

Woven material for bed encasement prevents mite penetration

To the Editor:

Bed encasement with a mite-proof cover is one way of controlling house dust mites by preventing exposure to beddings, thereby reducing mite antigen exposure.¹⁻³ Various types of materials used for house dust mite barriers include plastic, polyurethane-coated, tight-woven, and nonwoven fabrics.⁴ The plastic- and polyurethane-coated covers provide the best protection but are the least comfortable because of air flow limitation. Both woven and nonwoven encasement materials have been widely used and highly recommended to patients who have dust mite allergy. It was previously recommended that a woven cover with a pore size of 2 to 10 μm , allowing air flow, can prevent the passage of house dust mites (HDM).⁵ Nonwoven fabrics are usually made from spun-bonded polypropylene or polyethylene fibers and are claimed to be an HDM barrier, which is less expensive, still effective after long-term use, light in weight, and comfortable.^{6,7} Currently, the commercially available encasing materials vary in their properties to block the passage of HDM and their allergens. In one study, we found a number of mites (248 live mites of which 103 were *Dermatophagoides pteronyssinus* and the remainder were unidentified) on the outer surface as well as penetrating deep within a nonwoven pillow cover obtained from a patient allergic to mites after 4 months of use (unpublished data). Based on these observations, we investigated the ability of HDM to colonize within the surface of both woven and nonwoven covers in vitro.

Two brands of nonwoven (A and B) and one brand of tightly woven covers (C) were cut into 2-cm² strips, marked for inner and outer surfaces, and placed within a specially constructed Siriraj chamber. This chamber effectively located and restricted mites to the fabrics throughout the course of the study. It consisted of a 5 $\times$ 5 $\times$ 3-cm acrylic box with a 4.5 $\times$ 4.5 $\times$ 0.3-cm plastic sheet inserted at the top and a 1-cm-diameter aperture in the middle for ventilation. The hole was first covered by a 2 $\times$ 2-cm piece of the encasing material being evaluated, followed by an acrylic ring. Ten adult stages of *D pteronyssinus* were randomly picked from a laboratory culture and placed in the middle of the ring. The ring was covered by the chamber lid and locked on three sides to prevent mites from escaping. The chambers were heated with 60-Watt light bulbs positioned 10 cm above the chamber for 20 minutes to force the mite internally. The locale of mite placement was on the uppermost part of either surfaces (X or Y) of each sample, so that in one chamber, X was placed on the outer surface, whereas in another chamber, Y was on the outer surface. This meant alternating the outer exposed surfaces in 9 different Siriraj chambers. Room temperature was initiated and mite behavior was observed every day for 1 week under a stereomicroscope.

A scanning electron microscope was used to evaluate the surfaces of all samples. Fig 1 (upper left and right panels, labeled covers A and B) shows that HDM can

