

Nonallergic Reactions to Medical Tapes

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Background: Adverse dermatologic reactions to tapes are a common problem in the medical field and can delay or alter patient care, but their prevalence, etiology, and management are poorly defined.

Objective: The aims of this study were to make a distinction between true allergy and nonallergic tape reactions (NATRs) to medical tapes and to make recommendations for dermatologists in the approach to each.

Methods: We performed a cross-sectional analysis of the electronic medical record database at a large hospital system and a review of literature.

Conclusions: Although tape allergy is reported by 0.3% of patients, true tape allergies are rare. More commonly, patients experience NATRs. True tape allergy and NATR are mechanistically distinct and can be distinguished from each other based on history. The approach to management of each is distinct.

Adverse dermatologic reactions to tapes are a common problem in the medical field. Allergy to many medical adhesives, including medical tapes, electrocardiograph electrode adhesives, stoma adhesives, and octyl cyanoacrylate, has been well documented.^{1,2} However, although many patients report a tape “allergy,” there are very few documented cases of true allergic contact dermatitis reactions to medical adhesive tapes.³ Furthermore, there is little in the literature to describe the etiology and prevalence of nonallergic tape reactions (NATRs). We sought to clarify (1) the difference between true tape allergy and NATR, (2) the prevalence of true tape allergy and NATR, (3) the mechanism of NATR, and (4) the approach to the patient with true tape allergy and to the patient with NATR.

METHODS

We performed a cross-sectional study on the prevalence of “tape” or “adhesive” as a reported allergy in the electronic medical record at the Wexner Medical Center at the Ohio State University, which includes all patients who receive care at the institution on an inpatient or an outpatient basis in the 5 years that the current electronic medical record has been in place, current through the date of data collection in March 2014. In addition, we reviewed

the charts of all patients diagnosed with allergy to medical adhesive tapes at our contact dermatitis center in the past 8 years. Finally, we reviewed the literature using key word searches for articles containing *tape*, *adhesive* and *allergy*, or *allergic*. We also reviewed the reference lists in the articles that were identified.

RESULTS

Of the 2,829,241 electronic medical records reviewed, 9821 patients listed tape or adhesive as an allergy. Thus, 0.347% of all patients who have been seen at the Wexner Medical Center at the Ohio State University report a tape allergy, which is a reasonable proxy for the general population.

Two patients were diagnosed with tape or adhesive allergy over an 8-year period at the Ohio State University Contact Dermatitis Center. Both patients reacted to a single adhesive tape, one to a single type of generic Band-Aid and the other to an adhesive used in a medical device, and had no other reactions on patch testing. Both were patch tested to the North American Contact Dermatitis Group standard tray,⁴ multiple medical tapes (Tegaderm, Transpore, Durapore, Medipore, Micropore, and Microfoam), and expanded acrylate trays. The specific acrylates tested included methyl methacrylate, ethyl ethacrylate, *N*-butyl methacrylate, 2-hydroxypropyl methacrylate, triethyleneglycol dimethacrylate, ethyleneglycol dimethacrylate, 2-hydroxyethyl methacrylate, 1,6-hexanediol diacrylate, and ethyl methacrylate. Although we were unable to determine the exact total number of patients tested over the same 8-year period, a reasonable estimate is 6000 patients. This estimate is based on the number of patients seen in patch test clinic per day and the approximate number of patch test clinics held over the 8-year span. Using these approximations, we estimate that the prevalence of true tape allergy at our institution is 0.033% of patch tested patients.

It is difficult to extrapolate the prevalence of a rare allergen in a patch test population to the prevalence in the general population,

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but it is generally accepted that the prevalence is substantially higher in the patch test population. Overall, then, we estimate that the prevalence of NATRs is between 10 and 100 times higher than true allergic reactions to tapes.

DISCUSSION

To understand the mechanism of tape allergy and NATR and to be able to distinguish them clinically, it is necessary to have some background information regarding the composition of medical tapes. Medical tapes are most commonly composed of a fully polymerized pressure-sensitive acrylic adhesive (PSA), a backing (usually fabric, paper, or plastic), and a release liner that prevents the PSA from adhering to the backing as the tape is unrolled off of the roll.^{1,5} Each of these components may theoretically contain ingredients that can elicit an allergic or nonallergic reaction. The composition of the PSA and backing varies with the purpose of the medical tape. For example, if the tape is intended to adhere tightly to the skin for a prolonged period, a different PSA will be used than if it is intended to adhere lightly and for short periods. Alternatively, if the tape is intended to allow the skin to breathe and to allow moisture to evaporate away, a different backing will be used than if it is intended to be impermeable to water.⁵

Historically, most cases of true tape allergy, both to medical and nonmedical tapes, were due to derivatives of rosins (colophony) and components of rubber (latex and rubber accelerator).^{1,5,6} However, almost no modern medical tapes in common usage contain these ingredients, making newer tapes “hypoallergenic.”^{1,7} Little to no cross-reactivity between the older rosins and rubbers and the newer acrylates has been documented.

