that the Korean Standard Series was an appropriate screening system for the diagnosis of allergic contact dermatitis in Korea. For a past decade, most of Korean dermatology clinics have changed patch test allergens from Korean Standard Series to TRUE-Test panel 1 and 2 (24 allergens) for its convenience. Patch testers should work with

the Korean National Health Insurance system to cover a greater minimum number of allergen (up to 25 allergens). TRUE-test is composed of 36 allergens (panel 1 to 3) that include almost allergens of Korean Standard Series. However, TRUE-test panel 1 and 2 does not contain enough allergens for basic screening patch test. Mercury ammonium chloride 1.0% that is still common allergen in Korean patients is not included in TRUE-test panel. The increasing sensitivity to allergens and high rate of polysensitization in Korea were shown in this study. Screening patch testing is important for patients to be aware of and avoid sensitized allergens. As the European Standard Series contains 28 allergens and the North American Standard Series is composed of 65 allergens (3), more than 25 allergens are required as a basic screening tool in Korea. The changes with Korean National Health Insurance system of patch testing are needed according to the times.

References

1. Akyol A, Boyvat A, Peksari Y, Gurgey E. Contact sensitivity to standard series allergens in 1038 patients with contact dermatitis in Turkey. *Contact dermatitis*. 2005;52(6):333-7.
2. Lazzarini R, Duarte I, Ferreira AL. Patch tests. *Anais brasileiros de dermatologia*. 2013;88(6):879-88.
3. Davis MD, Scalf LA, Yiannias JA, Cheng JF, El-Azhary RA, Rohlinger AL, et al. Changing trends and allergens in the patch test standard series: a mayo clinic 5-year retrospective review, january 1, 2001, through december 31, 2005. *Archives of dermatology*. 2008;144(1):67-72.
4. Sul GD, Lee Sy, Kim JH, Hong H, Chun J, Ahn SK. Results of the Patch Test (T.R.U.E. Test) in Patients with Allergic Contact Dermatitis (2005~2010, Kangwon, Yeongseo Province). *Korean J Dermatol*. 2011;49(7):572-8.
5. Lee GY, Kim JK, Kim KJ. A Study of the Results of Patch Test in Patients with Contact Dermatitis. *Korean J Dermatol*. 2007;45(9):908-14.
6. Bae YI, Han JH, Yun SJ, Lee JB, Kim SJ, Lee SC, et al. Standard Patch Test Results in Patients with Contact Dermatitis. *Korean J Dermatol*. 2009;47(11):1227-35.
7. Hong YJ, Choi HY, Kim KJ, Lee GY, Kim DW, Kim SJ, et al. TRUE Test in Patients with Contact Dermatitis: A Multicenter Study. *Korean J Dermatol*. 2011;49(8):661-9.
8. Carlsen BC, Andersen KE, Menne T, Johansen JD. Patients with multiple contact allergies: a review. *Contact dermatitis*. 2008;58(1):1-8.
9. Schnuch A, Brasch J, Lessmann H, Geier J, Uter W. A further characteristic of susceptibility to contact allergy: sensitization to a weak contact allergen is associated with polysensitization. Results of the IVDK. *Contact dermatitis*. 2007;56(6):331-7.

10. Kim DS, Bae JM, Jee H, Lee H, Kim DY, Kim SM, et al. Analysis of contact allergens in Korean polysensitized patients by patch testing: a pilot study. *Acta dermatovenereologica*. 2014;94(1):80-1.
11. Schram SE, Warshaw EM, Laumann A. Nickel hypersensitivity: a clinical review and call to action. *International journal of dermatology*. 2010;49(2):115-25.
12. Han HJ, Lee BH, Park CW, Lee CH, Kang YS. A Study of Nickel Content in Korean Foods. *Korean J Dermatol* DE - 2005-05-01. 2005;43(5):593-8.
13. Warshaw EM, Belsito DV, Taylor JS, Sasseville D, DeKoven JG, Zirwas MJ, et al. North American Contact Dermatitis Group patch test results: 2009 to 2010. *Dermatitis : contact, atopic, occupational, drug*. 2013;24(2):50-9.
14. Akasya-Hillenbrand E, Ozkaya-Bayazit E. Patch test results in 542 patients with suspected contact dermatitis in Turkey. *Contact dermatitis*. 2002;46(1):17-23.
15. Sharma VK, Chakrabarti A. Common contact sensitizers in Chandigarh, India. A study of 200 patients with the European standard series. *Contact dermatitis*. 1998;38(3):127-31.
16. Lammintausta K, Kalimo K. Do positive nickel reactions increase nonspecific patch test reactivity? *Contact dermatitis*. 1987;16(3):160-3.
17. Brasch J, Geier J. Patch test results in schoolchildren. Results from the Information Network of Departments of Dermatology (IVDK) and the German Contact Dermatitis Research Group (DKG). *Contact dermatitis*. 1997;37(6):286-93.
18. Olsavszky R, Rycroft RJ, White IR, McFadden JP. Contact sensitivity to chromate: comparison at a London contact dermatitis clinic over a 10-year period. *Contact dermatitis*. 1998;38(6):329-31.
19. Lee B, Warshaw E. Lanolin allergy: history, epidemiology, responsible allergens, and management. *Dermatitis : contact, atopic, occupational, drug*. 2008;19(2):63-72.

