

VIBRATORY STIMULATION FOR THE RELIEF OF PAIN OF DENTAL ORIGIN

DAVID OTTOSON, ANDERS EKBLOM and PER HANSSON

Department of Physiology II, Karolinska Institutet, S-104 01 Stockholm (Sweden)

(Received 28 May 1980, accepted 9 September 1980)

SUMMARY

The present paper describes the effect of vibratory stimulation on pain of dental origin in 36 patients. The patients were from a clinic for dental surgery and all had suffered pain from pulpal inflammation, apical periodontitis or postoperative pain following extraction of an impacted wisdom tooth for more than 2 days. Vibration at 100 Hz was applied to various points in the facial region or the skull. All the patients except three experienced an effective reduction of the intensity of the pain. In the patients who experienced pain reduction there was usually a best point at which vibration had a greater pain alleviating effect than at other points. At some points the stimulation added to the pain. In 16 patients the stimulation caused a reduction in pain intensity of 75–100%; out of these 12 patients reported a complete relief of pain.

INTRODUCTION

Pain research has witnessed an unprecedented development in the last decade. On the basis of the results obtained in experimental studies new methods have been introduced for the treatment of chronic pain. The most widely used of these is transcutaneous nerve stimulation (TNS). Although the neurophysiological mechanisms underlying the relief of pain achieved with this method are still far from clear, it appears probable that the effect is mainly due to an interaction between large diameter fibers and small diameter fibers in the dorsal horn of the spinal cord [8]. Transcutaneous nerve stimulation is an efficient technique for activation of large diameter, afferent fibers but its excitatory effect is relatively unspecific. Therefore, depending on the stimulus parameters, a wide spectrum range of fibers may be activated [2]. A more selective way of activating large diameter fibers is mechanical

vibratory stimulation [11]. It is well established that Pacinian corpuscles, several types of rapidly adapting cutaneous receptors, as well as the primary endings of muscle spindles, are activated by vibration. This suggests that vibration would be a useful tool for activation of predominantly large diameter afferents in the treatment of pain [6]. Although it appears to be a common knowledge that vibration may have a pain relieving effect, no systematic study has, to our knowledge, been reported about the effect of vibration in different pain syndromes.

The starting point of the present study was an incidental observation that the aching of a tooth was alleviated when mild vibration was applied to a neighboring tooth. This observation prompted a systematic study of the effect of vibration on the tooth pain threshold measured with electrical stimulation. The results of this study (in course of publication) clearly demonstrated that vibratory stimulation caused an increase in pain threshold. This finding encouraged us to investigate the effect of vibration in various conditions of pain of dental origin. In the present paper we report observations on 36 patients suffering from dental pain of various types. As will be shown below vibratory stimulation had a pain reducing effect in all patients except three. In 12 patients stimulation caused a complete relief of pain that, in general, lasted throughout the application of the stimulation.

METHODS

The patients were from a clinic for dental surgery and they all had suffered pain for more than 2 days. None of them had taken analgesics less than 4 h before coming for examination. The mean age of the 14 males was

