OBJECTIVE ASSESSMENT OF THE EFFECT OF TREATMENT OF TENNIS ELBOW (LATERAL HUMERAL EPICONDYLITIS) WITH SKANLAB 25 BODYWAVE

K.Rodahl,M.D.,Professor emeritus, H.Frøseth,senior physiotherapist, S.Mæhlum M.D.,Professor and J.Meyer,electronic engineer.

Introduction

Tennis elbow is an extremely common complaint, not only in tennis players, but also in PC-MOUSE operators, and in manual workers engaged in static arm-muscular work. As many as 1-3% of the population may suffer from this complaint (Allander,1974, Kivi,1982). The pathophysiological basis for the complaint is not quite clear, and there are several different views concerning the damage of the tissues involved. (For further details, see Haker,1991).

Measurement of the muscle tension of the forearm muscles in PC-MOUSE operators showed that the cause of the pain in the tennis elbow patients may not be the static muscle tension, as such, in the muscles involved, because the same degree of muscle tension was observed both in operators who had, and who did not have, symptoms of tennis elbow (Rodahl et al.,1994). It appears that the pain is localized to the muscular attachment at the epicondyle, and that the pain occurs when the muscles are pulling on the tissues in and around the muscle attachment. For further details, see Åstrand and Rodahl,1986.

Haker (1991) carried out a comprehensive study of the effect of treatment with acupuncture, laser, ultrasound, steroids and elbow bandages on patients with typical symptoms of tennis elbow. She found that neither laser nor ultrasound could be recommended, while "deep" acupuncture was, according to her,"the treatment of choice". The steroid treatment was to be recommended in very serious cases.

As already pointed out, it appears that the pain associated with tennis elbow is related to the attachment of the extensor muscles of the forearm on the lateral humeral epicondyle. It is therefore of interest to note that local treatment of typical cases of tennis elbow with the Skanlab 25 Bodywave, which is claimed to generate heat in the deep subcutaneous tissue in the treated area, is said to be effective. From a pathophysiological point of view a local increase in the temperature of the deep subcutaneous tissue in the afflicted area might have a positive effect because increased blood flow and elevated tissue temperature might enhance the repair processes.

On this basis a systematic measurement of the deep tissue temperature over the lateral epicondyle before and after treatment with the Skanlab 25 Bodywave was carried out. This was followed by a series of six treatments of 10 patients with tennis elbow of different severity with this instrument. Finally, a series of six placebo-treatments were performed on 10 patients with typical symptoms of tennis elbow, using a non-effective Skanlab 25 Bodywave instrument, followed by six treatments with the ordinary instrument on the same patients.

The effect of treatment with the Skanlab 25 Bodywave on the skin and deep tissue temperature over the elbow (the lateral epicondyle) in healthy volunteers.

Skanlab 25 Bodywave is a fairly new Norwegian-made instrument, which is being used by a number of physiotherapists for the treatment of complaints such as tennis elbow. It is claimed that this instrument,with the aid of an electrostatic alternating current of 1.0 MHz is able to generate heat in the underlying deep tissue.The purpose of the present investigation was to measure objectively if this is the case.

The recording of the deep subcutaneous tissue temperature was made with the aid of a thin needle electrode, diameter 0.9 mm (Termo element,type K, produced by TECK Instruments Ltd,Trandby,Norway). It was inserted obliquely through the skin into the periosteum over the lateral epicondyle.The skin temperature over the epicondyle was measured by a skin electrode (Grant Instruments Ltd.,Cambridge,England) fixed by tape above the area where the deep tissue temperature was measured. Both electrodes were connected to a Squirrel electronic minilogger (Grant Instruments Ltd.),which stored the readings which were taken every second. Both temperature electrodes were calibrated against a standard thermometer.

In a series of preliminary measurements on different subjects it was shown that it might take several minutes before the temperature reached a stable level. For this reason the temperature was recorded continuously for a period of 10 min after the electrodes were in place. The electrodes were then removed and the treatment with the Skanlab 25 Bodywave was carried out in the usual manner. That is, the physiotherapist rotated the electrode (20 mm in diameter) from the Skanlab instrument, set at strength 4, for 10 min over the radial epicondyle and 5-6 cm below it. After the treatment, the electrodes were placed exactly as before, and the readings were repeated for another 10 minutes, while the subject remained lying in the same position. The recorded data were transferred from the memory of the logger to a portable Toshiba PC immediately after the completion of the recording. The mean values of the last five min.of the recording, before and after the treatment, were used for the statistical analysis (Two-Sample T-test) of the effect of the treatment on the skin and the subcutaneous temperature.

In order to find out how long the increase in the skin and subcutaneous temperature remained elevated after the treatment, the electrodes were, in one case, left in place for about an hour after the treatment.

Finally, the same procedure was repeated with a Skanlab 25 Bodywave instrument in which the active unit was removed, as a blind test, in one subject using exactly the same procedure as in the real experiments.