Although there has been some information on the composition of various acrylate-based medical adhesives published previously,⁵ there has been very little information made publicly available regarding the differences in the adhesive components of these medical tapes. To obtain this information, our study group contacted 3M, a manufacturer of many medical tapes. 3M demonstrated unprecedented cooperation with our research group in providing some of the ingredients in various common medical tapes used at our facility, including Durapore, Medipore Soft Cloth, Medipore H Soft Cloth, Tegaderm, Transpore Surgical, Transpore White, and Micropore. Although the exact composition and Chemical Abstract Services number of the acrylates used in the tapes is a trade secret, we did learn that there are 6 different adhesives used in the 7 products. In addition, the more general characteristics of the individual adhesives varied, including tackified that involves use of a tackifier to increase adhesion, nontackified, and moisture-compatible adhesives; similarly, the PSAs and backings of the medical tapes varied substantially. These findings illustrate the fact that the adhesives and other ingredients used in medical tapes are not uniform; rather, as discussed previously, the composition of the medical tapes, including the adhesive, reflects their individual purposes.

Clearly, allergy to tape is commonly reported. In extrapolating the data from our study, if 0.347% of the population in the United

States reports tape as an allergy, then there are 1,104,122 people in the United States who have experienced a tape reaction.⁸ However, a comprehensive review of the literature demonstrates just 11 documented cases of patch test–confirmed allergic contact dermatitis (ACD) to medical tapes (Table 1). Furthermore, the most cases were reported over 2 decades ago and illustrate allergy to components of adhesives that are now obsolete in modern medical tapes. A list of these reported allergens that are not already included in the standard North American Contact Dermatitis series⁴ can be found in Table 2.

Of note, most of the documented cases of ACD in medical tapes were directed against the adhesive portion of the tape. However, it stands to reason that the other components of tapes, namely, the backing that serves as the adhesive carrier, can also pose a source of allergens or of irritation. One of the first study groups to delve into this possibility was Fregert et al¹⁶ in 1982, who discovered that Leukoflex tape backing contained diphenylthiourea and phenylisothiocyanate, which proved to be allergenic in several patients when added to the group’s standard patch test series.

In addition to poor documentation of tape allergy in the literature, there is also a significant reporting bias. Proportionately, there are far more reported cases of ACD to medical tapes than there are cases of irritant contact dermatitis or NATR. Heskel et al⁶ reported on 2 patients with ACD to Curad bandages in 1982; they also noted, however, that 2 patients with suspected allergy had negative patch test result. In 1984, Marks et al¹⁷ considered potential allergens in the operative setting, including medical tapes, and concluded that none of the patients in the study reacted to medical tapes, either via allergy or NATR. Several study groups considered dermatologic reactions to medical tapes without patch testing the patients, thus leaving undifferentiated the patients who had true allergy versus the patients who demonstrated NATR.^{18–21}

One study specifically addressed the increased incidence of irritant reactions to medical tapes compared with ACD. Widman et al³ considered 26 subjects who suspected themselves to have an allergy to medical adhesive bandages or tapes. The experiment consisted of patch testing with both the adhesive and backing of the implicated tapes. Of the 26 patients, none was found to have positive patch testing to the tapes at 48 hours. Although some patients did experience tape-related allergies to products that were applied simultaneously with a medical tape, including Mastisol liquid adhesive and neomycin, bacitracin, and cortisone creams, none of the patients demonstrated ACD to the tapes themselves. Furthermore, at 48 hours, 2 patients demonstrated probable irritant reactions. Eleven patients were continued in this study for a total of 7 days; of these, 8 patients were found to have NATR to 1 or more medical tapes. Again, none of the 11 patients was found to have ACD to any of the tapes. Unfortunately, in this study, comparison of patch testing using the whole tape products versus the individual components of the tapes could not be completed because the manufacturers of the adhesives were not cooperative and refused to provide information about the tapes’ compositions.

