

COMPUTER ANALYSIS OF NOCTURNAL SCRATCH IN ATOPIC DERMATITIS

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Abstract. Scratch behavior was monitored with a paper strain gauge attached to the dorsum of the hand and an amplifier. The all-night recording was subsequently analysed every 60 sec with a specially devised computer system and the duration of scratching and the time(s) of its occurrence were printed out. This technique was applied in 10 patients with moderate or severe atopic dermatitis, 5 with generalized eczema and 5 non-itchy subjects. It was found that scratching occurred in cluster(s) or in an isolated form in both itchy and non-itchy subjects. Marked clustering of scratch behaviour was noted only in itchy subjects. No specific difference was observed in scratch patterns of atopic dermatitis vis-à-vis generalized eczema. Total scratch time of the right and left hands during the night ranged between approx. 1 and 5 thousand sec in itchy patients and between 1 and 5 hundred sec in non-itchy subjects. The ratio of the total scratch time to the recording time in atopic dermatitis did not differ significantly from that in generalized eczema. No correlation was observed between the duration of scratch and serum IgE level.

Key words: Scratch; Nocturnal scratch; Itching; Atopic dermatitis; Computer analysis

It is widely accepted that atopic dermatitis (AD) is a disease of itchiness, while scratching plays a cardinal role in the formation of characteristic skin lesions. However, itching occurs in many other skin diseases and the specific role played by scratching in the pathogenesis of AD has not been clarified. A previous study (1) revealed that scratch occurred in all stages of sleep (awake, 1, 2, 3, 4 and REM) without apparent difference between AD and the other itchy skin diseases.

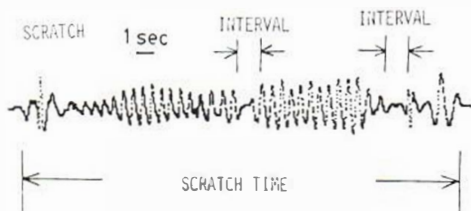


Fig. 1. Digitally signalled scratch waveforms and the definition of scratch (see text).

To facilitate the investigation of nocturnal scratching, we have developed a computer analysis system with which the all-night recording can be analysed relatively quickly. This was applied to AD, in comparison with generalized eczema (EZ) and non-itchy controls (CR).

SUBJECTS AND METHODS

Subjects

Three groups were studied (Table I):

I. Atopic dermatitis (AD). 10 Patients with persistent AD of adult type, all of whom had widespread skin lesions and who complained of moderate or severe itching.

II. Generalized eczema (EZ). Five patients with EZ of varying type and duration who complained of moderate or severe itching.

III. Non-itchy control (CR). Five non-itchy subjects including 2 normals and 3 patients with various diseases.

All-night scratch recording

Patients were usually admitted to the hospital on the day of

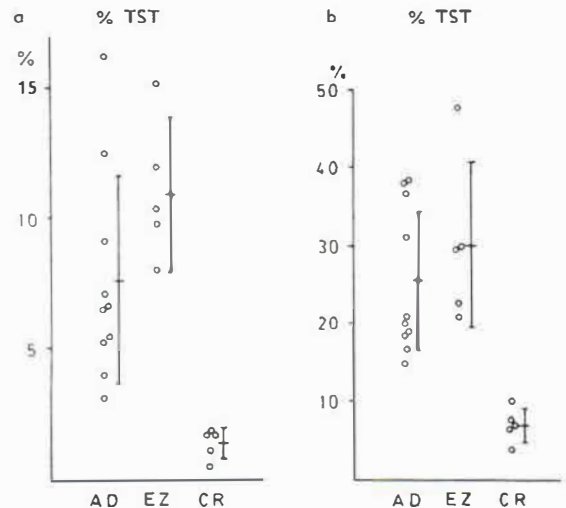


Fig. 2. Distribution of %TST (a) and %TSAT (b) in atopic dermatitis (AD), generalized eczema (EZ) and non-itchy control (CR). \bar{x} indicates mean and ± 1 standard deviation.

