

'EASIdig' – A Digital Tool to Document Disease Activity in Atopic Dermatitis

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Key Words

Telemedicine • Atopic dermatitis • Eczema Area and Severity Index • Scoring Atopic Dermatitis system • Digital imaging

Abstract

Background: Different scoring systems have been developed to determine the severity of atopic dermatitis (AD); the SCORAD (Scoring Atopic Dermatitis) and EASI (Eczema Area and Severity Index) are among the best-validated scoring systems. **Objective:** The aim of this study was to produce a rational quality control for routine clinical use by using the modern facilities of digital imaging. **Methods:** 63 AD patients were scored by a single person at each visit using the SCORAD and EASI scoring methods. Images were taken and rated by two non-dermatology physicians trained in the scoring system. In addition, blood samples were taken for the determination of total IgE, eosinophils and eosinophilic cationic protein. **Results:** The EASI score established from the digital images, hereby named 'EASIdig', correlated at all visits with the results of the SCORAD and EASI. Together with immunological parameters, they also reflected changes of disease severity during the 3 time points. **Conclusion:** The digital evaluation of the EASI is a reliable tool for the digital assessment of severity and extent of AD.

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Introduction

Atopic dermatitis (AD), one of the common dermatological abnormalities encountered in clinical practice, is a chronic pruritic skin disorder occurring in individuals with a personal or family history of atopic disease, such as asthma or allergic rhinitis [1]. In addition, there is a strong immunological disorder: the link between immunoglobulin E (IgE) antibodies and environmental allergens, allergic sensitization and AD is well established, yet treatment of this disease is largely symptomatic and fails to correct the underlying immune disorder [2, 3]. Also measurement of eosinophilic cationic protein (ECP) as well as eosinophil cells in serum has been utilized as a marker for allergic inflammation [3–6].

Because AD is such a fluctuating disease, it is rather difficult to produce reliable and valid descriptions of grades of severity. Subsequently, there has always been a dearth of standard systems for the assessment of disease severity. To solve this problem, different scoring systems have been developed to determine the severity of AD. The SCORAD (Scoring Atopic Dermatitis) is one of the best-validated systems [4]. It has also been demonstrated that it is feasible to be assessed by the patients themselves [5, 7]. For clinical treatment studies it could be an advantage to document the clinical status of the disease. A pos-

sibility to establish a clinical scoring system can be photodocumentation and judgement by an external examiner. However, as whole-body photographs and details are necessary to estimate the extent, large numbers of pictures as well as a lot of storage and financial resources would be needed. As digital imaging has proved to be a very useful tool in the estimation of naevi, we investigated the possibility and reliability of a digital documentation for AD. Hence, the method for analysing disease severity of AD should be as simple as possible requiring minimal additional equipment. Thus, the aim of this study was to produce a rational quality control for routine clinical use and research purposes with electronic monitoring.

Materials and Methods

Sixty-three patients with AD aged between 18 and 70 years were investigated at 3 different points for 3 months (week 0, week 6 and week 12). The diagnosis of AD was made according to the criteria of Hanifin and Rajka [6] from 1980. Before and after this 11-week period, the patients were examined clinically by a single examiner in a face-to-face visit. In addition, digital photographs were taken from the front, the back and antecubital areas, and other affected skin areas were also considered.

To evaluate the severity of AD, the SCORAD (Scoring Atopic Dermatitis) was used by a non-dermatology physician trained in the scoring system. Results of earlier studies indicate that a non-dermatology physician trained in the scoring system scores AD as well as a trained dermatologist [8]. To estimate intra-evaluator reliability, a second independent, trained non-dermatology physician was selected to evaluate the severity of AD of 10 patients at a given time point using the EASI (Eczema Area and Severity Index) score.

As sleep loss was not taken into consideration, we used the EASI instead of SCORAD for the digital analysis. The method of calculating the EASI assigns proportionate body surface areas to 4 body regions: the head (10%), trunk (30%), upper extremities (20%) and lower extremities (40%). The area of involvement of each body region is assigned a numerical score which represents the proportion of the total area within the region. The key signs of AD, erythema, infiltration or papules, excoriation and lichenification, were assessed on a scale of 0–3 indicating none (0), mild (1), moderate (2) and severe (3) expression of each clinical sign, with half-value scores being permitted. Each item should be scored on the most representative area, defined as the severest lesion, for a given intensity item [8]. The total EASIdig was then calculated, taking into account the severity of each key clinical sign, the involvement within each body region and the proportion of the whole body represented by each area. Therefore, the EASIdig could theoretically vary between 0 and 72 [9].