TABLE 1. Documented Case Reports of Patch Test-Proven Allergic Contact Dermatitis to Medical Tapes

Case	Product	Implicated Allergen	Other Allergens*	Patch Test Results
Case 1†	Band-Aid	None	None	Positive to Band-Aid
Case 2†	Unspecified medical device adhesive	None	None	Positive to unspecified medical device adhesive
Burden et al, ⁹ 1994	Unspecified medical tape	PTBP-F-R	Neomycin, tixocortol pivalate, hydrocortisone-17-butyrate	Positive to PTBP-F-R 1% pet.
Christoffers et al, ¹⁰ 2014	Leukotape classic and Klinidur Adhesive	Colophonium	None reported	and to unspecified medical tape Positive to colophonium 20% pet. and to both Leukotape classic and Klinidur Adhesive
Dwyer et al, ¹¹ 1997	Leukotape	Colophony	None reported	Positive (++++) to colophony and Leukotape
Greiner et al, ¹² 1999	Fixomull stretch	Benzoyl peroxide	None reported	Positive (++++) to benzoyl peroxide 1% pet.
Heskel et al, ⁶ 1982‡	Curad bandage	Dodecyl maleamic acid	Octyl maleic acid ester 1% pet., <i>N</i> -octadecyl maleamic acid 1% water/isopropanol, undecyl polyethylene oxymaleic acid ester 1% water/isopropanol	Positive (++) to dodecyl maleamic acid 5% pet. and Curad bandage
Heskel et al, ⁶ 1982	Curad bandage	Dodecyl maleamic acid	Octyl maleic acid ester 1% pet., <i>N</i> -octadecyl maleamic acid 1% water/isopropanol	Positive (++) to dodecyl maleamic acid 5% pet. and Curad bandage
Jordan, ¹³ 1975‡	Curad bandage	2-EHA monomer	2-ethyl-butyl-acrylate	Positive (++) to 2-EHA 5% olive oil and Curad bandage
Jordan, ¹³ 1975	Curad bandage	2-EHA monomer	Ethyl-acrylate and 2-ethyl-butyl-acrylate, both in 5% olive oil	Positive (++) to 2-EHA 5% olive oil and Curad bandage
Jordan, ¹³ 1975	Curad bandage	2-EHA monomer	2-ethyl-butyl-acrylate in 5% olive oil	Positive (++) to 2-EHA 5% olive oil and Curad bandage
Jordan, ¹³ 1975	Curad bandage	2-EHA and NTBM monomers	Ethyl-acrylate, <i>N</i> -butyl-acrylate, <i>t</i> -butyl-acrylate, 2-ethyl-butyl-acrylate, hydroxy propyl-acrylate, and hydroxy propyl-methacrylate, all in 5% olive oil	Positive (++) to 2-EHA 5% olive oil, NTBM 1% pet., and Curad bandage
Jordan, ¹³ 1975	Curad bandage	2-EHA and NTBM monomers	Ethyl-acrylate, <i>N</i> -butyl-acrylate, <i>t</i> -butyl-acrylate, 2-ethyl-butyl-acrylate, hydroxy propyl-acrylate, and hydroxy propyl-methacrylate, all in 5% olive oil	Positive (++) to 2-EHA 5% olive oil, NTBM 1% pet., and Curad bandage
Norris and Storrs, ¹⁴ 1990‡	Band-Aid Brand Sheer Strip	None reported	Epoxy resin 1% pet., phenol formaldehyde resin 1% pet. Previous positive patch tests: para-amino-azo benzene, disperse orange 3, tetramethyl thiuram monosulfide, 2-tert-butyl-6-methyl phenol, neomycin sulfate, thimerosal, formaldehyde, epoxy resin, shoes, shoe glue	Positive to Band-Aid Brand Sheer Strip and its vinyl backing; however, patient had negative patch testing to the individual known components of the Band-Aid Brand Sheer Strip.

(Continued on next page)

TABLE 1. (Continued)

Case	Product	Implicated Allergen	Other Allergens*	Patch Test Results
Norris and Storrs, ¹⁴ 1990	Band-Aid Brand Sheer Strip and Curad bandage	2,5-di(tertiary- <i>amyl</i>)hydroquinone antioxidant 1% pet.	Tricresyl phosphate 1% pet. Previous positive patch tests: waterless hand cleanser	Positive to Band-Aid Brand Sheer Strip and Curad bandage
Norris and Storrs, ¹⁴ 1990	Band-Aid Brand Sheer Strip and Curad bandage	None reported	None reported	Positive to Band-Aid Brand Sheer Strip and Curad bandage
Norris and Storrs, ¹⁴ 1990	Band-Aid Brand Sheer Strip and Curad bandage	None reported	None reported	Positive to Band-Aid Brand Sheer Strip and Curad bandage
Sjoberg and Fregent, ¹⁵ 1984	Steri-Strip	Foral 85, a glycerol ester of hydrogenated abietic acid	Hydrogenated abietic alcohol 5% pet.	Positive to Steri-Strip

*Refers to positive patch testing to allergens found in the standard patch testing series that the individual clinicians used and/or to additional products that the patient was patch tested to.