All the measurements were made on six healthy volunteers at the Top Athletic Center in Oslo, with the written consent of the Regional Committee for Medical Research Ethics.

The results are shown in Table 1, showing the deep tissue temperature, and Table 2 showing the skin temperature. Fig. 1 shows an example of the changes in the deep tissue temperature, and Fig.2 the skin temperature in one of the subjects.

The results show a mean increase in the deep tissue temperature of 0.9°C, which is stastically significant ($P<0.05$). All the six subjects had an increase of the deep tissue temperature after the treatment. The mean increase in the skin temperature was 0.8°C. This increase was not statistically significant ($P>0.05$). The increase was observed in 4 of the subjects, while 2 of the six subjects had no increase in the skin temperature after the treatment.

As is evident from Fig.3 and 4 it took about 45 min. before the elevated temperature after treatment had come down to the pre-treatment level.

Fig.5 and 6 show that the blind test, in which the active unit of the Skanlab 25 Bodywave was removed, had no effect.

From these observations it may be concluded that there is a statistically significant increase in the deep tissue temperature above the radial epicondyle after 10 min.treatment with Skanlab 25 Bodywave.The effect on the skin temperature was not uniform in that only four of the six subjects had an increased skin temperature. This may be due to the fact that the skin temperature is more affected by the environmental air temperature and the temperature of objects touching the skin, than in the case of the deep tissue temperature. After the treatment, the ointment which was rubbed into the skin during the treatment, was removed with a wet cloth, the temperature of which might have affected the skin temperature. The same might have been the effect of the sterilizing fluid which was applied on the skin prior to the insertion of the needle electrode. Finally, the type of physical activity in which the subjects had been engaged just prior to the experiment, might possibly have affected the skin temperature.

Nonetheless, it appears that the skin temperature above the epicondyle, on the whole, does follow the deep tissue temperature, so that in the future it might perhaps be possible to attain an insight into the temperature effect merely by measuring the skin temperature, providing it is done under standardized conditions.

The measurements also indicate that the increased deep tissue temperature remains elevated for a considerable period of time after the treatment with the Skanlab 25 Bodywave.The blind test which was carried out indicates that the observed effects are real.

The effect of the treatment with Skanlab 25 Bodywave on patients with tennis elbow symptoms of different degree and duration.

The 10 patients (subject nos.7-16) who were examined and treated were refered to the Østerås Physical Institute for physiotherapeutic treatment of their Tennis elbow complaints. All of them had the following positive findings: Pain associated with isometric contraction of the radial muscle group of the forearm; Pain by passive stretch of the elbow combined with flection of the fingers and the hand; Pain by palpation of the radial muscle group and the epicondyle. The mean age of the 10 patients was 62 years. Three of them were women, and seven were men.

The treatment consisted of the physiotherapist rotating the 20 mm wide electrode from the Skanlab 25 Bodywave, set at strength 4, over the radial epicondyle, and over an area 5-6 cm distal of the epicondyle, for a period of 10 min. This was repeated six times in the course of two weeks.

The measurement of the effect of the treatment, which was done by the same observer before and after the series of six treatments, consisted of three tests:

1. Testing of the maximal strength of the hand grip by squeezing a mechanical spring, calibrated in kg.
2. Testing of the maximal extension strength of the middle finger, expressed in pounds(lbs), using a modified version of the Kebo Care dynamometer,model 6, attached to the end of the long finger.
3. Extension endurance of the middle finger, loaded with a 500g or a 250g weight hanging by a hook placed at the root of the nail of the long finger, measured in seconds by a stop watch. The tests were discontinued when the patient no longer could endure the pain.
   The basis for these tests is the fact that pains in the skeletal-muscular system reduce the strength of the muscles involved. The purpose of this is obviously to avoid further damage of the tissue by exposing it to pulls, stretches or other harmful exposure.The patients were asked to fill out a questionnaire expressing the degree of the subjective feeling of improvement after treatment according to a scale from 0 (no improvement) to 6 (complete improvement), and the degree of pain sensation during each of the three tests, graded from 0(no pain) to 6(violent pains).

   The results are shown in Table 3, showing the results of the three tests before and after the complete series of treatment. All the three tests showed,on the average, an improvement after the treatment, but only the middle finger extension endurance test showed a statistical significant improvement from 32 to 90 seconds (P=0.001, Two-Sample T-test).

   The mean subjective feeling of pain during the performance of the three tests before treatment was 3 on the 0-6 scale, and 2 after treatment. The mean subjective conception of improvement after the treatment was between 3 and 4 on the 0-6 scale.

The effect of treatment with the Skanlab 25 Bodywave compared to placebo treatment with an ineffective instrument on patients with typical symptoms of tennis elbow.