Digital Imaging

Our equipment included a personal computer (Compaq Computer Corporation, Evo D510 SFF, Intel® Pentium® 4 CPU 2.00

GHz) with a 40-GB hard disc drive and 248 MB of RAM and an analogue colour monitor (Sony SDM-M51). The two independent non-dermatology physicians trained in the scoring system reviewed images on a 15-inch monitor at a resolution of $1,024 \times 768$ pixels with 65,000 colours (Microsoft Windows XP Professional Version 2002 Service Pack 1) (fig. 1).

The pictures were taken under artificial light instead of daylight. They were made with a digital camera [Coolpix 990, Nikon, a 3.34-megapixel CCD, which offers true (non-interpolated) image resolution of $2,048 \times 1,536$ for easy cropping and high print quality]. For each patient there were 12 pictures: 6 in week 0 (front, back, antecubital area and other affected skin areas) and 6 in week 12. Pictures from the front or back required 1.1 MB, pictures from the neck or other affected areas required 700 kB of memory.

Other skin lesions could be the face, popliteal areas, the hands, the trunk or feet. Images were stored in a compressed Joint Photographic Experts Group (JPEG) format. To measure the extent of AD, the pictures were analysed from the front and back of the patients. Small, discrete skin lesions were photographed at the closest possible focal distance which also included surrounding uninvolved skin.

Additional Immunological Markers of Disease Activity

In addition to these pictures, blood samples were taken from each patient. Total IgE, ECP and total blood cell count to define eosinophil granulocyte numbers were examined. IgE and ECP analyses were performed using commercial kits (Bühlmann Laboratories, Immunotech/Phadia). All analyses were done in duplicate. Normal values for total IgE were 0–150 IU/ml and 0–120 ng/ml for ECP.

Statistical Analysis

The correlations were calculated at a 5% level with Stat View on an HP Vectra using the Spearman rank test.

Results

Because of many drop-outs (16%), 53 patients were finally involved in this study. Patients who missed more than 2 sessions were excluded from the study. Finally, 29 women and 24 men took part in this study, and the average age of these 53 patients was 28.5 years. However, fewer than 53 patients were suitable for our study, as the pictures were not always taken of the whole body. To measure the SCORADdig, 48 patients were analysed (23 men and 25 women, age average 28.7 years), and 52 patients were analysed for EASIdig (25 men and 27 women, age average 28.6 years).

The SCORAD classifies the severity of AD into mild (<15), moderate (between 15 and 40) and severe (≥ 40) [8]. Most patients had a moderate severity of AD (32 in week 0 and 30 patients in week 12).

At all visits the results of the SCORAD and EASI taken clinically correlated highly significantly with the EASI

