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Pain-temperature relation in the application of local anaesthesia

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SUMMARY. **One hundred and thirty-six patients attending for local anaesthetic procedures in the trigeminal area were assigned to four groups. Each group was injected with the anaesthetic solution at temperatures 10°C, 18°C, 37°C and 42°C, respectively. Measurement of pain during injection was made on a numeric scale. The results show a strong relationship between the temperature of the anaesthetic solution and the pain of the injection ($p \ll 0.001$). This demonstrates that warming the anaesthetic solution significantly reduces the pain felt by the patient during injection, especially at 42°C.**

One of the main drawbacks of local anaesthesia, so widely used in plastic and reconstructive surgery, is the pain produced during injection. The mechanisms responsible for this pain are not clear, though there have been some reports about this. Alkalinisation of the anaesthetic solution by the addition of sodium bicarbonate significantly reduces the discomfort caused by the injection (McKay *et al.*, 1987; Korbon *et al.*, 1987; Christoph *et al.*, 1988; Martin, 1990). Studies reporting on the temperature of the injected solution in relation to pain experienced (Finkel and Berg, 1987; Cragg *et al.*, 1988; Bainbridge, 1991), without being conclusive, suggest that warming the anaesthetic solution may lessen pain caused when injecting it, although other reports do not agree (Kaplan *et al.*, 1987).

In this study we have examined the relationship between the temperature of the anaesthetic solution and the pain produced on injecting it subcutaneously, at four different temperatures.

Materials and methods

136 subjects were selected from ambulatory patients at our service. The selection criterion was the site of the area of surgery, which was within the trigeminal area.

A solution of 2% procaine with 1:80000 epinephrine (Laboratorios Palex S.A.) was injected subcutaneously in the area for surgery at either 10°C (refrigerator), 18°C (room temperature), 37°C (body temperature) or 42°C (above body temperature), with a 10 ml sterilised syringe and a 25 gauge needle. One of the four temperatures was chosen at random. All injections were done by the same person, with patients having no knowledge of the temperature of the anaesthetic.

In order to make the technique as standard as possible, all injections were applied at a speed of 0.1 ml/s. This is a factor which we believe is important and is not mentioned in any of the literature reviewed. All those patients in whom the injection could not be done at this speed (*i.e.* lesions in nose tip) were excluded from the study.

Sites of injections were recorded topographically within the trigeminal area as frontal, orbital, temporal, nasal, labial, malar, mental or preauricular.

The evaluation of pain was explained to patients, who were asked to score the pain on a 0 to 10 scale subjectively (absence of pain = 0 and an unbearable pain = 10). We established a point of reference of 5 for the pain produced by the puncture of the needle, so asking the patient to distinguish between the pain produced by the needle and the burning sensation caused by the anaesthesia.

For the 37°C and 42°C groups the anaesthetic vials were warmed in a commercially available baby food warmer fitted with a thermostat and additional thermometer. For the 18°C group, the vials were taken directly from the surgery cabinet. Finally, for the 10°C group, the vials were taken from a refrigerator, where they had been placed in a tray of water with thermometric control.

Statistics

The initial hypothesis (H_0) to be determined was that there were no significant differences between the perception of pain among the four temperature groups (H_1 = there were differences). The size of the initial sample was calculated foreseeing some losses during the study (such as inadequate application speed,

Table 1 Patient data

Group	*Number of patients in group*	*Male*	*Female*	*Mean age in years (SD*)*
42°C	32	20	12	61 (16)
37°C	31	12	19	51 (22)
18°C	41	22	19	46 (20)
10°C	32	15	17	51 (23)
Totals	136	69	67	52 (21)

* SD: Standard Deviation.

intradermal injection) for a bilateral hypothesis with $\alpha = 0.01$ and $\beta = 0.1$, and a minimal difference (D), clinically considered significant, of 2, with a standard deviation (SD) of ± 2 (D/SD = 1).

The Kolmogorov-Smirnov test was used to verify the normality (gaussian behaviour) of the population.