Ten patients (subject nos.17-26) with typical symptoms of tennis elbow, all of whom satisfied the criteria described previously in part 3, were subject to a comparative treatment. To start with they were given six treatments with a Skanlab 25 Bodywave instrument without the electronic mechanism producing the heat effect(placebo). This was followed by six treatments using an ordinary effective Skanlab 25 Bodywave,strength 4-6, for 10 min. Of the 10 patients, three were men and seven women,mean age:48 years.Most of them were office workers,and several of them used PC-MOUSE in their daily work. Eight of the patients worked in two large companies. In order to reduce the patient's absence from work because of the treatment, the measurements and the treatments were done at the place of work in the facilities of the Company health departments.

The patients were told that we had two different instruments for the treatment of their complaints, and that we now wished to find out which of them was best suited for the treatment of the patient's complaints.To start with we were going to give them six treatments using one of the instruments, followed by six treatments with the other instrument. We would measure the obtained effect at the end of each of the two treatment series. The treatment, both with the inactive and the active instrument, was the same as described under section 3 above. That is, also in the case of the inactive instrument, the electrode was rotated over the epicondyle and 5-6 cm distal of it, for 10 min. This was repeated six times in the course of two weeks.

The measurement of the three parameters described above was done before and after each treatment series. The patient's experience of pain during the tests, and their subjective evaluation of the degree of improvement were recorded.

Table 4 shows the results of the placebo treatment. An analysis of the mean values by the Two-Sample T-Test showed no significant improvement in any of the three parameters. Five of the 10 patients said that they felt better after the placebo treatment, on the average 1-2 on the 0-6 scale. The pain experience during the muscle strength tests was on the average 2 before the placebo treatment, and 2 after the treatment, on the 0-6 scale.

Table 5 shows the results of the treatment of the same 10 patients using the effective Skanlab 25 Bodywave. All the three measured parameters were improved after six treatments especially the extension endurance test of the middle finger. In this case the improvement was statistically significant ($P<0.01$). All of the 10 patients said that they felt better after the treatment ,on the average 4-5 on the 0-6 scale. The pain during the muscle strength tests was,on the average, 2 before treatment, and 1 after, on the 0-6 scale.

SUMMARY AND CONCLUSIONS

Skanlab 25 Bodywave is an instrument produced in Norway, which is used by a number of physiotherapists, also in the treatment of tennis elbow (lateral humeral epicondylitis). It is claimed that the instrument does produce heat in the deep subcutaneous tissue with the aid of an electromagnetic alternating current of 1.0 MHz

This was confirmed by measuring the deep tissue temperature with a thin needle electrode inserted obliquely through the skin into the periosteum before and after treatment with a Skanlab 25 Bodywave, strength 4, for 10 min. in six healthy volunteers. The mean subcutaneous deep tissue temperature increased by 0.9°C, which is statistically significant ($P<0.05$). The increased deep tissue temperature lasted about 45 min. A blind test showed that a Skanlab 25 Bodywave instrument in which the effective mechanism was removed, had no effect.

Objective assessments of the effect of six treatments of 10 tennis elbow patients (seven men, and three women, mean age 62 years) with Skanlab 25 Bodywave was made by using three tests which measure the strength (which is affected by pain in the tissue) in the muscles which are attached to the epicondyle area: 1. Grip strength of the fist. 2. Extension strength of the middle finger.3. Extension endurance of the middle finger. Each of these three tests showed an average improvement after treatment. The improvement of the extension endurance of the middle finger was statistically significant ($P=0.001$). The subjective assessment of improvement after treatment was, on the average, between 3 and 4 on a 0-6 scale.

Finally 10 patients (three men and seven women, mean age 48 years) with typical tennis elbow symptoms, were given six placebo treatments with an ineffective Skanlab 25 Bodywave. This was followed by six treatments with a proper,effective instrument. The placebo treatment produced no statistically significant improvement in any of the three tests, but 5 of the 10 patients said that they felt better after the placebo treatment (on the average 1-2 on the 0-6 scale).After the treatment of the same 10 patients with the proper effective Skanlab 25 Bodywave, all the three measured parameters showed improved values, especially the extension endurance of the middle finger, which showed a statistically significant improvement ($P<0.0l$).All the 10 patients said that they felt better after the treatment, on the average 4-5 on a 0-6 scale.

On the basis of the results from this project, one may draw the following conclusions:

1. Skanlab 25 Bodywave does increase the temperature in the subcutaneous tissue. This elevated temperature is maintained for a significant length of time.
2. Of the parameters which were assessed, the extension duration of the middle finger was by far the most sensitive parameter.
3. A statistical significant improvement of this parameter was recorded in 20 tennis elbow patients who were treated with Skanlab 25 Bodywave,strength 4-6 for 10 min, six times in the course of two weeks. All of the 20 patients said that they felt better after the treatment, on the average, 3-5 on the 0-6 scale.

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Table 1

Subcutaneous deep tissue temperature, ^{o}C, recorded by needle electrode over the radial epicondyle before and after treatment with Skanlab 25 Bodywave.

