

Evaluation of the Antibacterial Activity of a Special Silk Textile in the Treatment of Atopic Dermatitis

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Key Words

Atopic dermatitis · Silk textile · Antibacterial properties · Quaternary ammonium · *Staphylococcus aureus*

Abstract

Background: Increased skin *Staphylococcus aureus* colonization is frequently found in atopic patients. The reduction of local overinfection decreases skin inflammation and improves the flares. **Objective:** To evaluate the effectiveness of the antimicrobial activity of a silk fabric (MICROAIR DermaSilk[®]) coated with alkoxysilane quaternary ammonium with durable antimicrobial properties (AEGIS AEM 5572/5) in children affected by atopic dermatitis (AD). **Methods:** Sixteen children, 12 affected by AD with symmetric eczematous lesions on the antecubital areas and 4 without any cutaneous disease, used, for 7 days, tubular arm covers made of this special silk fabric but only one of each pair was coated with AEGIS AEM 5572/5. Microbiological examinations were done with standard cultural swabs and by means of quantification of bacterial agents using agar plates at baseline, after 1 h and after 7 days. **Results:** After 7 days a significant improvement in the mean value of the 'local SCORAD' index was observed in both the covered areas compared to the values obtained at baseline. The reduction in the mean number of colony forming units per square centimetre was similar in both areas. **Conclusions:** Although this special silk fabric seems to

be able to improve skin lesions in AD, we were unable to demonstrate that such silk fabrics coated with AEGIS AEM 5572/5 have an antibacterial activity in vivo, as shown in vitro.

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Introduction

There are many factors known to worsen atopic dermatitis (AD), including fabrics [1]. A study by Hermanns et al. [2] assessed the beneficial effects of softened fabrics on atopic skin, suggesting that softened fabric is less aggressive to the skin than unsoftened fabric. In addition, the increased *Staphylococcus aureus* colonization of the skin frequently found in patients with AD [3] exacerbates or maintains skin inflammation, so topical and general antibacterial drugs are often used to keep the skin under control. Topical steroids and immunomodulators also appear to be able to reduce the degree of bacterial colonization [4–6], as does the recently proposed use of silver-coated textiles [7]. In a previous work with a special silk fabric (MICROAIR DermaSilk[®]) [8] we observed a clinical improvement of eczema in the area covered by the textile in 46 children with AD. This fabric also has antibacterial properties in vitro [9] thanks to a water-resistant treatment with AEGIS AEM 5572/5, a durable anti-

microbial finish for textile products that prevents bacterial survival (including *S. aureus*) and odour. The aim of our work was to evaluate the effectiveness of the antimicrobial activity of this silk fabric coated with AEGIS AEM 5572/5 in children affected by AD.

Materials and Methods

We studied 12 children aged between 2 and 8 years (mean age 4 years) affected by AD diagnosed by the criteria of Hanifin and Rajka [10]. At the time of examination, they presented eczematous lesions symmetrically located on the flexures of both elbows. No signs of impetiginization were observed even though topical steroids, immunomodulators and antibiotics had been excluded for at least 2 weeks, systemic antibiotics for at least 4 weeks and antihistaminics for at least 2 weeks. Four healthy children, matched for age, were enrolled as normal controls. Each patient received 2 pairs of tubular arm covers made of MICROAIR DermaSilk produced by AL.PRE.TEC (S. Donà di Piave, Venice, Italy). Two different sizes were available to suit the dimension of the arm.

All enrolled patients were volunteers and informed consent was obtained from the parents before the children were included in the study. No approval was required from our ethics committee and the authors had no conflict of interest concerning sponsorship of any kind in this study.

In each pair of tubular covers the sides were clearly marked 'right' or 'left', and the parents were asked to always put them on the respective arms of their child. Only one cover of each pair was treated with AEGIS AEM 5572/5 and the authors and parents did not know which one had been coated. The main characteristics of these fabrics were clearly explained to the parents and they were also informed that the continuous use of the arm covers for all 7 nights and days (removed only when the child was taking a shower) was necessary to obtain an improvement and that the covers needed to be changed and washed every day with a mild soap as indicated by the producer. Only moisturizing therapy with Cetafil® was permitted. The patients' detergents were continued as usual but none of these contained antiseptics or antimicrobial products. The children did not receive any anti-inflammatory treatment for other lesions on their body during the trial.