20. Nguyen SH, Dang TP, MacPherson C, Maibach H, Maibach HI. Prevalence of patch test results from 1970 to 2002 in a multi-centre population in North America (NACDG). *Contact dermatitis*. 2008;58(2):101-6.
21. Schafer T, Enders F, Przybilla B. Sensitization to thimerosal and previous vaccination. *Contact dermatitis*. 1995;32(2):114-6.
22. Lazarov A. European Standard Series patch test results from a contact dermatitis clinic in Israel during the 7-year period from 1998 to 2004. *Contact dermatitis*. 2006;55(2):73-6.
23. Wentworth AB, Yiannias JA, Keeling JH, Hall MR, Camilleri MJ, Drage LA, et al. Trends in patch-test results and allergen changes in the standard series: a Mayo Clinic 5-year retrospective review (January 1, 2006, to December 31, 2010). *Journal of the American Academy of Dermatology*. 2014;70(2):269-75 e4.

Table 1. Frequencies of sensitization to allergens from the Korean Standard Series

Allergen	Number of patients			
	Total (%)	1+	2+	3+
Nickel sulfate 5%	157 (47.5)	65	47	45
Cobalt chloride 1.0%	152 (46.1)	105	42	5
Potassium dichromate 0.5%	138 (41.8)	111	26	1
Mercury ammonium chloride 1.0%	84 (25.5)	61	21	2
Thimerosal 1.0%	72 (21.8)	50	14	8
4-Phenylenediamine base 1.0%	65 (19.7)	35	21	9
Parabens 12%	52 (15.8)	42	9	1
Fragrance mix 8%	52 (15.8)	35	15	2
CI-Me-Isothiazolinone 0.01%	47 (14.2)	34	12	1
Colophony 20%	45 (13.6)	37	7	1
Balsam of Peru 25%	43 (13.0)	32	9	2
Captan 0.5%	38 (11.5)	32	6	0
Formaldehyde 1.0%	37 (11.2)	28	7	2
Thiuram mix 1.0%	36 (10.9)	24	8	4
Wool alcohols 30%	35 (10.6)	34	1	0
Mercaptobenzothiazole 2.0%	35 (10.6)	31	4	0
Neomycin sulfate 20%	31 (9.4)	27	4	0
4-t-Butylphenol formaldehyde resin 1.0%	29 (8.8)	23	4	2
Black rubber mix 0.1% (N-isopropyl-n-phnly para-phenylene-diamine)	27 (8.2)	25	1	0
Mercapto mix 2.0%	26 (7.9)	23	3	0
Imidiazolidinyl urea 2.0%	21 (6.4)	20	1	0
Quinoline mix 6%	19 (5.8)	11	8	0

Quaternium 15 1.0%	19 (5.8)	14	4	1
Tixocortol-21-pivalate	16 (4.8)	14	2	0
Budesonide	6 (1.8)	5	1	0
Total number of patients = 330				

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Table 2. Distribution of positive patch test reactions according to gender

