

## Results of patch testing in pediatric patients with plantar dermatitis and literature review

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**SUMMARY:** Akkurt ZM, Uçmak D, Ayhan E, Uçak H, Arıca M. Results of patch testing in pediatric patients with plantar dermatitis and literature review. *Turk J Pediatr* 2014; 56: 160-165.

We aimed to determine the frequency of positive patch test reactions in pediatric patients with plantar dermatitis. Children diagnosed as inflammatory dermatitis of the plantar foot were included. Demographic and clinical characteristics of the patients were recorded, and patch testing was done using the European standard series antigens. Seventeen patients (9 females, 8 males) were included in the study. Ages of the patients ranged from 4-13 years, and the median age was 7.0. Seven patients had one to three positive reactions, seven had all negative reactions, one showed angry back syndrome, and results of two could not be assessed. Dermatitis of the feet is not rare in pediatric patients, and a significant percentage of these patients will be diagnosed as allergic contact dermatitis (ACD) if detailed and appropriate patch testing is done.

**Key words:** allergic contact dermatitis, plantar dermatitis, patch testing.

Dermatologic conditions involving the plantar surfaces of the feet are frequently encountered in pediatric patients. When the typical picture of hyperkeratotic, erythematous plaques sometimes with vesiculation and fissuring involving the feet is encountered, differential diagnoses such as allergic contact dermatitis (ACD), irritant contact dermatitis, juvenile plantar dermatosis, psoriasis, keratoderma, and tinea pedis come to mind. While tinea pedis can be treated effectively with antifungal agents, the treatment of the aforementioned noninfective causes is challenging. Of these, ACD, if a relevant allergen can be detected, may be treated by identification and removal of the offending agents.

In the past, ACD was thought to be rare in pediatric patients, but nowadays, the rate of positive patch tests in children with suspected ACD is increasing. The reasons for this may be the increased incidence and/or more frequent patch testing of children. In addition, the patterns of referral, selection criteria for patch testing, and regional and social variations in allergen exposure and allergens tested may be involved. Children are becoming exposed to a wider variety of allergens at a younger

age. Girls tend to use beauty products at a younger age, and face painting, body piercing and other hobbies and activities are common<sup>1</sup>.

Dermatitis of the plantar area is not infrequent in pediatric patients and can cause an important decrease in quality of life. We aimed to determine the frequency of positive patch test reactions in pediatric patients with eczema of the plantar area.

### Material and Methods

This study was funded by Dicle University Scientific Research Projects Commission. Approval of Dicle University's Ethical Committee was obtained. Pediatric patients between 3-16 years of age clinically diagnosed as inflammatory dermatitis of the plantar foot were included in this study. Exclusion criteria were as follows: dermatological conditions causing plantar lesions, i.e. juvenile plantar dermatosis, keratoderma, keratolysis exfoliativa, ichthyosis, and tinea pedis, and presence of systemic diseases and/or use of immunosuppressants. In addition, the use of antihistaminics in the past three days and/or the use of systemic corticosteroids in the past three weeks were among the exclusion criteria. Informed consent of the patients' parents

or guardians was obtained. Demographic and clinical characteristics of the patients were recorded, and the European standard series antigens were applied to the back via specialized chambers on hypoallergenic tape. Test areas were inspected at 48 hours and at 72 and 96 hours, if necessary. Homogenous erythema and infiltration were considered as a positive reaction. Patients who tested positive were further informed regarding the materials containing the sensitizing substance.

## Results

Seventeen patients were included in the study (9 females, 52.9%; 8 males, 47.1%). Ages of the patients ranged from 4-13 years, and the median age was 7.0. Mean age of onset of lesions was  $5.33 \pm 2.6$  years, and mean duration of the lesions was  $2.67 \pm 1.84$ . Seven (41.1%) patients reported worsening of their symptoms in the summer. None of the patients could identify any offending substance in their environment. Three patients lived in rural areas. Five patients had not tried any form of treatment previously. The rest had tried topical treatments, which had failed. Five (29.4%) patients had primary relatives who were also affected. When personal and family history of atopy was questioned, 2 patients had allergic rhinitis, 1 had asthma, and 2 had a family history of atopy. On dermatologic evaluation, the hands were also involved in 3 patients. Except for 1 patient with unilateral lesions, all patients had bilateral lesions. One patient had verrucae. Seven (41.1%) patients had skin findings of atopy. Clinically, the most frequently affected part of the foot was the toes (10 patients), followed by heels (8 patients), medial aspects of the sole (4 patients), whole plantar surface (4 patients), and lateral aspects of the plantar surface (2 patients). All patients had hyperkeratotic plaques with varying degrees of erythema and fissuring (Fig. 1). No vesicular and eroding lesions were observed. The general evaluation was noted as mild in 9 (52.9%), moderate in 7 (41.2%) and severe in 1 (5.9%).

