THE EFFECTS OF ELECTROACUPUNCTURE STIMULATION THERAPY ON THE PAIN THRESHOLD OF MANDIBULAR POSTERIOR TEETH USING LI4(HAP GOK) POINTS

Ai-Ree Chung, D.D.S., M.S.D., **Ki-Suk Kim**, D.D.S., M.S.D.,Ph.D.

Department of Oral Medicine, Dental College, Dankook University

CONTENTS

I. Introduction

Acupuncture is an oriental method of treating illness and pain, which has been used originally in traditional oriental medicine. Acupuncture therapy was intended by ancient Korean oriental medical doctor to correct blockages or excess in the flow of the vital life force and to correct disharmonies or imbalances in the vital life force and elements on which physiologic function depended. During the past few decades researches have explained some of the basic fundamentals in the working mechanism of acupuncture. The gate control theory and the endorphin systems are some of the physiologic mechanisms involved.[1,2]

Richard et al.[3] reported that different levels of electroacupuncture analgesia were induced by three different frequencies of stimulation. Hannson and Ekbolm[4] compared the effects of high frequency, low frequency, and placebo transcutaneous electric nerve stimulation(TENS) therapy for acute orofacial pain patients attending an emergency outpatient dental clinic. The results showed a significant reduction in pain ratings in two TENS groups as compared to the placebo group.

Roth et al.[5] assessed the effects of low frequency/high intensity electroacupuncture like TENS which affects on periodontal pain associated with orthodontic separation and suggested that TENS was an effective non-pharmacologic method of controlling postadjustment tooth pain. Mumford[6] assessed the effects of TENS on the pain threshold of electrically stimulated tooth pulp. The results demonstrated a higher pain sensory threshold after the TENS application.

Kim[7] reported that electroacupuncture stimulation therapy(EAST) on S5(Dae Yeong) and CV24(Seung Jang) points showed an analgesic effect on mandibular canine. Han[8] assessed the effects of EAST applied on LI4(Hap Gok) point of the sensory and pain threshold of electrically stimulated tooth pulp. He suggested that the reason EAST had an effect at mandibular anterior teeth area distant from the site of stimulation was due to endorphin release which increased the pain threshold of whole body.

The purpose of the present study was to identify the effect of EAST on the pain and sensory thresholds of mandibular posterior teeth using LI4(Hap Gok) points.

II. Materials and Methods

A. Subjects

Healthy fifteen male volunteers were participated in the study. The mean age was 26.7 years and the range was 25 to 30 years. Exclusive criteria were endodontic treatment, prosthesis or dental caries on the mandibular posterior teeth. No special demographic characteristics were considered.

B. Procedure

EAST was performed with Pulse Generator(PG)-8®(ITO Co. Tokyo, Japan) at the LI4(Hap Gok) point. One channel including two electrodes was used in this study. Two electrodes were attached by negative pressure resulted from the suction force. Positive one attached on the right LI4 point and another negative one on the left side. Electrodes were attached after alcohol sponges were applied to each point. All subjects received EAST for 20 minutes.

PG-8® produced a biphasic wave current (120 μs pulse width) of 3 x 15 Hz and the current was slowly increased to cause a strong, but not painful, tingling sensation at the electrode.

An NEOTEST-ADP®(AMADENT, Cherry Hill, U.S.A.) was used to measure the sensory and pain threshold of teeth. Before EAST, at the 10 minute-point of EAST and after EAST the sensory and pain threshold were measured at 8 mandibular posterior teeth. The test current was slowly increased and the subject was instructed to raise his hand at the moment of feeling sense as a sensory threshold and at the moment the subject felt pain as a pain threshold. Then, electric pulp test was stopped and the value of the current was recorded.

After 2 days, all subjects were received sham-EAST of which procedures were identical to EAST except the electric stimulation and the sensory and pain thresholds were measured before sham-EAST, at the 10 minute-point of sham-EAST and after sham-EAST.

C. Statistical analysis

All data were averaged. Statistical analysis was performed to compare the rates of sensory and pain thresholds. To determine the significance of differences among the measurements before EAST, during EAST and after EAST, and between the measurements in groups of EAST and shamEAST respectively, one factor ANOVA and Scheffé & Fisher's PLSD(protected least significance difference) tests were used.