†These patients are the two that were patch tested at our institution.

‡These authors reported multiple cases. Each separate row denotes a separate case.

2-EHA, 2-ethylhexyl-acrylate; PTBP-F-R, para-tertiary-butylphenol-formaldehyde resin; NTBM, *N*-tert-butyl maleamic acid.

Having established that true tape allergy is 1 to 2 orders of magnitude less common than NATR, we must now draw a distinction between the mechanisms of the 2 skin reactions. Allergic contact dermatitis is well known to be a delayed-type hypersensitivity reaction, mediated by lymphocytes that are extremely specific to a single allergen.^{3,4} Conversely, the etiology of NATR is not able to be so concisely defined. Patch test findings in a patient with a history of NATR are negative or suggest an irritant reaction, demonstrated by well-demarcated homogenous erythema or edema that is strictly maintained within the bounds of the applied tape.³ The difficult question that we cannot answer definitely or precisely is, "What is the irritant that causes these reactions?"

We suspect that the pathogenesis of NATR is likely a combination of multiple factors that are unique to medical tapes. The combination of occlusion, prior skin damage, physical skin distortion, and prolonged contact with potential irritants makes medical tapes a unique trigger for dermatologic events.

Generally, medical bandages are put in place for prolonged periods, from several hours to several days. The effect of occlusion alone is known to alter skin physiology by raising skin temperature, which induces sweating, and by increasing skin pH, which can alter lipid synthesis.²² In addition to sweat acting as a direct irritant, plugging of eccrine ducts may induce miliaria, starting an inflammatory cascade.^{23–25} Similarly, entrapment of sweat beneath medical tape may also induce follicular plugging, yielding a follicular rash that may be confused with an allergic reaction.¹ Although occlusion of normal skin has previously been shown in a single study to have no significant effect on skin barrier function,²² that study considered the area under a nitrile glove material rather than an area occluded by adhesive. Based on the aforementioned pathophysiology of skin occlusion and on clinical experience, we suspect that prolonged occlusion with adhesives may cause unique damage to the skin barrier and trap sweat, which may contribute the resultant NATR.

Kobaly et al²⁶ reported on the effects of occlusion in atopic patients, noting that transepidermal water loss and production of proinflammatory cytokine IL-8 were significantly increased in the skin that had been occluded by polyethylene for a variable period of 8 hours to 4 days. Dai et al²³ demonstrated that sweat contains multiple proinflammatory cytokines, including IL-1 α , IL-1 β , and

TABLE 2. Suggestions for Additional Compounds for Patch Testing of Patients Suspected to Have True Tape Allergy

- Benzoyl peroxide
- Dodecyl maleamic acid
- 2-ethylhexyl-acrylate
- *N*-tert-butyl maleamic acid
- 2,5-di(tertiary-*amyl*)hydroquinone antioxidant 1% pet.
- Foral 85, a glycerol ester of hydrogenated abietic acid

These are the suggestions for additional compounds for patch testing of patients suspected to have true tape allergy based on reports of ACD to these components of medical tapes in the literature. These compounds are in addition to the 65 compounds in the standard North American Contact Dermatitis Group series.⁴

IL-31, and that sweat can activate inflammatory pathways in epidermal keratinocytes via stimulation of NF- κ B, ERK, and JNK. Another recent study showed that some patients have positive prick tests to their own sweat.²⁵ Although these studies specifically considered atopic patients, it should be noted that many of the case reports of proven tape allergy and of NATR were in patients who were atopic or in whom the absence of atopy was not specified; thus, it is probable that the damaging effects of skin occlusion observed in this study may also apply to nonatopic patients. In either instance, it would follow that in these patients, occluding sweat against the skin and in eccrine ducts would induce inflammation in the skin.

Although the application of medical tapes is not limited to atopic patients, the tapes are often applied to areas of already damaged skin. Skin may be damaged by primary wound, as in the closure of surgical sites or the application of tape over intravenous sites. Damage may also be secondary to earlier application of tape or bandages that have been removed for dressing changes, resulting in tape stripping at the site. Tape stripping is known to affect skin composition by removing the stratum corneum.²² Furthermore, tape stripping has been observed to induce epidermal expression of Th2 cells and eosinophilic chemokines in mouse models.²⁷ This mechanism may contribute to a spectrum of allergic and NATRs.