Table I. List of data

For abbreviations see text

Group	Patient no, sex, age	Recording time (min)	TST (R + L) (sec)	% TST	TSAT (min)	% TSAT
Atopic dermatitis	1 F 43	560	5 435	(16.2)	173	(30.9)
	2 M 29	546	4 097	(12.5)	200	(36.6)
	3 F 16	521	2 842	(9.1)	199	(38.2)
	4 F 26	457	1 954	(7.1)	173	(37.9)
	5 M 26	547	2 159	(6.6)	113	(20.7)
	6 F 20	542	2 121	(6.5)	90	(16.6)
	7 M 22	560	1 811	(5.4)	105	(18.8)
	8 M 44	560	1 733	(5.2)	103	(18.4)
	9 M 15	519	1 242	(4.0)	103	(19.8)
	10 F 47	560	1 054	(3.1)	83	(14.8)
Generalized eczema	11 M 84	560	5 091	(15.2)	267	(47.7)
	12 M 54	546	3 915	(12.0)	162	(29.7)
	13 F 45	560	3 498	(10.4)	126	(22.5)
	14 M 47	418	2 467	(9.8)	123	(29.4)
	15 M 28	560	2 359	(7.0)	116	(20.7)
Non-itchy control	16 M 20	493	519	(1.8)	38	(7.7)
	17 M 37	485	500	(1.7)	48	(9.9)
	18 F 36	435	452	(1.7)	28	(6.4)
	19 M 19	503	345	(1.1)	34	(6.8)
	20 M 48	540	146	(0.5)	21	(3.9)

the test. A paper strain gauge was attached to the dorsum of the each hand by means of adhesive tape. This was connected to an amplifier (Nihonkoden RP5) and then to a data recorder (SONY UFR61430). Feasibility of the system was checked by a test scratch movement visualized on a display monitor. Recording was started between 9 and 10 pm and was finished around 6 am in the standard test.

Computer analysis

The record was analysed on a Digital Equipment Corp. PDP 11/40 computer with 28 KW of core memory, a magnetic disk (2.4 MW), a graphic display and an analog-to-digital conversion unit. The system was designed so that it can be operated at 16 times real time, making it possible to process a 9 hr scratch record in about 50 min. The analogous signal was filtered through the 1-5 Hz band pass filter and then converted to the digital form at an effective sampling rate of 20 Hz/channel and the sampled data were stored on a magnetic disk. The digital signal was processed every 60 sec and the analysis was made by the zero-crossing method combined with the amplitude and period criteria. The scratch was defined as the waveforms between 1 and 3 Hz with the amplitude exceeding a certain threshold level and with the duration greater than 2 sec. An interruption of less than 3 sec in between two scratches was counted as a continuous scratch (Fig. 1).

RESULTS

Difference between 1st and 2nd night

Six subjects (4 AD, 1 EZ and 1 CR) were tested on two nights and % total scratch times (see below)

for the two nights were compared in each individual. An appreciable decrease was noted in 2 AD and 1 EZ and a marked increase in 1 AD on the second night. Almost identical results were obtained in 1 AD and 1 CR. All data described in this paper are those for the 1st night, except for a few examples.

% Total scratch time (%TST)

The duration of scratching throughout the night was summed for each hand and addition of the two hand records gave the total scratch time (TST). This was believed to indicate active scratching during the night. TST was divided by the recording time (RT) to give the %TST (Table I). %TST was compared between disease groups but the difference in the means was not significant for AD vs. EZ, while it was highly significant ($p < 0.001$, *t*-test) for AD and EZ vs. CR (Fig. 2a).

% Total scratch-associated time (%TSAT)

The minute in the record in which scratch occurred in either or both hands was summed up to give the total scratch-associated time (TSAT). This was divided by RT to obtain %TSAT which is thought to indicate the relative ratio of time occupied by