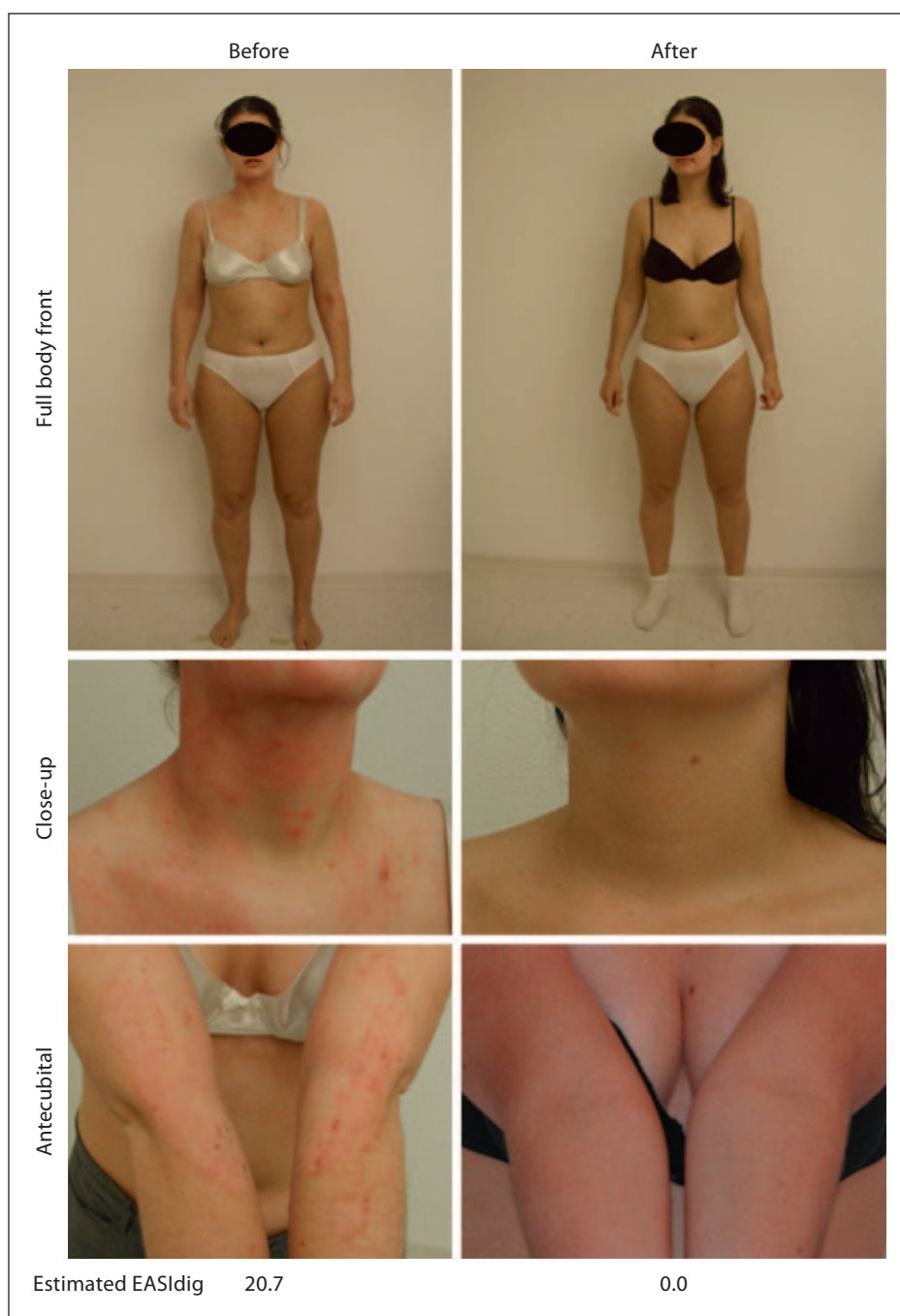


Fig. 1. EASIdig: digital imaging of a patient with AD in week 0 and in week 12.

score established from the digital images ($r = 0.921$, $p < 0.0001$ at week 0 and $r = 0.887$, $p < 0.0001$ at week 12). In addition, the EASI score established from the digital images by the two independent, trained non-dermatology physicians correlated highly significantly ($r = 0.971$, $p < 0.0001$). Also, a low SCORAD index was associated with decreased immunological parameters and vice versa (table 1).

The average of SCORADdig was 27 ± 14 in week 0 and 21 ± 11 in week 12.

Additionally, because pruritus and loss of sleep were not considered in the EASI, we had 52 patients (27 women) instead of 48 patients (25 women) in the SCORADdig. However, the results are: the EASIdig was 7.8 ± 7.5 in week 0 and 6.0 ± 7.0 in week 12.

Table 1. Clinical and immunological parameters of the study population**a** Week 0

AD	Age $\pm$ SD years	Sex (M/F)	SCORAD $\pm$ SD	Eosinophils $\pm$ SD $n \times 10^3/\mu\text{l}$	ECP $\pm$ SD ng/ml
Mild	24.6 $\pm$ 3.6	4/5	10.89 $\pm$ 2.10	0.158 $\pm$ 0.054	9.0 $\pm$ 1.3
Moderate	30.1 $\pm$ 13.0	15/17	25.41 $\pm$ 7.78	0.315 $\pm$ 0.205	15.9 $\pm$ 13.8
Severe	27.7 $\pm$ 6.4	4/3	51.69 $\pm$ 7.79	0.703 $\pm$ 0.264	30.9 $\pm$ 10.8
Total	28.7	23/25	26.52 $\pm$ 13.79	0.335 $\pm$ 0.247	16.0 $\pm$ 13.2

The different grading of AD is compared with SCORADdig, eosinophil cells and ECP in week 0. Note that the blood parameters and SCORADdig increase gradually with the severity of AD.

b Week 12

AD	Age $\pm$ SD years	Sex (M/F)	SCORAD $\pm$ SD	Eosinophils $\pm$ SD $n \times 10^3/\mu\text{l}$	ECP $\pm$ SD ng/ml
Mild	26.2 $\pm$ 6.9	6/10	10.02 $\pm$ 4.11	0.278 $\pm$ 0.197	18.4 $\pm$ 22.5
Moderate	30.5 $\pm$ 13.1	16/14	23.72 $\pm$ 5.21	0.393 $\pm$ 0.258	22.4 $\pm$ 16.6
Severe	25.0 $\pm$ 7.6	2/1	49.64 $\pm$ 10.43	0.720 $\pm$ 0.467	23.3 $\pm$ 15.2
Total	28.7	23/25	20.77 $\pm$ 11.14	0.367 $\pm$ 0.258	21.0 $\pm$ 18.5

The different grading of AD is compared with SCORADdig, eosinophil cells and ECP in week 12. Note that all the blood parameters gradually increase with the severity of AD. There are very few patients with severe AD.

