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COMPARISON OF TENS TREATMENTS IN HEMIPLEGIC SHOULDER PAIN

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ABSTRACT. The aim of this paper is to evaluate the effectiveness of high-intensity versus low-intensity transcutaneous electrical nerve stimulation (TENS) and versus placebo for treatment of hemiplegic shoulder pain. Three groups of 20 patients each (A, B, C) were studied. In group A high-intensity TENS was delivered at 3 times the sensory threshold with frequency of 100 Hz; in group B low-intensity TENS was delivered at the sensory threshold with frequency of 100 Hz. Group C received placebo stimulation. The treatment protocol consisted of 12 sessions (4 weeks). Before treatment, at the end of it and one month after, passive range of motion (PROM) for flexion, extension, abduction and external rotation were evaluated. Statistically significant improvements of PROMs were recorded for group A, but not for groups B or C.

Key words: TENS, hemiplegic shoulder pain, myofascial pain.

INTRODUCTION

Shoulder pain occurs in a high percentage of hemiplegic patients (1) and it may seriously hamper rehabilitation programs. Several physical therapeutic strategies have been attempted to cope with the problem: proper positioning and handling of the dependent patient, early mobilization of the shoulder muscles either by hand manoeuvres or by neuromuscular electrical stimulation, electromyographic biofeedback, transcutaneous electrical nerve stimulation (TENS), application of heat and cold, diathermy and ultrasound have been reported to be effective, but results of these procedures are contradictory (1, 6). Consequently, there is need of further research in order to refine or develop new techniques of treatment for the hemiplegic painful shoulder. In the present paper we compare the effectiveness of two different forms of TENS in treating this condition. The rationale of our study is based on the fact that there are two forms of TENS currently available; the first is the traditional and most widely used low-intensity TENS, where the electrical stimulation is just above the level of the sensory threshold; the second is high intensity TENS, where stronger currents elicit muscle contraction and almost painful sensation. The high intensity TENS is particularly effective in relieving myofascial pain (5, 7); two papers (3, 9) have recently reported good results in treating various forms of shoulder pain with this technique. We propose that the possible mechanism of action of high-intensity TENS lies in its strong vasodilatory effect (2, 4) not obtained from the low-intensity TENS.

METHOD

Subjects

We studied 60 patients suffering from hemiplegic shoulder pain following ischaemic stroke; all of them were affected by discrete loss of motor function, but were able to stand and walk if assisted. Patients with polyarthritis, other bony disorders and overt psychological disturbances were excluded from the study. The ischaemic nature of cerebral damage was ascertained by CT scan. The patients were randomly assigned to one of three groups of 20 each, called A, B and C, in order to undergo different forms of treatment. The clinical characteristics of each group are summarized in Table I. All the patients underwent a basic rehabilitation program including early mobilization and positioning since the time of the stroke. Before being scheduled for this study, each patient gave fully informed consent to the procedure.

Materials

TENS stimulation was performed by means of a DANTEC stimulator unit, type 15E05/15E25, with digital display of peak current and voltage. Square pulses of 0.2 msec duration were delivered at the frequency of 100 per second. Intensity was set at the sensory threshold level (which ranged between 4 and 9 mA) for the low-intensity TENS, and at three times the sensory threshold for the high-intensity TENS (4). We used circular electrodes, made of conductive rubber, that had a diameter of 1.5 cm for high intensity stimulation and 4 cm for low intensity TENS (4). Patients undergoing sham stimulation were connected to the stimulator whose output was loaded with a 3 kOhm resistor, while the patient circuit was interrupted. So the stimulator display showed appropriate values of current and voltage, but the patient received no stimulus.

Design

Each group of patients received a different TENS treatment. Group A had the basic physical treatment (every day in the morning) and high-intensity TENS three times a week (in the afternoon). Group B underwent basic physical treatment and

Table I. *General patient data for each group*

Group	Age	Months	Males	Femls	Right	Left	Luxn	HSS
A	67.90 (7.01)	3.42 (2.17)	5 (25%)	15 (75%)	13 (65%)	7 (35%)	8 (40%)	5 (25%)
B	65.65 (4.94)	2.72 (1.88)	6 (30%)	14 (70%)	14 (70%)	6 (30%)	9 (45%)	4 (20%)
C	64.30 (5.40)	3.17 (2.72)	5 (25%)	15 (75%)	13 (65%)	7 (35%)	7 (35%)	6 (30%)

Age = patient's age in years; mean and standard deviation. Months = months elapsed since occurrence of ictus; mean and standard deviation. Males = number of male patients (also expressed as percentage). Femls = number of female patiens (also expressed as percentage). Right = number of patients (and percentage) with paresis on the right side. Left = number of patients (and percentage) with paresis on the left side. Luxn = number of patients (and percentage) with shoulder subluxation. HSS = number of patients (and percentage) with hand–shoulder syndrome.

low intensity TENS at the same times as group A. Group C received sham stimulation in addition to the basic physical treatment. Duration of the study was 4 weeks, for a total of 12 TENS sessions. All the patients were hospitalized in our department for the duration of the study.