Allergen	Female (%) (n = 230)	Male (%) (n = 100)	Odds ratio	P value
Potassium dichromate 0.5%	95 (41.3)	43 (43)	0.93	0.7741
4-Phenylenediamine base 1.0%	46 (20.0)	19 (19)	1.07	0.8338
Thiuram mix 1.0%	28 (12.2)	8 (8)	1.59	0.2671
Neomycin sulfate 20%	22 (9.6)	9 (9)	1,07	0.8715
Cobalt chloride 1.0%	106 (46.1)	46 (46)	1.00	0.9884
Mercury ammonium chloride 1.0%	58 (25.2)	26 (26)	0.99	0.8808
Nickel sulfate 5%	125 (54.3)	32 (32)	2.41	0.0004
Quinoline mix 6%	15 (6.5)	4 (4)	1.60	0.4143
Colophony 20%	32 (13.9)	13 (13)	1.08	0.8243
Parabens 12%	38 (16.5)	14 (14)	1.22	0.5638
Black rubber mix 0.1% (N-isopropyl-n-phnnyl diamine)	19 (8.3)	8 (8)	1.04	0.9367
Wool alcohols 30%	30 (13.0)	5 (5)	2.85	0.0358
Mercapto mix 2.0%	21 (9.1)	5 (5)	1.91	0.2073
Thimerosal 1.0%	46 (20.0)	26 (26)	0.71	0.2264
Balsam of Peru 25%	25 (10.9)	18 (18)	0.56	0.0799
4-t-Butylphenol formaldehyde resin 1.0%	20 (8.7)	9 (9)	0.96	0.9285
Mercaptobezothiazole 2.0%	29 (12.6)	6 (6)	2.26	0.0798
Formaldehyde 1.0%	23 (10.0)	14 (14)	0.68	0.2920
Fragrance mix 8%	42 (18.3)	10 (10)	2.01	0.0622
Imidiazolidinyl urea 2.0%	16 (7.0)	5 (5)	1.42	0.5053
Quaternium 15 1.0%	12 (5.2)	7 (7)	0.73	0.5243
Captan 0.5%	26 (11.3)	12 (12)	0.93	0.8556.

CI-Me-Isothiazolinone 0.01%	34 (14.8)	13 (13)	1.07	0.8530
Budesonide	2 (1.0)	4 (4)	0.21	0.0748
Tixocortol-21-pivalate	11 (4.8)	5 (5)	0.95	0.9327

Table 3. Localization of dermatitis in patients with contact dermatitis

Localization	Number of patients	%
Face	150	45.5
Trunk	72	21.8
Hands	71	21.5
Extremities	53	16.1
Scalp	26	7.9
Feet	24	7.3
Neck	21	6.4
Genitalia	6	1.8

Note 1. Results do not add up to 100% since each patient generally had more than one lesion on the same or different parts of the body.

Note 2. Extremities exclude hands and feet.

Table 4. Associations between allergens and localization of allergic contact dermatitis by stepwise multiple logistic regression analysis

Localization	Allergen	Odds ratio (95%CI)	P-value
Scalp	4-Phenylenediamine base	3.07 (1.30-7.23)	0.0013
Extremities	4-t-Butylphenol formaldehyde resin	2.63 (1.13-6.15)	0.0419
	Fragrance mix	0.18 (0.04~0.76)	0.0067
Hands	Wool alcohols	3.44 (1.60-7.39),	0.0083
	Formaldehyde	2.52 (1.22-5.20)	0.0178
	Colophony	2.05 (1.03-4.06)	0.0499

Note 1. Extremities exclude hands and feet.

Table 5. Comparisons with previous published studies

Coutry	Israel ^[19]	USA ^[20]	Korea (Present study)
Year of study	1998~2004	2006~2010	2009~2014
Published year	2006	2014	
Patch test	European Standard Series	Mayo Clinic Standard Series	Korean Standard Series
No. of Patients	2,156	3,115	330
Overall positivity	43.5%	66.0%	85.8%
Rank of sensitivity	Allergens with a high frequency of positivity (%)		
1	Nickel sulfate (13.9%)	Gold sodium thiosulfate (17.0%)	Nickel sulfate (47.6%)
2	Fragrance mix (7.1%)	Nickel sulfate (16.5%)	Cobalt chloride (46.1%)
3	Potassium dichromate (3.8%)	Balsam of Peru (12.6%)	Potassium dichromate (41.8%)
4	Balsam of Peru (3.6%)	Cobalt chloride (11.6%)	Mercury ammonium chloride (25.5%)
5	Cobalt chloride (3.4%)	Fragrance mix (10.4%)	Thimerosal (21.8%)