At baseline (T0) and after 7 days (T2), the local disease severity was measured by 2 investigators following the same 'local SCORAD' protocol as used by Gauger et al. [7].

The microbiological evaluation of the skin resident flora was performed by means of two methods. A sterile tampon was wiped over the antecubital areas on the normal skin of the controls and on the eczematous skin in children with AD at baseline (T0), after 1 h (T1) and after 7 days (T2). The culture was made by streaking the skin swab onto blood agar plate and mannitol salt agar. Identification of *S. aureus* was performed using the GP test VITEK 2 (BioMérieux).

Because the antimicrobial activity of AEGIS AEM 5572/5 is not selective we decided to evaluate the total number of bacterial colonies by the agar plate technique. An agar plate (6 × 6 cm in diameter) with tryptic soy agar culture media prepared 3 days before was applied on the same antecubital areas. The plates were applied for a few seconds on the normal skin of the controls and

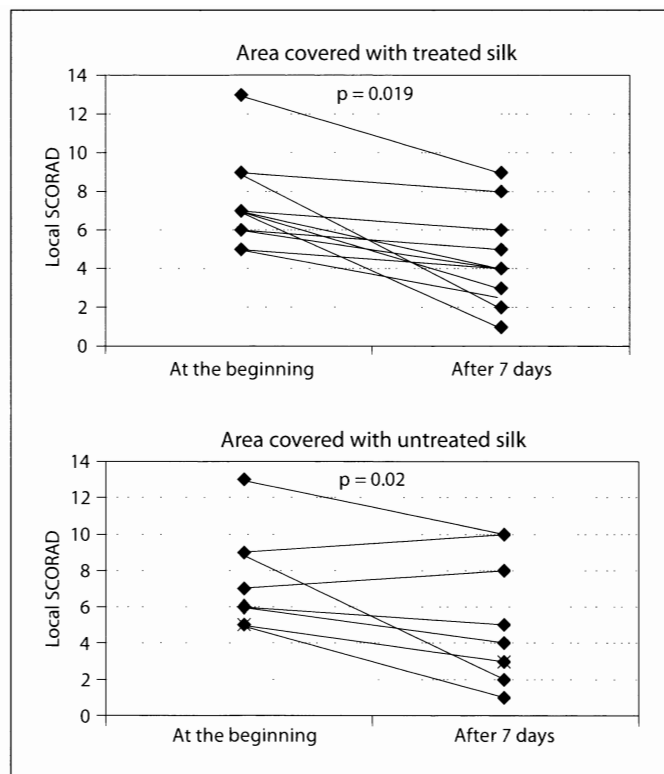


Fig. 1. Local SCORAD of the antecubital area in 10 children with AD in acute phase coated with silk fabrics with AEGIS (mean value before and after treatment from 7.3 to 4.4; $p = 0.019$) and without AEGIS (mean value before and after treatment from 7.1 to 5; $p = 0.02$).

on the eczematous skin in children with AD. Successively the plates were put into an incubator at 37°C for 48 h and the number of bacterial colonies was quantified by microscopic count and expressed as colony forming units per square centimetre (CFU/cm²) of antecubital area.

The Statistical Package for Social Science (SPSS/PC; SPSS Inc., Chicago, Ill., USA) was used for statistical analysis. The χ^2 test for non-parametric analysis and Student t test were used for comparison. A significant level of $p = 0.05$ was chosen. We considered a quantitative microbiological improvement significant if the number of CFU was reduced at least to half of the baseline value.