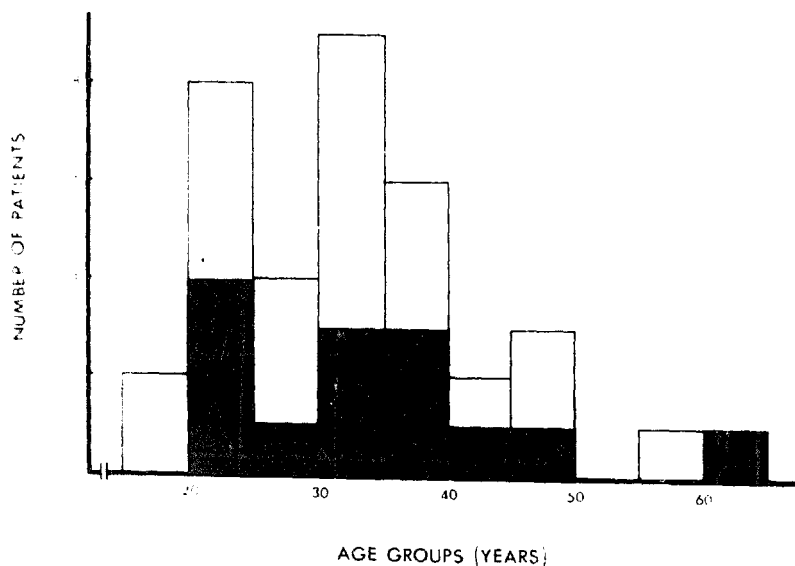


Fig. 1. Distribution of age groups. Black and white areas indicating males and females respectively.

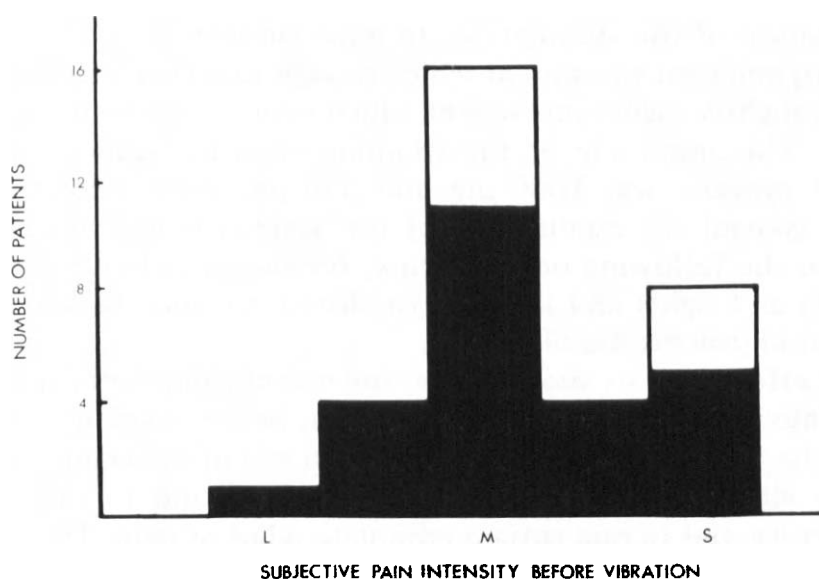


Fig. 2. Subjective pain intensity before vibratory stimulation. Patients who experienced pain reduction of more than 50% are represented by black areas. L = light pain; M = moderate pain; S = severe pain.

34 years (24–61) and of the 22 females 33 years (17–59) (Fig. 1). Following vibratory stimulation, all subjects were examined by a dental surgeon for diagnosis and further treatment. The most common cause for the pain was pulpal inflammation, apical periodontitis or postoperative pain following removal of an impacted wisdom tooth.

Before vibratory stimulation the patients were asked to describe the characteristics, duration and distribution of the pain and to rate its intensity on a 3-grade scale — light, moderate or severe. Some patients defined their pain as light-to-moderate and some as moderate-to-severe (see Fig. 2). The effect on their pain by vibration was assessed using a visual analogue scale consisting of a lever attached to a linear potentiometer [4]. The patients were instructed to move the lever from the zero position (which indicated the pain intensity before the beginning of the stimulation) to one side when pain was reduced, the end position of the lever indicating no pain, and in the opposite direction if pain increased in intensity. The potentiometer was connected to an ink-writer that was out of sight of the patient. No verbal communication took place with the patient either during stimulation or, in case pain was reduced, until the pain had returned to its pre-stimulatory level. In this case the patient was asked to rate the effect of stimulation verbally and in terms of pain reduction relative to the original pain intensity. In general there was a good agreement between the verbal score and the visual scaling rate [5,10].

Vibration at 100 Hz was applied to various parts of the skull. The probe of the vibrator had a diameter of 3 cm and was covered with foam rubber. The pressure with which the probe was applied was measured continuously

throughout the application of the stimulation. In most subjects two different pressures were tried; one light pressure at which mostly superficial tissues were stimulated and a slightly higher pressure at which contact was achieved with underlying bone. The amplitude of the stimulus when the stimulator was applied with light pressure was 1000 μm and 300 μm when stronger pressure was used. In general the stimulation of the various points of the skull was carried out in the following order: vertex, forehead (midline), the zygomatic process (left and right) and the chin (midline). In some patients stimulation of the mastoid process was also tried.