III. Results

The mean and standard deviations of the sensory and pain thresholds of all groups were shown by Table 1 and 2. Comparison of the change of the sensory and pain thresholds of all

Table 1. Mean and standard deviaions of the sensory thresholds of EAST and shamEAST group.

		Before	During	After
L4	Sensory-EAST	0	47.57±47.06	57.38±52.55
	Sensory-ShamEAST	0	2.37±26.33	1.48±29.53
L5	Sensory-EAST	0	45.72±76.98	58.35±89.87
	Sensory-ShamEAST	0	6.61±25.09	14.66±24.14
L6	Sensory-EAST	0	29.55±46.46	40.92±42.38
	Sensory-ShamEAST	0	9.54±29.64	16.28±26.89
L7	Sensory-EAST	0	11.14±36.08	45.52±65.55
	Sensory-ShamEAST	0	5.62±39.67	10.59±37.02

L4 : First premolar L5 : Second premolar Unit : %
L6 : First molar L7 : Second molar

Table 2. Mean and standard deviations of the pain thresholds of EAST and shamEAST group

		Before	During	After
L4	Pain-EAST	0	33.76±30.92	54.05±33.23
	Pain-ShamEAST	0	-0.45±14.48	1.78±21.54
L5	Pain-EAST	0	20.48±22.79	30.03±32.02
	Pain-ShamEAST	0	5.57±21.79	2.96±16.26
L6	Pain-EAST	0	38.00±43.48	44.46±43.67
	Pain-ShamEAST	0	5.25±24.21	6.96±22.45
L7	Pain-EAST	0	41.54±43.11	53.96±45.32
	Pain-ShamEAST	0	-0.17±15.42	1.43±13.55

L4 : First premolar L5 : Second premolar Unit : %
L6 : First molar L7 : Second molar

groups were shown by Figure 1 and 2, and there were significant differences between EAST and shamEAST groups in sensory and pain thresholds.(<0.0001)

The sensory and pain thresholds of mandibular first premolars showed significant differences between "before" and "during" and "before" and "after" EAST (Table 3). The sensory and pain thresholds of mandibular second premolars also showed significant differences between "before" and "during" and "before" and "after" EAST (Table 4). The sensory and pain thresholds of mandibular first molars showed significant differences between "before" and "during" and "before" and "after" EAST (Table 5). The sensory thresholds of

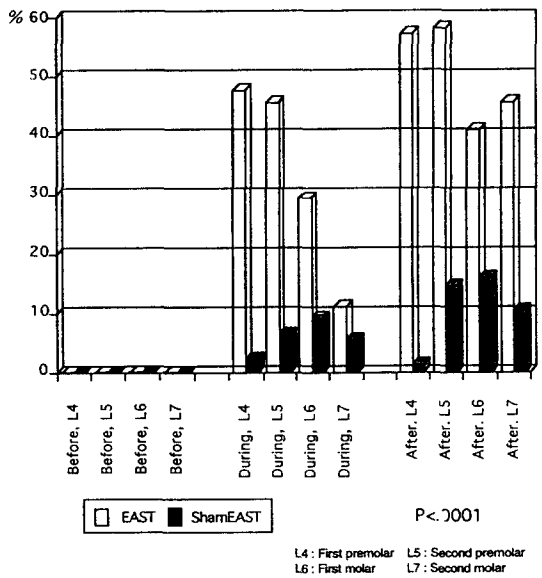

Fig. 1. Columnar graph showing the comparison betwen the change of the sensory thresholds of all groups.