In total, 19 reactions were seen in 8 of the 17 children tested. A six-year-old male had removed the tests and could not be evaluated. A 10-year-old male did not return for evaluation of the results. A seven-year-old boy had positive reactions in 8 areas and was considered as angry back syndrome (Fig. 2). Patch testing

was negative in 7 (50%) patients. Seven (50%) patients (5 girls, 2 boys) had positive reactions, 1 of them in 3 areas. Two patients tested positive for nickel sulphate hexahydrate. The other positive reactions were to paraben mix, potassium dichromate, benzocaine, and lanolin. The patient who tested positive in 3 areas had reaction to para-tertiary butyl phenol formaldehyde resin (PTBFR), sesquiterpene lactone mix and Lyril. One patient had a vesicular reaction.

## Discussion

In our study, patch test positivity was seen at a rate of 50% in pediatric patients with plantar dermatitis. This result is higher compared to reported patch test positivities in populational studies. In the general population, sensitivity to patch test allergens ranges from 13-24%<sup>2-5</sup>. ACD in children may be quite common. Although the prevalence is thought to increase with adolescence<sup>6-8</sup>, some authors have found an early peak in the prevalence in children under the age of three<sup>9-11</sup>. The most frequent allergens reported among children are nickel, thiomersal, neomycin, fragrance, cobalt, and rubber chemicals<sup>1</sup>. The rate of positive reactions in population studies are different from that of positive reactions in patients referred for patch testing who have symptoms of dermatitis. Studies conducted on children referred for patch testing have reported higher positive results, ranging from 27-70%<sup>1,12-14</sup>. The prevalence of shoe dermatitis among patients with ACD has been estimated at 3.3-11.7%<sup>15,16</sup>.

Clayton et al.<sup>17</sup> investigated whether the site of dermatitis could predict a diagnosis of ACD. Although their results were not statistically significant, dermatitis of the sole of the foot (29%) was the second most common primary body site to yield positive patch test results. Shah et al.<sup>18</sup> reported 18% foot dermatitis in a study of 83 patch-tested children, and 40% of these patients had relevant allergic reactions on patch testing. All reactions were to shoe chemicals. Rates of positive patch test reactions in pediatric patients with foot dermatitis in other studies have been reported to range from 48-70%<sup>1,19,20</sup>. Patch test positivity in juvenile plantar dermatosis has been reported as 29%<sup>19</sup>.

Allergic contact dermatitis (ACD) due to shoes was reported as 12.5% in a study by Romaguera et al.<sup>21</sup> In a study conducted by Rani et al.<sup>22</sup>,

73% of 119 patients suspected of having shoe dermatitis were reported to have positives on patch testing. The most common allergens in this study were PTBFR (21.6%), chromate, rubber chemicals, and dyes.

Allergic contact dermatitis (ACD) to shoes mostly affects the feet bilaterally and symmetrically. The clinical picture is an eczematous dermatitis limited to the dorsa of the foot and toes that can occasionally involve the soles and the heel<sup>23</sup>. Affliction of the dorsal side of the foot is more likely to be associated with a positive patch test<sup>20</sup>. The interdigital areas tend to be spared. The occlusion caused by shoes allows a warm and moist environment and thus may potentiate development of ACD<sup>24</sup>.

The most common allergens involved in ACD of the feet are related to shoes and are those involved in leather or rubber processing. While leather was the most frequent antigen in the past, over time, rubber has emerged as the most common shoe antigen involved in ACD<sup>24</sup>. This may be linked to the increasing trend for sports shoes<sup>1</sup>. Rubber chemicals, such as thiuram, carbamate, mercapto, and thiourea, can all cause shoe dermatitis, and as a group, represent the most common etiology in shoe dermatitis. Thioureas are often used in insoles that patients insert into shoes after purchase. This may lead to a chronic, scaly plantar dermatitis on the plantar area<sup>25</sup>. Chromium salts are used to tan leather. An example of this group is potassium dichromate, which is the most frequent single allergen causing shoe dermatitis<sup>24</sup>. PTBFR has been used as an additive in rubber glues and is currently found as a component of neoprene adhesives used to attach shoe linings and insoles. The frequency of PTBFR positivity has been reported differently in different studies. This may be due to different inclusion criteria and regional differences<sup>24</sup>. Rarely, nickel found in buckles or straps may cause ACD.

In a study conducted by Holden et al.<sup>26</sup>, the most common allergens identified in patients with foot dermatitis were chromate, medicaments (neomycin, tixocortol, triamcinolone), rubber chemicals, dyes (PPD, Disperse Yellow 3, Disperse Orange 3), and cosmetic constituents (lanolin, fragrance mix, cetyl stearyl alcohol). In this group of patients, PTBFR positivity

was not prominent. In Warshaw et al.'s<sup>24</sup> retrospective study, 109 patients with ACD of the foot and a shoe source of allergens were evaluated. PTBFR was the most frequent single allergen, followed (in order) by potassium dichromate, carba mix, thiuram mix, colophony, mercaptobenzothiazole, mercapto mix, mixed dialkyl thioureas, p-phenylenediamine, and black rubber mix. When the data were examined according to groups of allergens, rubber additives were most frequent (40.4%), followed by adhesives (32.5%) and leather components (20.1%).