The tension of the tape on the skin may also contribute to NATR. Tokumura et al²⁸ studied the elasticity of various tapes and the resultant conformability of the tapes to skin. They found that the application of tapes with poor conformability caused localized skin distortion, which in turn resulted in skin irritation. This was most evidenced by the fact that the worst conformability of tapes to skin occurs at the edges of the tape, which is where irritant reactions were observed to be greatest. Other cases of increased skin tension resulting in dermatitis have also been reported.¹

We will now propose criteria for distinguishing true tape allergy from NATR, based on our clinical experience, understanding of the mechanisms of each, and knowledge about the composition of modern medical tapes. Specifically, as noted previously, the composition of various medical tapes varies greatly, and ACD is highly specific and reproducible on allergen exposure. Thus, true allergy to a component of a medical tape necessitates specificity to only the particular tape(s) containing that product. Therefore, in true tape allergy, (1) the patient only has reactions to one or a few specific tapes, and (2) the reaction is consistently reproducible on testing with the implicated tape. Conversely, in NATR, (1) the patient has reactions to many different types of tape, including tapes with different backings and differing levels of skin adhesion, and (2) the reaction is not consistently reproducible on testing with implicated tapes.

Having delineated the differences between true tape allergy and NATR, we will now make recommendations as to how to approach both the patient with true tape allergy and the patient with NATR. The approach to the former patient is simple; avoidance of the known allergen, including avoidance of medical tapes containing the allergen, will prevent allergic reactions.

Because true allergy will be specific to 1 or a few medical tapes and because the exact composition of tapes is trade secret, the best approach is to patch test with multiple tapes. To perform the patch test, we recommend cleaning the skin with isopropyl alcohol and applying a piece of each tape measuring 2 × 2 cm. Patches should be removed and read by the patch testing physician at 48 hours. A second reading should be performed at 96 hours to detect delayed reaction. The patch test readings should be performed in accordance to the guidelines of the North American Contact Dermatitis Group.⁴ True-positive reactions suggest true ACD, and tapes that cause such reactions should be avoided. Specifying avoidance of these particular tapes in the medical record will facilitate both prevention of recurrent episodes of contact dermatitis and ease of patient care. A dermatologist who is experienced in patch testing should be able to differentiate between true allergic reactions and reactions that are more consistent with an irritant contact dermatitis—in the case of adhesives, likely caused by a combination of occlusion, prior skin damage, physical skin distortion, and/or prolonged contact with potential irritants, as previously described. Such a finding on diagnostic patch testing or in the clinical setting comprises the NATR.

The approach to the patient with a history of NATR is based on the mechanisms described previously and on the clinical experience of the contact dermatitis specialists in our practice. First, limiting occlusion of the skin is imperative. We recommend avoiding tapes that exceed 1 cm in width, limiting total surface area of occlusion, and minimizing time of occlusion. Second, application of tapes to areas that have been previously injured should be avoided if possible, as should reapplication of tape to the same area repeatedly. Clearly, these situations are unavoidable in the primary application of tape to the site of a wound; however, in cases such as application of tape to secure an intravenous line, applying fresh tape to an area that has not previously been stripped may minimize irritation of the damaged skin. Third, use of more elastic medical tapes may increase the conformability of the adhesive to the patient's skin, resulting in less skin distortion and thus in less irritation. Finally, in a patient with persistent NATR despite the above measures, care providers might consider using silicone-based adhesive products, a new class of products that are specifically designed to be elastic and to adhere less tightly, leading to less occlusion, less damage with removal, less skin distortion, and, overall, less irritation.⁷

It is clear that the exact prevalence of true tape allergy and of NATR cannot be precisely determined from the data available in this cross-sectional study. Further studies might incorporate a standard tray of medical tapes for more exact monitoring of the prevalence of reactions on patch testing. What we do know from this analysis is that there is a high rate of self-reporting of tape allergy and little evidence in the literature to support such a substantial allergic population, making the topic a primary concern for contact dermatologists.

In summary, although adverse dermatologic reactions to medical tapes are a common clinical problem, the differences in composition of various medical tapes suggest that true tape allergy is

in fact a quite rare phenomenon. Recognizing the difference in mechanism and presentation of true tape allergy versus NATRs allows for an effective approach to caring for the patient who presents with tape allergy.

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