Subject no	Before	After	Difference
1	32.4	33.9	+ 1.5
2	35.0	35.2	+ 0.2
3	32.2	33.3	+ 1.1
4	34.5	35.1	+ 0.6
5	32.5	34.1	+ 1.6
6	33.9	34.4	+ 0.5
Mean	33.4	34.3	+ 0.9

Table 2

Skin temperature, ^{o}C, recorded by skin electrode over the radial epicondyle before and after treatment with Skanlab 25 Bodywave.

Subject no.	Before	After	Difference
1	31.0	32.4	+ 1.4
2	32.8	33.8	+ 1.0
3	31.1	31.8	+ 0.7
4	32.7	32.4	- 0.3
5	30.6	33.0	+ 2.4
6	32.0	31.5	- 0.5
Mean:	31,7	32.5	+ 0.8

TABLE 3

Strength and endurance in the forearm muscles before and after treatment. a = grip strength, kg. b = extension strength of middle finger, lbs. c = extension endurance of middle finger,sek.

Patient	Before treatment			After 6 treatments		
no.	a	b	c	a	b	c
7	40	4.2	64	43	2.3	68
8	33	1.5	21	34	3.1	37
9	26	1.7	57	32	1.4	91
10	35	2.5	57	36	3.0	135
11	34	1.9	10	33	2.2	116
12	31	2.5	22	57	2.8	37
13	32	1.5	10	30	2.6	80
14	29	1.2	24	26	1.6	132
15	13	1.1	12	18	1.0	50
16	19	0.3	39	20	1.1	153
Mean:	29	1.8	32	33	2.1	90

TABLE 4

Strength and endurance in the forearm muscles before and after placebo treatment with an ineffective instrument.

Patient no.	Before treatment a	b	c	After 6 treatments a	b	c
17	27	2.4	112	28	2.0	62
18	13	3.1	8	20	2.1	11
19	34	2.0	20	34	2.2	62
20	37	3.0	45	48	2.9	29
21	12	0.9	5	12	1.5	12
22	13	2.2	9	11	2.1	25
23	30	1.1	82	28	1.5	35
24	8	2.0	110	12	2.4	97
25	7	1.2	20	12	1.2	29
26	2	0.9	15	5	0.8	41
Mean:	18	1.9	43	21	1.9	40

TABLE 5

Strength and endurance in the forearm muscles before and after treatment with Skanlab 25 Bodywave. a = grip strength, Kg. b = extension strength of middle finger, lbs. c = extension endurance, sec.

Patient	Before treatment			After 6 treatments		
no.	a	b	c	a	b	c
17	28	2.0	62	27	2.0	135
18	20	2.1	11	25	3.0	12
19	34	2.2	62	37	2.2	112
20	48	2.9	29	45	3.3	58
21	12	1.5	12	14	1.6	19
22	11	2.1	25	15	2.1	39
23	28	1.5	35	34	2.5	157
24	12	2.4	97	21	2.5	125
25	12	1.2	29	14	1.5	85
26	5	0.8	41	17	1.1	52
Mean:	21	1.9	40	25	2.2	79