Results

Two atopic children withdrew from the study due to difficulty in keeping the fabrics on the antecubital folds for all 7 days. The other 14 children completed the study, following the instructions regarding the continuous use of the silk garments. No local side effects owing to the

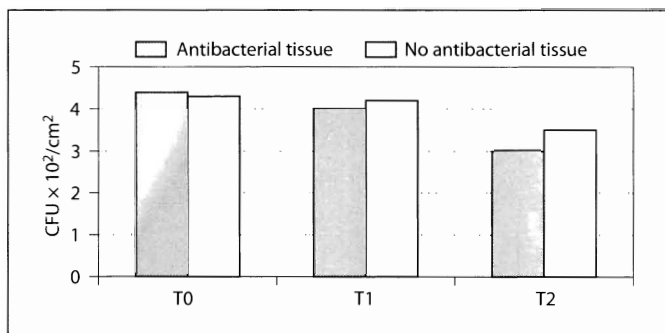


Fig. 2. Mean number of CFU/cm² observed in the antecubital area in children with AD at the beginning of the study (T0), after 1 h (T1) and after 7 days (T2) of use of a silk fabric coated or not coated with the antibacterial agent AEGIS.

textile such as acute and cumulative irritation, allergic contact dermatitis, or contact urticaria were observed and none of the patients presented rhinitis or asthma during the trial. After 7 days, in the 10 children with AD, a significant improvement in the mean value of the local SCORAD index was observed in both covered areas (fig. 1) and the reduction in the mean number of CFU/cm² was similar in both areas (fig. 2). Microbiological cultures were positive for *S. aureus* in 5/12 children (42%) at baseline and in 3/10 atopic children (30%) at the end of the study, without any statistically significant difference.

In the unaffected subjects no microbiological cultures resulted positive for *S. aureus* and the number of CFU/cm² always remained similar to baseline.

Discussion

The possibility to detect *S. aureus* varies with the different methods used. In a previous study [11] using a dry standard swab in the antecubital area we observed a positive culture of 38% in children affected by AD and this percentage is similar to that observed in the present paper and in the recent work by Patel et al. [12]. Higher percentages of *S. aureus* have been detected with the scrub technique and also with the contact-plate technique. The latter method evaluates a wider sample area with a consequently higher possibility to detect bacteria. As observed in a recent paper [13], *S. aureus* was isolated from the majority of the bacterial colonies in subjects with AD. In the present study we were unable to typify the bacteria from the isolated bacterial colonies, so we chose to utilize the

standard cultural method routinely performed to confirm that the isolated bacteria in our AD patients were mainly *S. aureus*, in association with the agar plate technique to quantify the number of bacterial colonies for evaluation of the entity of colonization in our cases. The validity of this method is confirmed by the difference observed between the atopic patients and controls.

In a previous study [7] with the same silk fabric we observed a clinical improvement in skin lesions in children with AD and in this study too our data showed a statistically significant clinical improvement but without any difference between the area covered by the treated silk fabric and that covered by untreated fabric. Moreover, the number of cases with evident reduction (to at least half of the previous value) of CFU/cm² was similar both in the areas covered by treated fabric (5 cases) and those covered by untreated fabric (4 cases), even if a slight but not significant reduction in the mean number of CFU/cm² was present in the area covered by treated fabric.

On the basis of the analysis of our data, although the silk fabric treated with AEGIS AEM 5572/5 shows in vitro antibacterial properties, we were unable to demonstrate any such activity in vivo. The most realistic explanation is that the strong adhesion of the fibre does not allow the product to penetrate into the skin and to contact bacteria sufficiently to kill them, as happens with the silver-coated textiles [7]. The inability to reach bacteria in the lower layer of the stratum corneum or follicles would therefore allow them to survive. On the other hand, the strong adhesion of AEGIS AEM 5572/5 to the fibre minimizes any possible toxicological side effects of coated ammonium because the ammonium is so closely covalently bound to the textile fibre that there is no absorption through the skin lesions into systemic tissues.

In any case the use of soft fabric improved the AD rapidly and considerably in these patients, probably because the covering of the affected areas prevents external bacterial overinfection and reduces the contact with other types of clothes by forming a protective barrier which permits the recovery of the cutaneous barrier. A recent study has, in fact, suggested that antimicrobial silk clothing in the treatment of AD proves comparable to a topical corticosteroid treatment [14].

In conclusion, the improvement seen in the eczema appears to be related to the direct contact with a delicate and soft fabric such as serine-free silk [8] which relieves itching, restores the disrupted cutaneous barrier and, thanks to the AEGIS coaction, protects the area from further overinfection.

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