Analysis of variance (ANOVA) using the Newman-Keuls test for the analysis of multiple comparisons was used to test our hypothesis.

Finally, the simple correlation coefficient with its corresponding regression line was calculated to evaluate the temperature-pain relation.

Values of $p < 0.05$ were considered statistically significant.

Results

The four groups were compared in relation to sex and age and no significant differences were seen (Table 1).

The average scoring of pain overall (mean $\pm$ SD) was 5.47 ± 2.52 (Range: 0–10). The respective mean values for the four groups are shown in Table 2. Comparing these values shows highly significant differences ($F = 21.758$, $p \ll 0.001$). Moreover, all comparisons among the groups were significant (Table 3). The correlation rate for the pain and temperature variables was $r = -0.554$ ($p < 0.001$).

The pain scored in the four groups in relation to sex, age or subdivisions of the trigeminal territory did not show significant differences.

Discussion

The results of this study show that there is an inverse linear relationship between the temperature of the anaesthetic solution and the pain on injection. This was observed with temperatures ranging from 10°C–42°C. The highest mean pain level occurred in the 10°C group, followed by the 18°C, 37°C and 42°C, in that order, as is shown in Figure 1.

In a double blind study Kaplan *et al.* (1987) showed no significant difference when lidocaine was used with and without warming the solution (44.4°C/112°F vs room-temperature). The results obtained by our study do not necessarily contradict those of Kaplan *et al.* First, the rate of injection may have been different (we believe that pain may vary according to the speed of injection). Second, the type of anaesthetic used in both studies was different (lidocaine was used in Kaplan's study vs procaine in the present study). Third, we observed a progressive decrease in pain when the anaesthetic solution was warmed up to 42°C. Our data do not exclude the possibility that additional increase in the temperature of the solution could start to produce pain due to heat induced injury. This could explain that in Kaplan's study pain produced by anaesthetic at 44.4°C temperature was similar to that produced by anaesthetic at room temperature. Thus, theoretical pain reducing factors associated with higher temperature (reduction in the onset time of the anaesthesia or increase in the nervous blockade) (Hilgier, 1985; Difazio *et al.*, 1986; Mehta *et al.*, 1987) would be offset progressively by the thermal irritation produced by heat, taking place from 42°C onward.

In conclusion, according to our results the pain produced by anaesthetic injection can be diminished by warming the anaesthetic solution up to 42°C.

Table 2 Pain score

Group	*Mean*	*SEM**	*Min*	*Max*
42°C	3.40	0.40	0	9
37°C	4.87	0.47	1	9
18°C	6.02	0.30	1	10
10°C	7.43	0.22	4	10
Totals	5.47	0.21	0	10

* SEM: Standard Error Mean.

Table 3 Comparison between the groups using Newman-Keuls test

Groups	*Value of p*
42°C–37°C	< 0.01
42°C–18°C	< 0.01
42°C–10°C	< 0.01
37°C–18°C	< 0.05
37°C–10°C	< 0.01
18°C–10°C	< 0.01

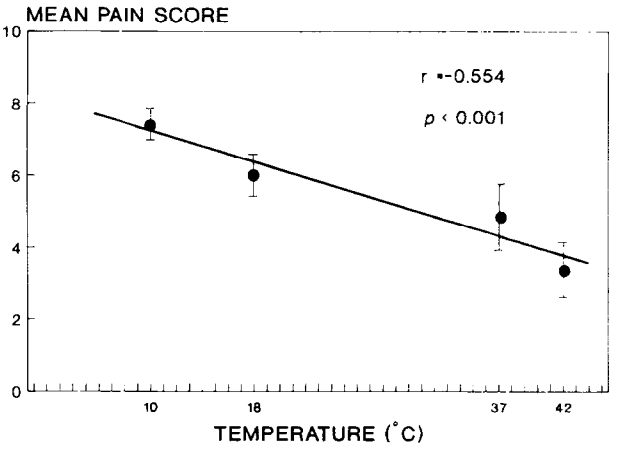

Fig. 1

Figure 1—Relationship between mean pain score and temperature with its corresponding regression line.

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