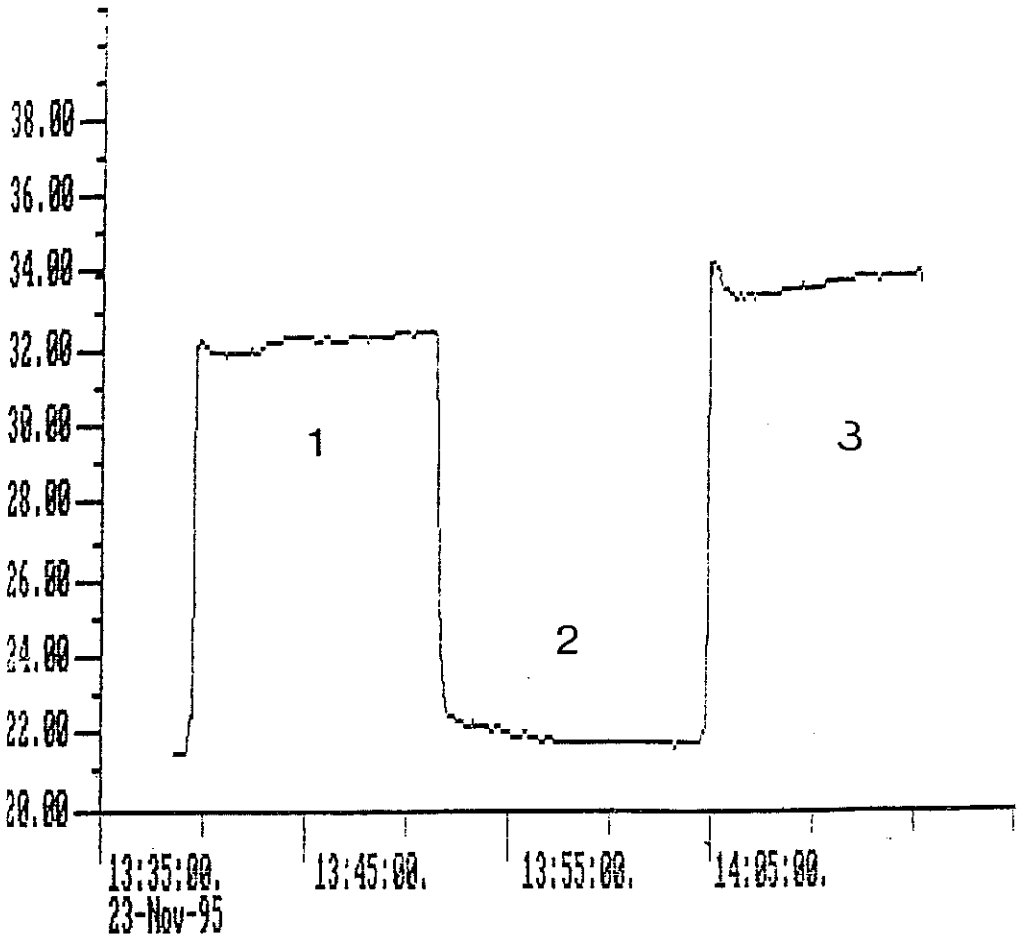

Fig. 1. Subcutaneous, deep tissue temperature recorded at the right radial epicondyle in a 41 year old male volunteer before (1) and after (3) treatment with the Skanlab 25 Bodywave (2). During the treatment, the temperature recording electrode was removed and left to record the ambient air temperature.

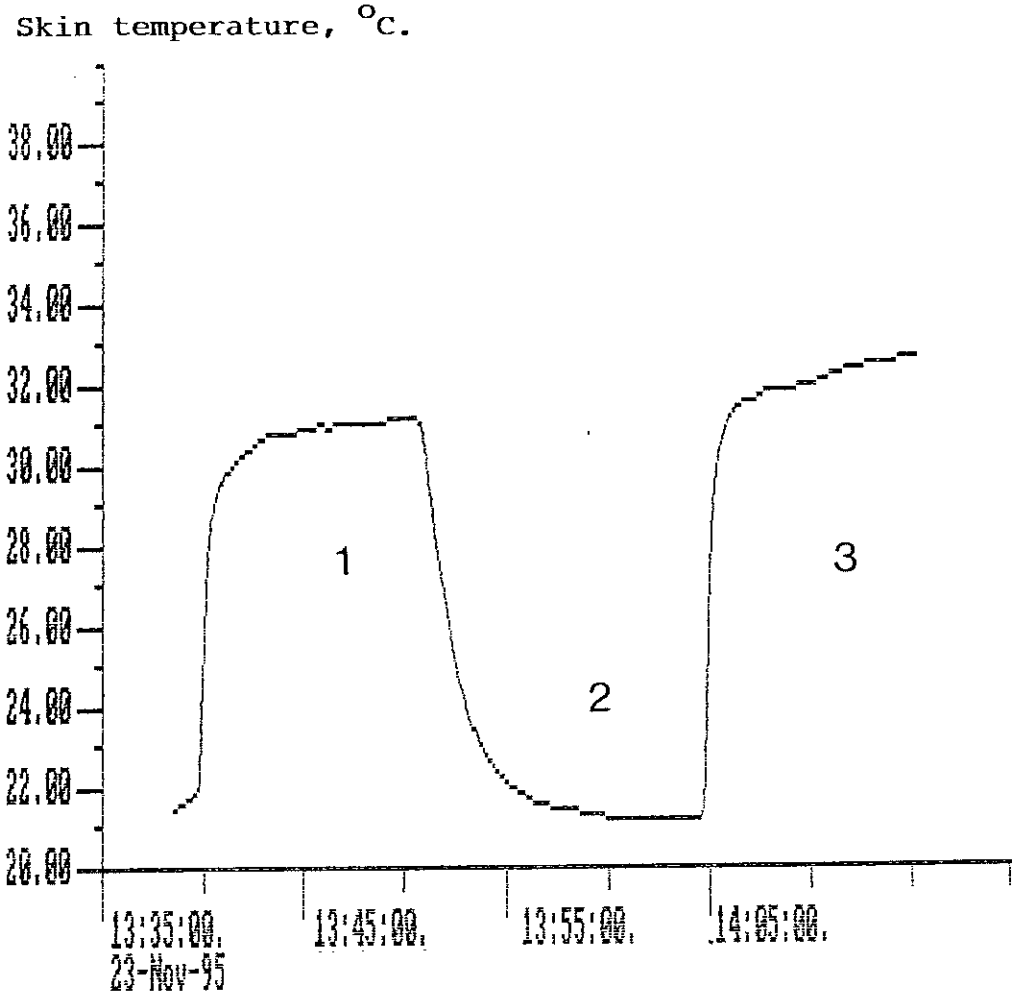

Fig. 2. Skin temperature recorded over the right radial epicondyle in a 41 year old male volunteer, before (1) and after (3) treatment with the Skanlab 25 Bodywave (2). During the treatment, the temperature recording electrodes were removed and left to record the ambient temperature.