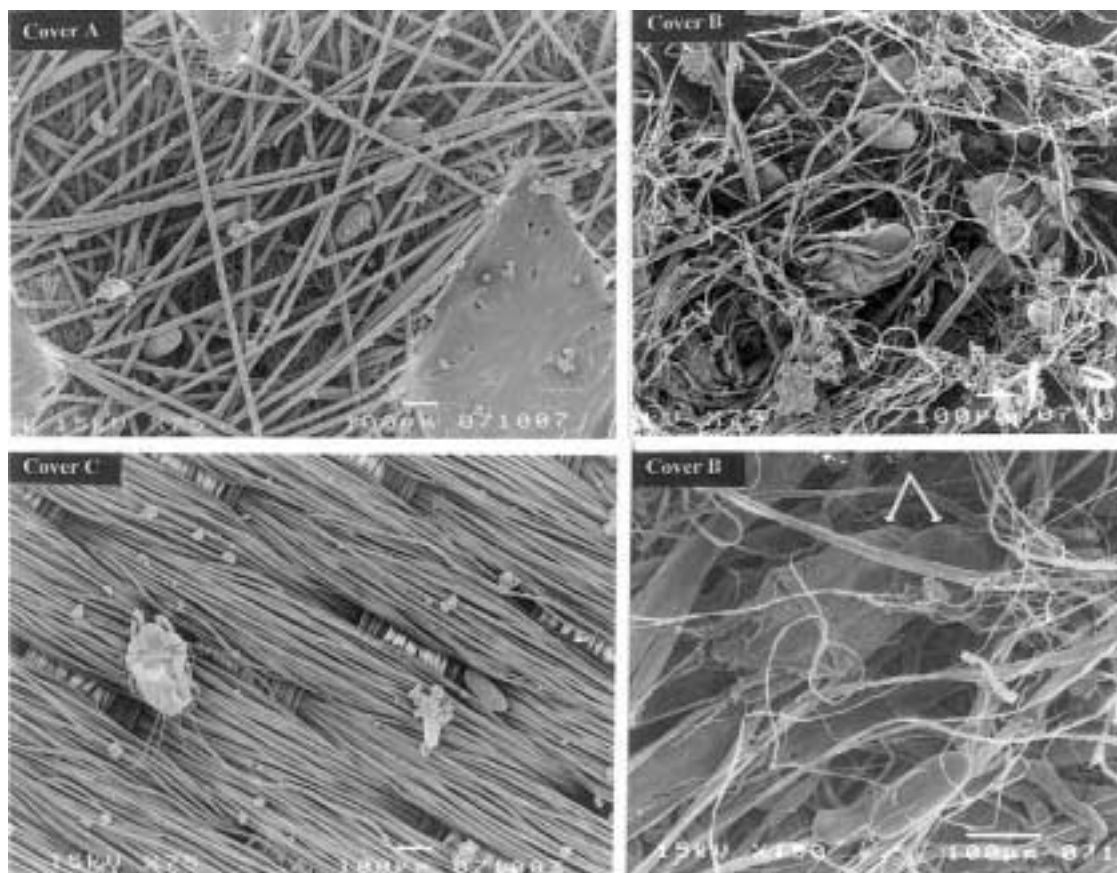


FIG 1. Scanning electron micrography shows ultrastructure of nonwoven and woven covers with mite penetration. *Upper left panel*, Mite eggs localized within nonwoven cover A; *upper right panel*, mite habitat within unorganized fibers of nonwoven brand B cover; *lower right panel*, pair of copulating mites (indicated by arrows) amid fibers of nonwoven brand B cover; *lower left panel*, HDM, mite eggs, and their fecal pellets on the surface of tightly woven fibers of the brand C cover.

colonize within the unorganized fibers of the nonwoven material. Now the presence of dust mites alone does not indicate colonization, but the presence of copulating mites (*arrows in lower right panel* labeled cover B) with subsequent egg-laying is the initial step in colonization, which would develop further in the presence of suitable conditions (nutrients and humidity). The view presented in both upper panels and the lower right panel implies that this material may be readily penetrated and within 2 days after exposure, provide a sound habitat for colonization. The fibrous material surrounding the mites supported active copulation and afforded a structured medium for laying eggs. For the nonwoven cover (A), mite colonization was found on both surfaces, whereas for B, the mites colonized on the outer surface only, due to the film-coated inner surface of this particular material. In contrast, the fibers of the woven cover C (*lower left panel*) were tight and well organized, so HDM and their eggs were not able to pass through the outer surface because of the small pore size. A χ^2 comparison of the nonwoven brands A and B summed over the three sets of each side revealed insignificant differences ($\chi^2 = 0.18$, df

$= 1$, $P > .05$). The comparisons of A and B versus C are notable because there were no penetrations of brand C; therefore, colonization was nonexistent on either the inner or outer surfaces.

The vast majority of mite allergens come from mite feces, which are fine particles ranging in size from 10 to 40 μm .⁸ Thus, materials with a pore size of 6 μm will completely prevent the passage of mite droppings. The ideal HDM barrier should have the ability to block the passage of dust mites and their allergens from either moving into or out of the bedding material and still retain a level of comfort as the result of air permeability. However, not only the pore size of the material used for an HDM barrier must be considered, but from our observations, we are suggesting that the texture of the material should also be of concern. It either provides a sound reservoir for mite habitation (nonwoven material), which might come from either inside and outside the bedding, or completely prevents penetration and subsequent colonization (woven material).⁹

To study the effect of washing on mite removal, the location of the mites was marked on the surface of the woven fabric. Subsequent manual washing in tap water

(22°C) for 5 minutes removed any trace of the mite's previous occupancy. Since mite allergens are highly soluble, it has been suggested that fabric washing is a highly efficacious procedure in removing most sources of mite allergen.¹⁰ An inherent disadvantage of using a nonwoven cover is that it should not be washed if one were to observe the manufacturer's prohibition. This recommendation along with our results is detrimental for the mite-sensitive patient, since HDM cannot be washed from either surface.

In conclusion, our study has shown that HDM from the environment can penetrate and colonize on the outer surface of nonwoven covers, which then become a potential reservoir of mite allergens. The recommended material for HDM control should be tightly woven fabrics, since HDM cannot penetrate this material.

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REFERENCES

1. Halken S, Host A, Niklassen U, Hansen LG, Nielsen F, Pederson S, et al. Effect of mattress and pillow encasing on children with asthma and house dust mite allergy. *J Allergy Clin Immunol* 2003;111:169-76.
2. Rijssenbeek-Nouwens LHM, Oosting AJ, De Monchy JGR, Bregman I, Postma DS, De Bruin-Weller MS. The effect of anti-allergic mattress encasings on house dust mite-induced early- and late-airway reactions in asthmatic patients: a double-blind, placebo-controlled study. *Clin Exp Allergy* 2002;32:117-25.
3. Tovey ER. Methods and effectiveness of environmental control. *J Allergy Clin Immunol* 1999;103:179-91.
4. Frederick JM, Warner JO, Jessop WJ, Enander I, Warner JA. Effect of a bed covering system in children with asthma and house dust mite hypersensitivity. *Eur Respir J* 1997;10:361-6.
5. Vaughan JW, McLaughlin TE, Perzanowski MS, Platts-Mills TAE. Evaluation of materials used for bedding encasement: effect of pore size in blocking cat and dust mite allergen. *J Allergy Clin Immunol* 1999;103:227-31.
6. Available at <http://www.user.globalnet.co.uk> access at 12/6/2002.
7. Available at <http://www.jipin.net/products/n-sleeve.htm> access at 9/10/2002.
8. Tovey ER, Chapman MD, Platts-Mills TAE. Mite feces are major source of house dust allergens. *Nature* 1981;289:592-3.
9. Mahakittikun V, Komoltri C, Nochot H, Angus AC, Chew FT. Laboratory assessment of the efficiency of encasing materials against house dust mites and their allergens. *Allergy* 2003;58:981-5.
10. Tovey ER, Taylor D, Mitakakis TZ, De Lucca SD. Effectiveness of laundry washing agents and conditions in the removal of cat and dust mite allergen from bedding dust. *J Allergy Clin Immunol* 2001;108:369-74.
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