Before the start of the study (Time 0), at the end of it (Time 1) and one month after (Time 2), one of the authors (R) who was not aware of the patient's group assignment recorded the range of 4 passive movements of the shoulder (passive range of motion: PROM): flexion, extension, abduction (all with the arm in the neutral position), and external rotation with the arm adducted. A total PROM, that is the sum of single movement's PROMs, was also calculated. The measurements were taken by means of a double armed (10 inches long = 25.4 cm) goniometer; the measurements were always taken twice and each was rounded off to the nearest 5 degrees. According to the findings of Riddle et al. (8) this method of measurement should ensure sufficient reliability.

We carefully looked for areas tender to pressure on the shoulder muscles and the gleno-omeral joint. The two stimulating electrodes were placed on the two most painful of these areas; in case no pain could be evoked by pressure, the electrodes were placed on the two spots which were most painful after active or passive movement. At time 1 and time 2 the patients were asked to express a subjective judgement on their conditions.

Data processing and statistical analysis

Mean values and standard deviations of PROMs were calculated. Analysis of variance (ANOVA) was employed to compare PROMs evaluated at different times: Time 0 versus Time 1; Time 0 versus Time 2; Time 1 versus Time 2. Within this study "significant" will refer to significance with $p \leq 0.01$.

RESULTS

The results obtained in the three groups are summarized in Tables II, III and IV. In group A (Table II) a significant improvement for PROMs of each single movement, as well as for the total PROM, was recorded at Times 1 and 2 with respect to Time 0; also, all the values taken at Time 2 were significantly higher than those at Time 1; this means that further pain relief was obtained even at some distance from the treatment. When asked to express a personal judgement on their conditions, 15 patients said they were better at the end of treatment; after one month the number of patients considering themselves improved was 18.

Patients of group B (Table III) showed a slight

Table II. *Results in group A*

Time		F	E	A	Ex	Tot
0	Mean	52.87	43.75	49.12	42.47	187.42
	SD	6.65	4.90	8.43	6.37	20.96
1	Mean	63.25	54.75	60.75	54.87	233.62
	SD	5.32	5.43	6.34	4.25	15.09
2	Mean	65.50	55.75	61.62	55.37	238.25
	SD	3.68	4.66	6.08	3.74	13.62

F = flexion PROM, E = extension PROM, A = abduction PROM, Ex = external rotation PROM, Tot = total PROM (sum of F + E + A + Ex).

Table III. *Results in group B*

Time		F	E	A	Ex	Tot
0	Mean	54.25	43.37	46.12	40.50	184.25
	SD	7.12	5.51	6.20	2.49	14.19
1	Mean	58.37	45.00	48.50	43.12	195.00
	SD	6.34	4.93	5.75	3.33	13.93
2	Mean	56.37	44.00	47.25	40.87	188.50
	SD	6.71	4.68	6.32	3.06	14.58

F = flexion PROM, E = extension PROM, A = abduction PROM, Ex = external rotation PROM, Tot = total PROM (sum of F + E + A + Ex).

Table IV. *Results in group C*

Time		F	E	A	Ex	Tot
0	Mean	53.37	44.25	45.25	41.25	184.12
	SD	6.13	6.49	7.69	4.09	16.62
1	Mean	55.25	44.25	45.12	41.12	185.75
	SD	6.87	6.74	7.41	4.76	18.15
2	Mean	53.00	43.25	44.25	39.75	180.25
	SD	6.36	6.83	7.21	4.28	18.42

F=flexion PROM, E=extension PROM, A=abduction PROM, Ex=external rotation PROM, Tot=total PROM (sum of F+E+A+Ex).

increment of their PROMs at Time 1 and Time 2, but without ever reaching significativity. Figures obtained at Time 2 were slightly lower than those at Time 1, still without significant difference. Subjective judgement was positive in 5 cases at the end of treatment and in 2 cases after one month.

In patients of group C (Table IV), treated with sham stimulation, just negligible and not significative differences could be noted among PROMs at the various times. On interview, 5 patients reported to be better by the end of the treatment, and only 1 did so one month after.

DISCUSSION

A definite improvement of PROM was achieved by patients of group A, treated with high-intensity TENS; subjective reports on pain relief were also very satisfactory in this group. Both PROM and subjective pain relief had further amelioration one month after the end of treatment. This result suggests that the treatment was not just a symptomatic one, but possibly acted upon some basic mechanism of the pain syndrome by producing long lasting effects. As mentioned in the introduction, high-intensity TENS has a remarkable vasodilatory effect (2, 4). Such an effect may be of particular importance in relieving myofascial pain, which is often in connection with painful areas (trigger points) characterized by ischaemia and autonomic hyperactivity (10). A number of vasodilatory agents applied to these areas bring long lasting relief (10). High-intensity TENS may be a very effective means of causing vasodilation within these areas. No significative improvement was recorded in groups B and C. Both groups showed a slight increase in PROM figures just after the treatment; a fall to lower values was recorded one month later. The subjective reports, slightly satisfactory only immediately after the treatment, were in agreement with the PROM figures. It is possible that the temporary improvement seen in those two groups was due to a placebo effect; but it may also be possible that the low-frequency TENS may have had a slight temporary effect, which, however, was not clinically relevant.

In conclusion, this study suggests that high-intensity TENS may be a valuable technique in treating hemiplegic shoulder pain, whereas traditional low-intensity TENS seems to be of no use in such case. We believe that because of the particular mechanisms involved (i.e. vasodilation) the high-intensity TENS is useful in treating also other forms of myofascial pain, as suggested by some previous papers (5, 7).

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