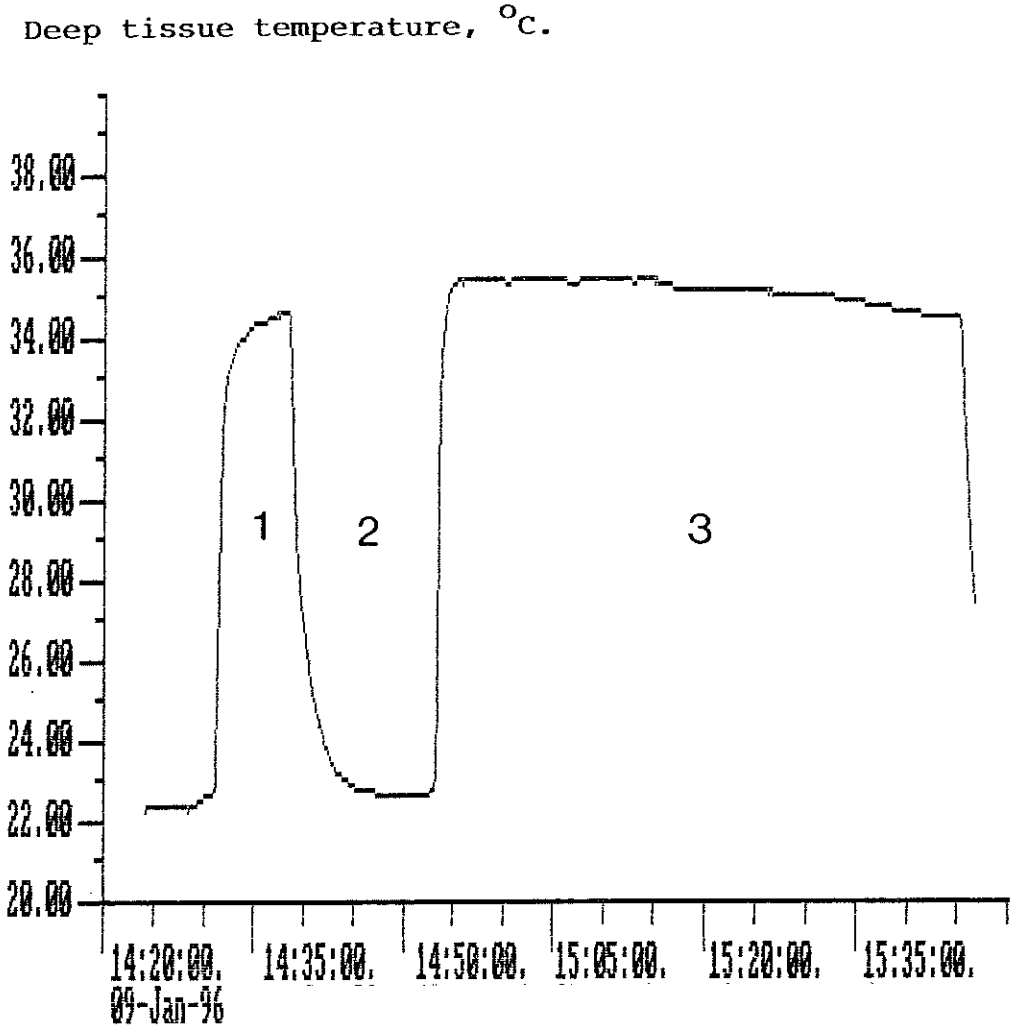

Fig. 3. Subcutaneous, deep tissue temperature recorded at the right radial epicondyle in a 24 year old male volunteer before (1) and after (3) treatment with the Skanlab 25 Bodywave. During the treatment the temperature recording electrode was removed and left to record the ambient temperature. After treatment the temperature recording electrode was left in place for about an hour in order to find out how long the elevated tissue temperature was maintained.