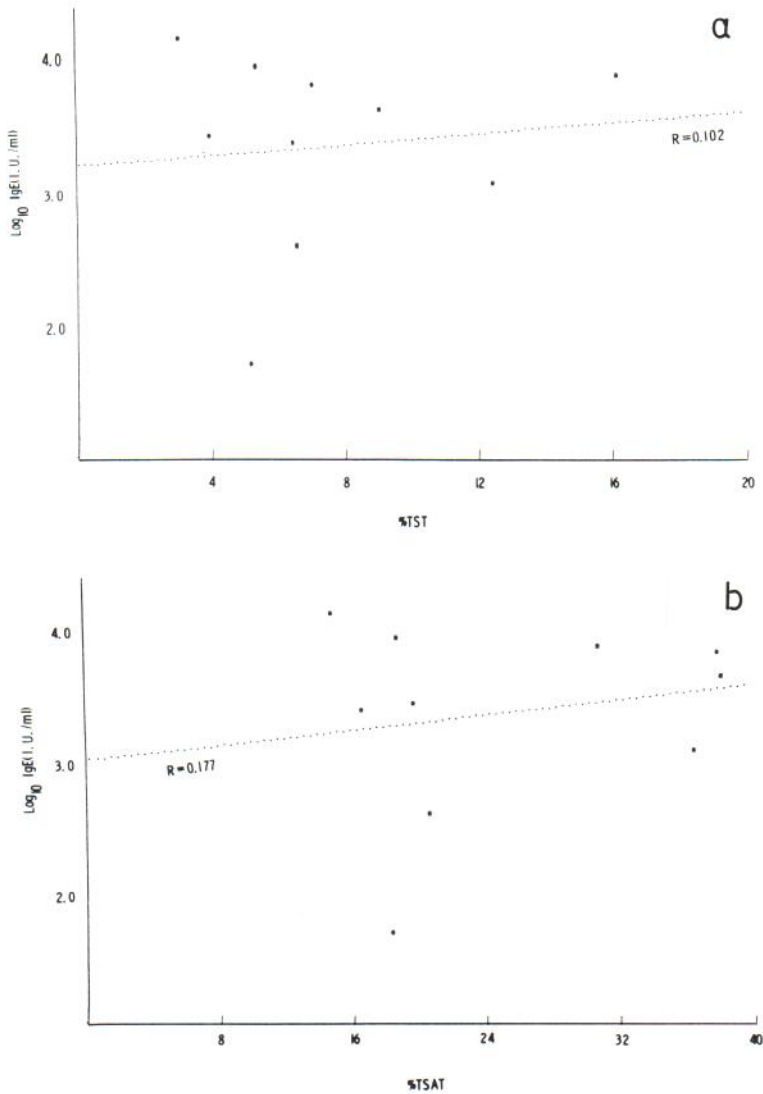


Fig. 3. Relation of log₁₀ serum IgE to %TST (a) and %TSAT (b).

scratching (Table I). The difference in the means of %TSAT was not significant for AD vs. EZ, while it was highly significant ($p < 0.001$, *t*-test) for AD and EZ vs. CR (Fig. 2b).

Relation of scratch to serum IgE

%TST and %TSAT were compared with the log value of serum IgE in each AD individual. In 7 of 10 patients, IgE was estimated within a month of the test. As shown in Fig. 3a & b, no correlation was noted in either test.

Graphic display of scratch

The time occupied by scratching in every 60 sec was printed out on the ordinate (1 sec = 1 point)

and the time of its occurrence on the abscissa. Two examples (AD no. 4 and CR no. 17) are shown in Fig. 4a & b. As seen in the figures, scratch occurred sometimes in a cluster and sometimes in isolated form. A cluster usually ranged over a few or several min. This may be called a small cluster. However, large clusters ranging over 20, 40 or even more than 60 min could also be observed. The large cluster was comprised of small clusters and isolated scratches. It appeared in more or less all itchy patients (AD and EZ), usually several times or occasionally during the night. In some it appeared in the early stages of the record and in others in the late stages. Scratches of the right and left hands often