Discussion

To date, there is a paucity of data in the literature on the digital evaluation of AD using the EASI score system. In our study, the digital documentation of disease severity in AD using the EASI is a reasonable, reliable and time-saving tool in evaluating the severity of AD. As the images can be taken by using a simple digital camera by a non-dermatology physician trained in the scoring system, digital evaluation of the EASI, hereby named 'EASIdig', can also be a cost-saving tool. To evaluate a patient with AD, it takes not more than 30 min to establish the score of the EASIdig (see also fig. 1). In addition, it is not only time saved for the physician, but also for the patients, who do not need to be present all the time. Intra-evaluator reliability of the EASIdig indicated in our research that the evaluators assessed the patients consistently. A highly significant correlation of the EASIdig has been found between the two trained non-dermatology physicians. This is in line with the literature. Hanifin et al. [10] tested the reliability of the EASI scoring system by assessing inter- and intra-observer consistency. Twenty adults and children with AD were examined. Finally, they came

to the conclusion that overall intra-evaluator reliability of the EASI was in the fair-to-good range. Inter-evaluator reliability analyses indicated that the evaluators assessed the patients consistently [10].

Several reports indicate that telemedicine applications in dermatology hold great promise as an alternative means of health care delivery. Whited et al. [11] assessed and compared the reliability and accuracy of dermatologists' diagnoses and management recommendations for clinic-based and digital image consultation. Thus, 168 lesions found among 129 patients were independently examined by 2 clinic-based dermatologists and 3 different digital imaging dermatologist consultants. Digital imaging consultants provided diagnoses which were similar to those of the clinic-based examiners [11].

Teledermatological methods have also been successfully applied for hand eczema. Baumeister et al. [12] tested and compared two validated scores (Osnabrück Hand Eczema Severity Index; Hand Eczema Severity Index) for their suitability in an occupational telemedical screening and showed that both scores were suitable to assess severity of hand eczema by teledermatology. Nordal et al. [13] compared the diagnoses made by one dermatologist via

telemedicine with those of another dermatologist made in face-to-face consultation. Of 121 patients, there was a high degree of concordance between the two sets of diagnoses, with 72% complete agreement and 14% partial agreement between the two dermatologists [13]. In another study, reasonably high levels of agreement were found between a dermatologist seeing a patient and a dermatologist using the telemedicine system (77%) [14]. Rajbhandari et al. [15] evaluated the measurement of foot ulcers using a digital imaging technique and compared this with the traditional method. Three independent observers calculated the area of an ulcer. Of 30 diabetic foot ulcers, there was significantly less interobserver variation using the digital image than the traditional method [15].

Another field of interest in teledermatology are pigmented skin lesions. Accurate diagnosis and management are critical because of the morbidity and mortality associated with melanoma. Warshaw et al. [16] compared the accuracy of store-and-forward teledermatology for pigmented neoplasms with standard, in-person clinic dermatology. In general, the addition of dermatoscopic images did not significantly change the rate of teledermatology diagnostic accuracy. Rates of appropriate management plans for teledermatology were superior and/or equivalent to clinic dermatology. However, for the subgroup of malignant lesions (n = 124), the rate of appropriate management was significantly worse for teledermatology than for clinic dermatology [16]. Therefore, teledermatology and teledermatoscopy should be used with caution for patients with suspected malignant pigmented lesions.

Eosinophils and IgE play a central role in allergic diseases. The eosinophil's capacity to release and be influenced by a variety of mediators (e.g. lipid mediators, cytokines, granule proteins) implicates this cell in the pathology of inflammation [17]. However, it is well known that other factors such as disrupted barrier function or microbial agents are also crucial factors in AD and may

therefore also influence immunological parameters such as eosinophils and IgE [18]. It has been shown that the severity of AD is highly correlated with the levels of serum IgE [2, 19, 20]. Severe chronic cases with ever-recurrent exacerbations showed the most extreme values [2]. Although not consistently, a correlation between serum IgE and the severity of AD has also been found in studies in the adult period [21, 22]. However, in the so-called 'intrinsic' type of AD, patients show normal total serum IgE levels, no specific IgE and negative skin-prick tests to aero-allergens or foods [23]. In few studies also levels of interleukin-31 have been shown to correlate with disease activity in AD [18, 24].

Our study has some limitations: data analysis was performed in a retrospective design. Longitudinal or multicentric therapeutic studies in AD by blinded investigators allowing a fast exchange of digital images and associated information are needed.

Conclusion

To sum up, our study demonstrated that the EASIdig can be learned quickly and utilized reliably in the assessment of the severity and extent of AD. Thus, a follow-up of patients with management based on disease activity can be given by the EASIdig also on a distant base. Also for studies referring to disease activity, the EASIdig presents an ideal tool as it allows completely blinded documentation or analysis of the extent of AD, respectively. Thus, the EASIdig would be worthwhile to be implemented in larger studies to be further assessed.

Disclosure Statement

The authors declare that there are no conflicts of interest.

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