To test the placebo effect various sites, such as the manubrium sterni and the wrist, were stimulated. Furthermore, in all patients, before starting the vibratory stimulation the vibrator was applied lightly on top of the skull for 1–2 min without any vibration. In two patients this was found to cause reduction of pain intensity and in one patient complete relief of pain. These 3 patients are not included in the present material.

RESULTS

To illustrate the general procedure of the experiments and the effects obtained with vibration, a typical experiment will first be described (Fig. 3). The patient was a 45-year-old woman who had been suffering from aching pain in the right upper jaw for 4–5 days. Examination by the dental surgeon revealed an apical periodontitis in the region of the first molar. Application of vibratory mechanical stimulation on top of the head added to the pain and the stimulation was therefore discontinued after a few minutes. Stimulation on the forehead produced an initial reduction followed by an increase in pain. A similar effect was obtained by stimulating at the left zygomatic process. Stimulation was thereafter applied at the right zygomatic process. Shortly after application of the stimulus the patient indicated a marked reduction in pain intensity and after about 1 min a further reduction was indicated. With continued stimulation the pain was reduced to about 70% of its original intensity. After cessation of vibration pain returned within 2 min to about the same level as prior to stimulation. Following this, vibration was applied to the chin. At this point pain was reduced, although not as much as when the right zygomatic process was stimulated.

The observations made on this patient bring out some points common to all patients in the present study. Firstly, the effect obtained with vibration varied from one site of stimulation to another. At some sites stimulation was without effect or caused a slight increase in pain. The conclusion to be drawn from this appears to be that the pain-reducing effect obtained from other points most probably were not placebo effects. Secondly, there was usually a best point at which stimulation caused a greater pain-reducing effect than at all other test points. In many cases stimulation at the best point produced complete relief of pain. The best point was in almost all patients located on the same side as the pain or in the midline and, in general, within the area innervated by the trigeminal branch carrying the pain. For