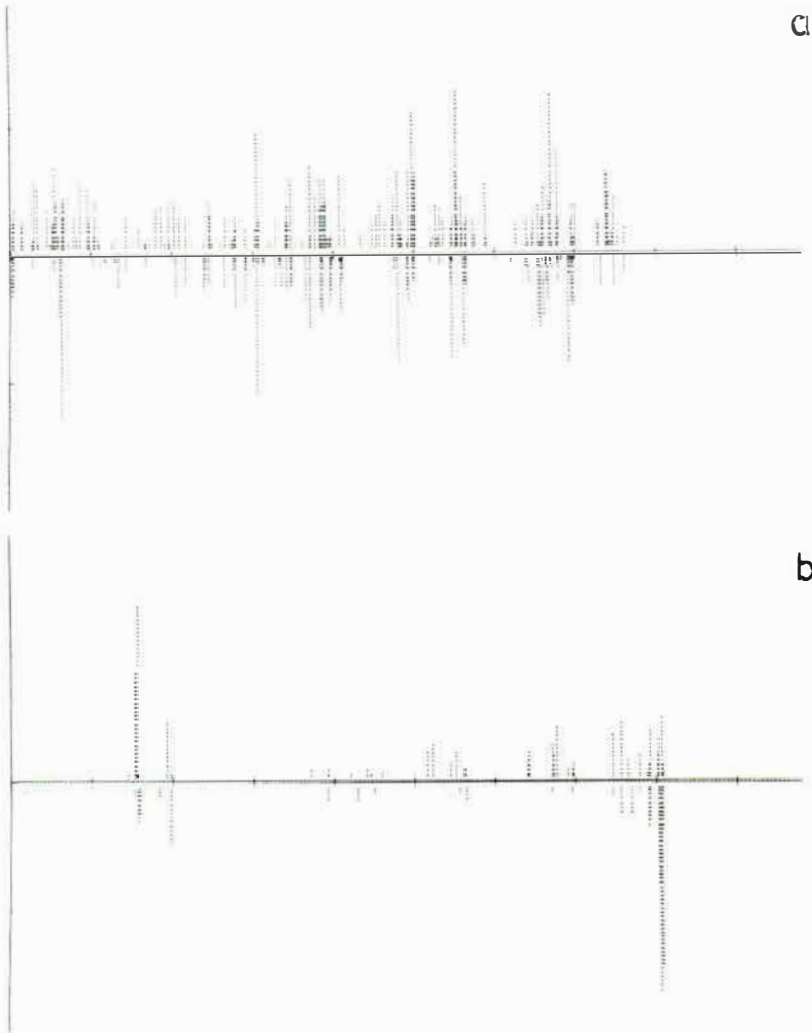


Fig. 4. Graphic display of nocturnal scratch. (a) Atopic dermatitis (no. 4), (b) non-itchy control (no. 17). Ordinate; time occupied by scratching in every 60 sec (1 sec = 1 point), upward, right hand and downward, left hand from the horizontal line of the middle. Abscissa: time flow from left to right (1 div = 1 h).

occurred at nearly the same time but alternative scratches were also noted on occasions.

There seemed to be no specific difference in the scratch patterns of AD and EZ.

A not insignificant amount of scratch was noted in CR. Most scratches were isolated sporadic ones, but a few small clusters were sometimes observed. The large cluster did not appear in any of the CR subjects.

DISCUSSION

Research into nocturnal scratching has not been an easy task. Savin et al. (1) initiated studies into nocturnal scratching in AD by all-night recording on paper and painstaking reading. Felix & Shuster

(2) devised simple methods to estimate scratching during the night and applied them to the evaluation of the response to treatment. The computer analysis system described in this paper constitutes a reliable and quick method for the analysis of nocturnal scratch.

Graphic display disclosed that nocturnal scratching appeared in a cluster or in an isolated sporadic form in both itchy and non-itchy subjects. In very itchy patients, scratch formed several or a few large clusters, each of which lasted for 20, 40 or even more than 60 min. Since the human sleep cycle is approximately 100 min in length, repeated several times a night, large scratch clusters may be related to certain stages of sleep. Research into this subject is now in progress in our laboratories (3).

Patients with AD scratch much more during the night than during the daytime. This may be attributable to the increased body temperature or to the absence of distraction by daily activities (4). The relation of scratching to various physiological functions of the body is a subject of interest that will be elucidated in future investigations.

Many dermatologists believe that the skin lesions of AD are induced by scratching and we are inclined to accept as a matter of course that patients with AD scratch more often than those with the other types of eczema. This is symbolized by the general mention that polished nails are characteristic of AD. However, our results indicate that this does not seem to be true. The aggravating effect of scratch is a general phenomenon seen in various kinds of dermatitis and excema. It seems, therefore, that what is responsible for the formation of characteristic skin lesions in AD is not the scratching itself, but probably the preceding inflammation which renders the skin hyperresponsive to scratching in a specific way.

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DISCUSSION

Hanifin (Portland). Q: The data you presented referred to quantitative changes and I wonder if you have any information with regard to qualitative changes, and when the patients come in the hospital there is a miraculous resolution of the disease. Have you been able to follow these patients over a period of time in hospital and see if the itching continues?

A: With this method I cannot estimate any kind of quantitative character of itching. That must be studied separately.