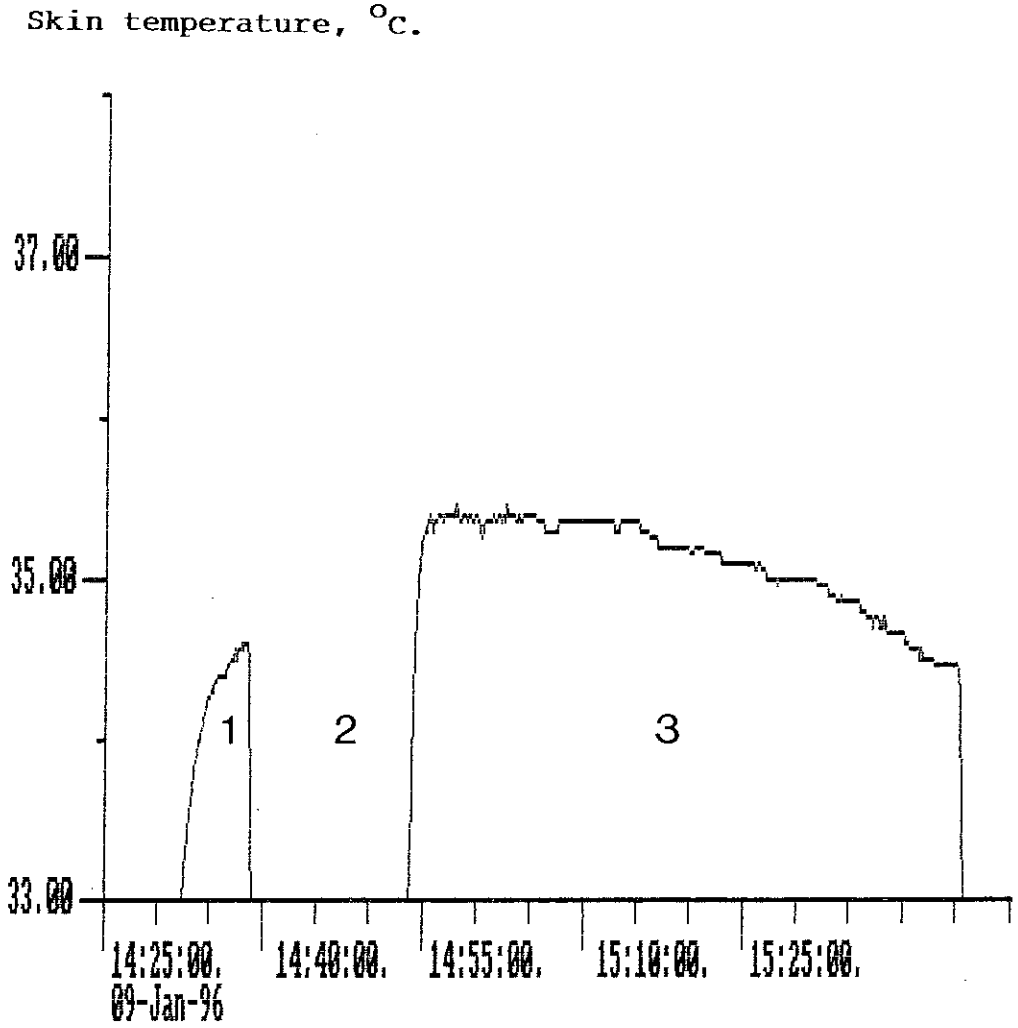

Fig. 4. Skin temperature recorded over the right radial epicondyle in a 24 year old male volunteer, before (1) and after (3) treatment (2) with Skanlab 25 Bodywave. During the treatment the temperature recording electrodes were removed and left ro record the ambient temperature. It took almost 45 min for the skin temperature to return to the initial temperature before the treatment.