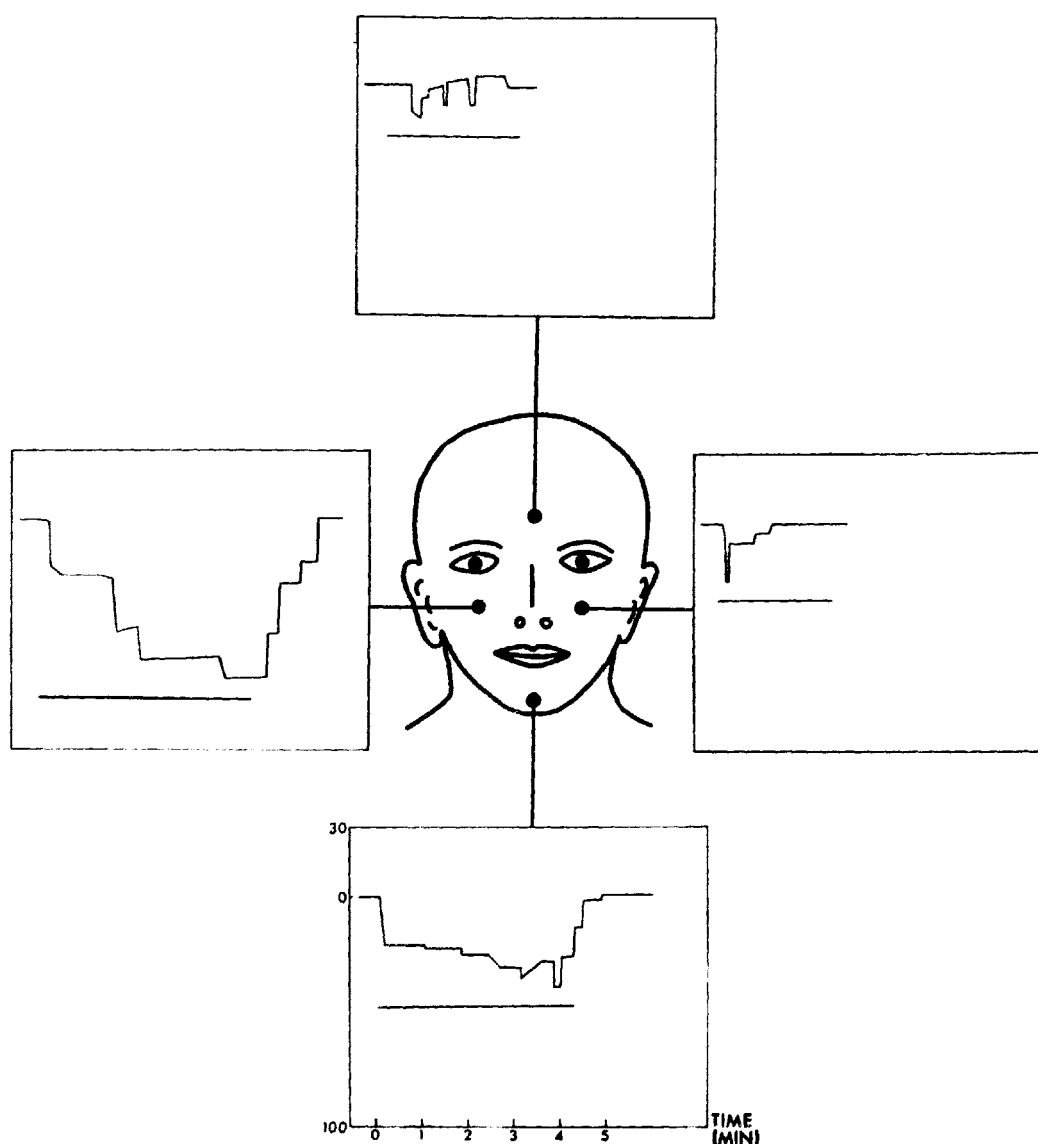


Fig. 3. Typical experiment showing effect of vibratory stimulation on different points of the skull on a patient suffering from an apical periodontitis in the region of the first molar in the right upper jaw. Stimulated areas are: forehead (top figure), left and right zygomatic processes and chin (bottom figures). Abscissa: time in minutes. Ordinate: subjective pain intensity. Zero indicates pain intensity before vibratory stimulation. Downwards deflection pain reduction, 100% indicating complete relief of pain; upwards deflection increase in pain intensity. Horizontal bars indicate duration of vibratory stimulation.

instance, in pain originating from the upper jaw stimulation over the zygomatic process on the same side was more effective than stimulation of the chin whereas in pain originating from the lower jaw this pain was more effectively reduced by stimulation of the chin.

The pain-reducing effect obtained at the best point was reproducible, as is illustrated in Fig. 4. In this case stimulation at the right zygomatic process

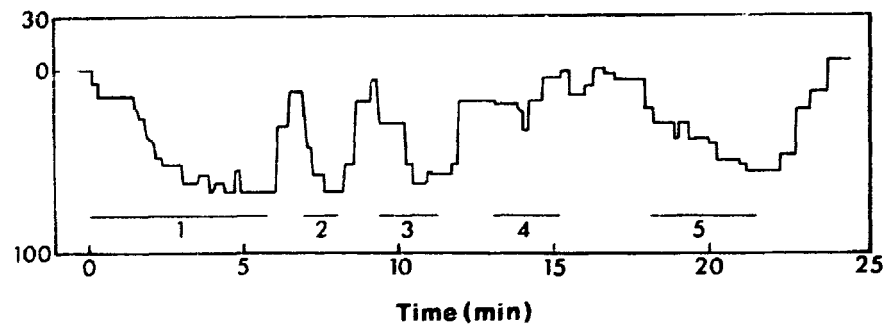


Fig. 4. The pain-reducing effect of repeated application of vibration on a patient suffering from pain in the right upper jaw. Continuous registration. 1, 2, 3, and 5, vibratory stimulation applied to right zygomatic process; 4, vibratory stimulation applied to left zygomatic process. Abscissa and ordinate as in Fig. 3. Horizontal bars indicate duration of vibratory stimulation.