Some studies report different positive antigens in patients with dermatitis of the foot. In a study of 110 patch-tested children, in those who had hand and foot dermatitis, the most commonly detected allergens were medicaments, followed by mercaptobenzothiazole and chromate<sup>27</sup>. There are several possible explanations for these differences. Shoe manufacturing processes and materials change over time and vary around the world. Different environments require appropriate footwear choices, and fashion trends can change quickly. In addition, the series of allergens tested among studies are not consistent, and many standard series may lack important relevant shoe allergens. The variance in percentages of positive reactions in the different studies may be due to variations in study design rather than definitive rates<sup>24</sup>.

The question remains of whether or not to patch test patients with foot dermatitis using special shoe series. Beattie et al.<sup>1</sup> stated that the standard series of patch testing were sufficient, and that the shoe series did not detect further cases of shoe allergy in their study. In Holden et al.'s<sup>26</sup> study, 19% of 230 patients tested with the shoe series showed relevant positive reactions to allergens in the British Contact Dermatitis Society standard series. The shoe series demonstrated an allergen not identified by the standard series in only 4%. In Warshaw et al.'s<sup>24</sup> study, in patients for whom shoes were considered a relevant source of allergens, the North American Contact Dermatitis Group standard series did not identify the specific shoe allergen in 12.7% of cases and was unable to identify all relevant shoe allergens in 24.9% of cases. Allergens relevant to shoe dermatitis that are not present in standard testing series are as follows: Dithiodimorpholine (a rubber



Fig. 1. Mild dermatitis of the sole. Note fissure on the right fifth toe.



Fig. 2. Angry back syndrome showing eight positive reactions.

accelerator), 4-aminoazobenzene, Disperse Orange 3, Disperse Yellow 3, Disperse Red 1 (dyes), dodecyl-mercaptan (an adhesive), diphenylthiourea (an accelerator in neoprene manufacture), hydroquinone monobenzyl ether, benzoyl peroxide, 2-thiocyanomethyl benzothiazole, 2n-octyl-4-isothiazolin-3-one, Desmocoll 400 (Bayer MaterialScience; Leverkusen, Germany), and Desmodur R (Bayer MaterialScience)<sup>24</sup>.

If patch testing remains negative despite testing with specialized series, testing with samples of the patient's own shoes may be carried out<sup>16,28,29</sup>. However, it is important to recognize that shoe samples must be very thin to avoid pressure effects and false-positive results. Samples should also be first soaked in water for 15 minutes before application and left in place for four to five days to avoid false-negative results<sup>24</sup>.

Despite high rates of patch test positivity in children with dermatitis, the clinical relevance of a positive patch test reaction should be

confirmed by detailed history-taking including the patient's personal hygiene and clothing practices, school and home environment, and hobbies. History related to the family is also necessary. If patch testing fails to detect the causative allergen, and the diagnosis of ACD is strongly considered, a detailed diary of the patient's daily activities may help discover patterns of exposure<sup>30</sup>. It is difficult to identify all antigens in shoes due to the lack of information from manufacturers. Future studies of footwear dermatitis would be greatly enhanced by more complete chemical information from manufacturers<sup>24</sup>.

In our study, two of our patients had reactions to shoe chemicals. We could not relate the clinical relevance of the other positive reactions to footwear, but informed the patients appropriately on allergen avoidance. A noteworthy finding in our patients was the worsening of symptoms in the summer in 41.1%. This may be related to increased perspiration during the summer. A significant

proportion of our patients (41.1%) had history and/or findings of atopy. The relationship between atopy and ACD is poorly understood. Whether patients with atopic dermatitis are more prone to ACD than nonatopic individuals remains controversial<sup>17</sup>. Atopy, either personal or familial, has been found in 62.5-76.0% in some studies<sup>19,23</sup>.

The patch testing of young children may not be advocated by some. However, it has been performed and shown to be of benefit even in children younger than two years of age<sup>31</sup>.

Securing the patches might pose a problem in this age group. To avoid this, the use of Tubifast® vests may be recommended<sup>1</sup>.

When the appropriate allergen is identified, the patient must be informed regarding potential sources of exposure and offered suggestions for avoidance. This may be especially difficult when small children are affected, since the products used by the parents and siblings may also serve as sources for allergen exposure<sup>30</sup>. Perspiration permits leaching of rubber and chromates from footwear, and some patients benefit from control of perspiration. Since rubber chemicals from pervious shoes may be retained in socks, purchasing new socks is recommended. Insoles free of rubber chemicals can be used to replace existing insoles. Custom shoemakers can make shoes free of specified allergens<sup>25</sup>. If avoidance is not sufficient, topical emollients, corticosteroids, and calcineurin inhibitors may be used. Severe dermatitis may necessitate use of systemic corticosteroids or immunosuppressants<sup>30</sup>.

The limitations of this study included the small number of patients, lack of patch testing with shoe series and lack of follow-up after informing patients regarding allergen avoidance.

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