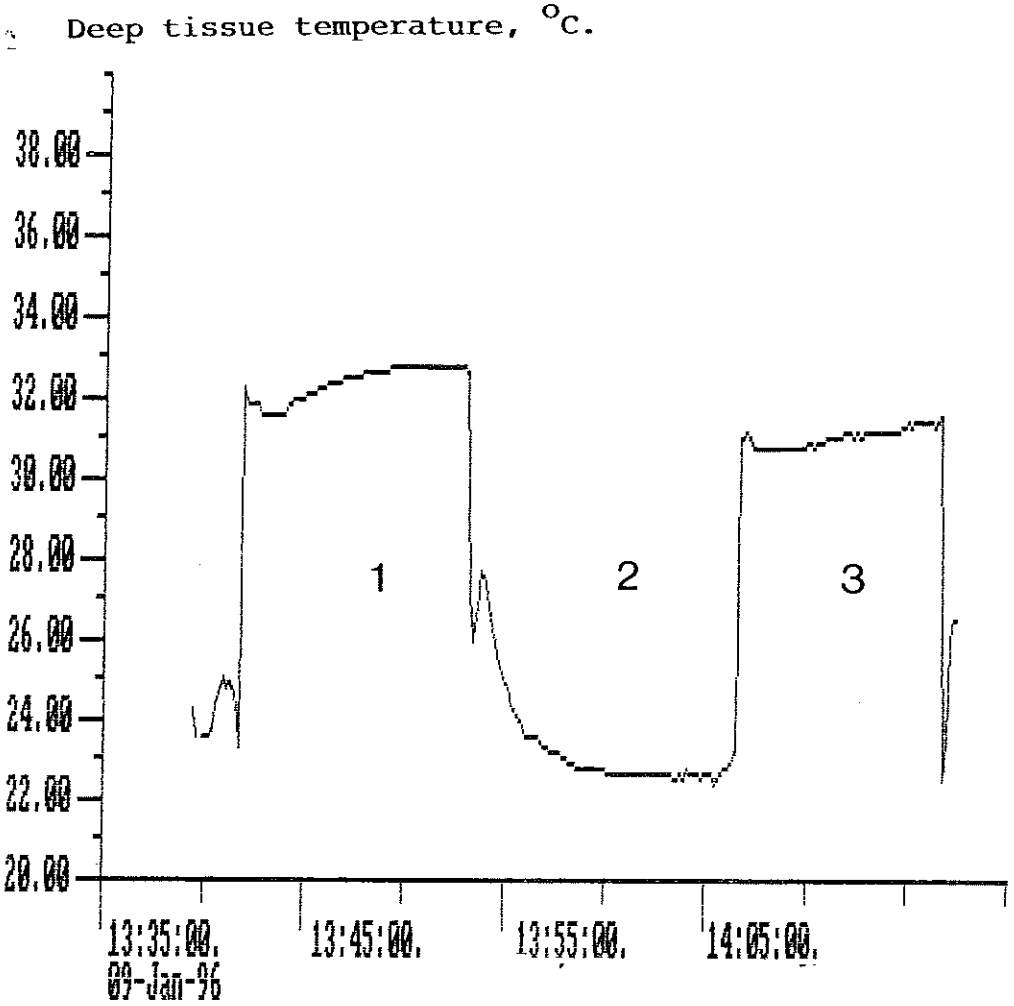

Fig. 5. Subcutaneous, deep tissue temperature recorded at the right radial epicondyle in a 24 year old male volunteer, before (1) and after (3) placebo treatment (2) with an ineffective Skanlab 25 Bodywave in which the functioning unit was removed.

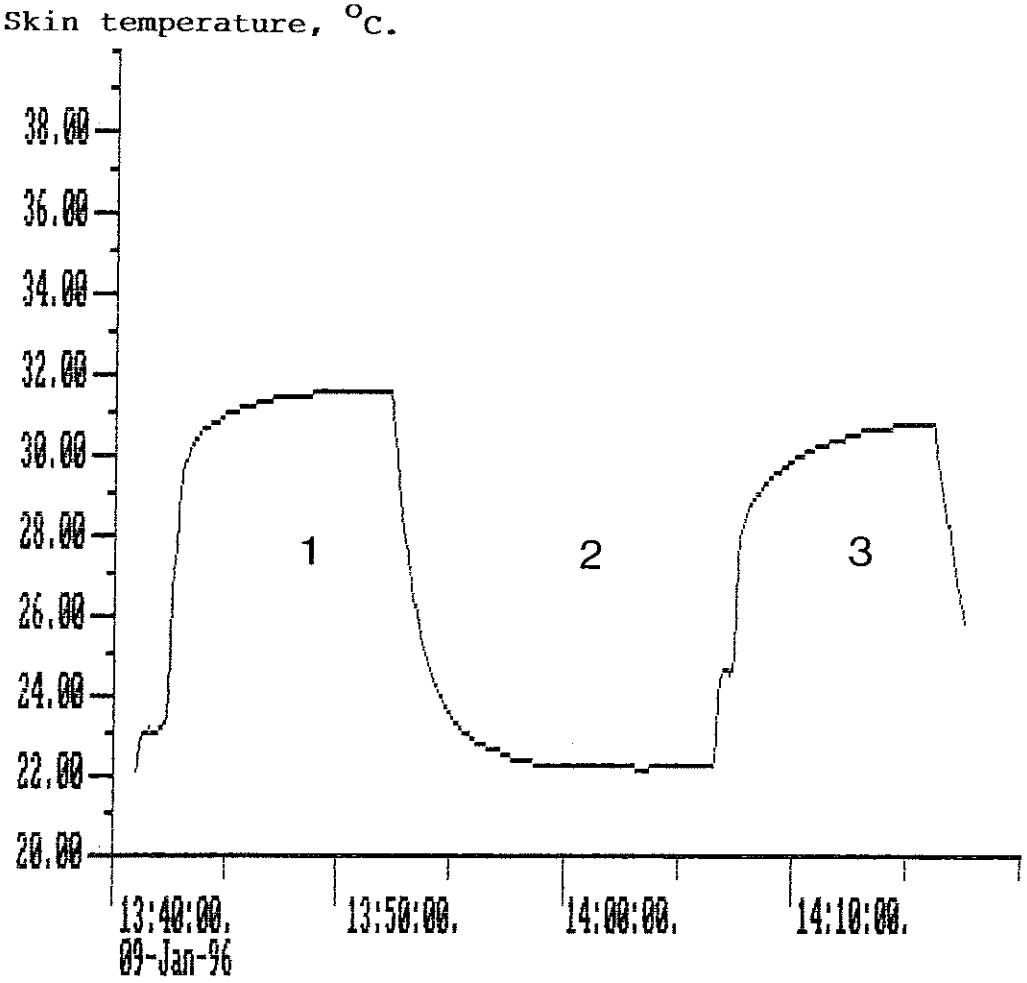

Fig. 6. Skin temperature recorded over the right radial epicondyle in a 24 year old male volunteer, before (1) and after (3) placebo treatment (2) with an ineffective Skanlab 25 Bodywave in which the actual functioning unit was removed.