produced a gradually increasing pain reduction and after 5 min of stimulation pain was reduced by about 70%. Following cessation of stimulation pain rapidly came back but was reduced again when vibration was again applied. The stimulation was repeated a third time with the same effect. For control, vibration was thereafter applied at the left zygomatic process. Here the vibration added to the pain and was therefore discontinued after about 2 min. As a final test vibration was thereafter again applied at the right zygomatic process and pain was once more alleviated.

Of 33 patients in the present study, 30 had reduction of pain during vibratory stimulation at some points of the skull. In 3 patients stimulation was without effect or caused a slight increase in pain at certain points. From the histogram in Fig. 5 it can be seen that of the 16 patients who experienced a

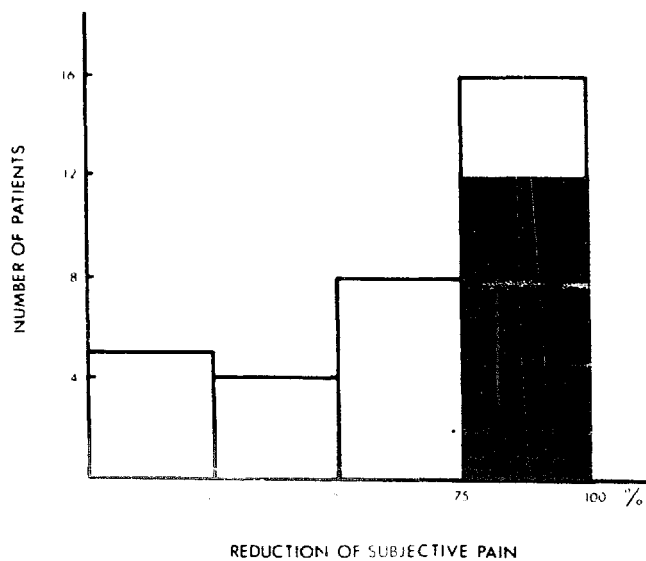


Fig. 5. Pain reduction in percent of complete pain relief during vibration. Number of patients who experienced total pain relief represented by black area.

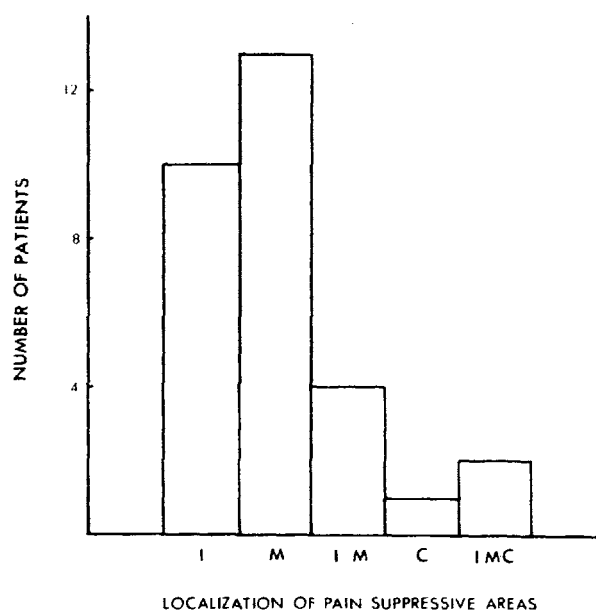


Fig. 6. Correlation of "the best" pain suppressive area with the side of pain localization. I = vibratory stimulation applied ipsilaterally (= same side as pain); M = midline; I-M = ipsilaterally plus midline; C = contralaterally; I-M-C = ipsilaterally, midline plus contralaterally.

reduction in pain intensity of 75–100%, 12 patients reported a complete relief of pain. In 8 patients the pain reduction was 50–75% and in 4 patients 25–50%. For 5 patients the reduction was less than 25%; out of these, 3 patients reported no relief.

The degree of reduction in pain was related to the intensity of pain before the beginning of stimulation (cf. Fig. 2). As seen in these experiments, relief of pain by more than 50% with stimulation at the best point was obtained in all patients who reported light or light-to-moderate pain before treatment, while in patients with moderate or severe pain 8 patients reported a reduction of less than 50%. The "best points" were in general located on the same side as the pain or in the midline (Fig. 6). In most patients the best effects were obtained when the probe of the stimulator was applied so that contact with bone was achieved. It is likely that, not only did this involve increased activation of a given set of receptors but also recruitment of receptors in deep tissues.

Following cessation of stimulation, pain returned gradually and the pre-treatment level was usually obtained in 5 min. It thus appears that the post-stimulatory effect of vibration is relatively short lasting. However, it should be noted that the stimulation periods in general were short and usually not more than 5 min. It is conceivable that by prolonging the stimulation period a more long-lasting effect might be obtained. In some patients who experienced a pain-reducing effect the pain continued to decrease in intensity for a few minutes following cessation of stimulation and then began to return.

DISCUSSION

The results of the present study clearly show that vibration may effectively reduce pain originating from teeth or the surrounding tissues. All the patients except three experienced some degree of pain relief; twelve of the patients were completely relieved of pain. In studies of pain there is always the disquieting possibility that the pain relief obtained is a placebo effect. Several lines of evidence appear to suggest that the pain alleviating effects observed in the present study cannot be explained as placebo effects. Thus pain reduction was only observed at certain points of the skull and there was usually a best point at which vibration had greater effect than at other points. Furthermore, stimulation at some points added to the pain [12]. These observations strongly suggest that the reduction of pain obtained is due to the afferent input from receptors which are activated by vibratory stimulation. This conclusion lends support to earlier reports [1,9] showing that vibration causes an elevation in subjective threshold for detection of pain. In contradiction to this it has been reported by Ertekin and Akcali [3] that vibration at 100 Hz enhances nociceptor reflexes and is without effect on subjective pain sensation. It is interesting to note also that vibration may reduce the intensity of experimentally induced itch [7]. A pertinent question is what kind of receptors are activated by the vibratory stimulus. In the present study we used vibration of 100 Hz. It is likely therefore that predominantly rapidly adapting receptors were activated. The observation that a more effective pain reduction was observed when the probe of the stimulator was applied so as to stimulate the underlying bone appears to suggest that activation of receptors in the periosteum and bone is required to obtain a maximal effect. It is also of interest to note that vibration was most effective when applied to the region from which pain appeared to come. This would appear to suggest that in order to obtain a good relief of pain the afferents of the trigeminal branch which carried the noxious input had to be stimulated. For instance, stimulation which, presumably, activated mainly receptors of the third branch had less effect than a corresponding activation of receptors of the second branch when pain was located in the region innervated by fibers of the second branch.

As indicated above, the post-stimulatory effect was relatively short lasting. This might be due to the fact that vibration was usually only applied for short periods. Subsequent studies (in course of publication) of patients suffering from other pain syndromes in the trigeminal region indicate that, following vibratory stimulation for 20–30 min, the patients may be relieved of pain for 4–6 h.

The effect of vibration is most likely dependent on the activation of rapidly adapting receptors in the skin, periosteum, muscle and bone, and is probably due to an interaction between large fibers and small pain-carrying fibers. Thus, this effect is analogous to the pain-relieving effect obtained with certain forms of transcutaneous nerve stimulation. Vibration may, however, differ in this aspect from transcutaneous nerve stimulation in activating large fibers more selectively.

ACKNOWLEDGEMENTS

This work was supported by grants from Magn. Bergvalls Stiftelse and from Karolinska Institutets Fonder.

The authors wish to thank Dr. Lill-Gitt Hasselgren-Linder for referring the patients and providing facilities for this study. We are greatly indebted to Dr. Steven Orman for his constructive comments in the preparation of the manuscript.

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