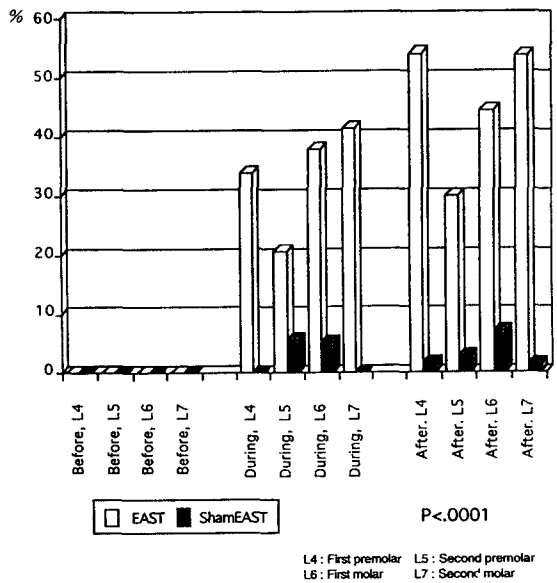

Fig. 2. Columnar graph showing the comparison between the change of the pain thresholds of all groups.

Table 3. Result of mutiple comparison test (Fisher's PLSD) for the sensory and pain thresholds of mandibular first premolar.

		Before	During	After	
EAST	Sensory	0	47.57±47.06	57.38±52.55	*†
	Pain	0	33.76±30.92	54.05±33.23	*†
ShamEAST	Sensory	0	2.37±26.33	1.48±29.53	NS
	Pain	0	-0.45±14.48	1.78±21.54	NS

* : 95% significant difference between Before and During

Unit : % † : 95% significant difference between Before and After

NS: Not significant

mandibular second molars showed significant differences between "before" and "after" EAST (Table 6). The pain thresholds of mandibular second molars showed significant differences between "before" to "during" and "before" to "after" EAST (Table 6).

In the comparison of sensory and pain thresholds between EAST and ShamEAST, there was no significant difference but the sensory threshold "during" of mandibular second molars (<0.05) (Table 7). In the comparison of pain thresholds between EAST and ShamEAST, there were significant differences in all cases (<0.05)(Table 8).

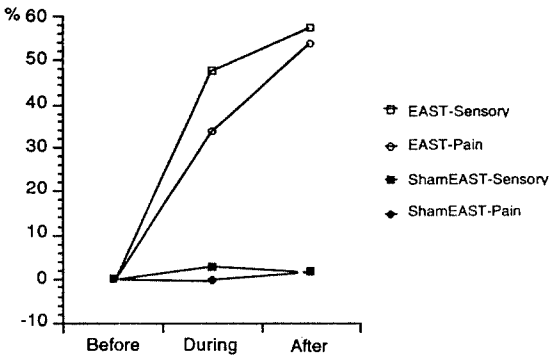

Fig. 3. Linear graph showing the changes of sensory and pain thresholds of mandibular first premolar in the EAST and shamEAST groups.

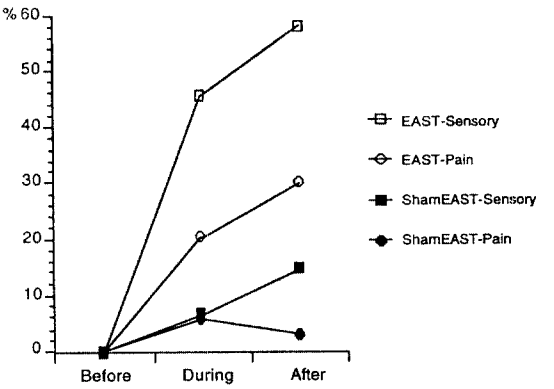

Fig. 4. Linear graph showing the changes of sensory and pain thresholds of mandibular second premolar in the EAST and shamEAST groups.

Table 4. Results of mutiple comparisom test(Fisher's PLSD) for the sensory and pain thresholds of mandibular second premolar.

		Before	During	After	
EAST	Sensory	0	45.72±76.98	58.35±89.87	*†
	Pain	0	20.48±22.79	30.03±32.02	*†
ShamEAST	Sensory	0	6.61±25.09	14.66±24.14	NS
	Pain	0	5.57±21.79	2.96±16.26	NS

Unit:%

* : 95% significant difference between Before and During
†: 95% significant difference between Before and After
SN : Not significant

Table 5. Results of mutiple comparison test (Fisher's PLSD) for the sensory and pain thresholds of mandibular first molar.

		Before	During	After	
EAST	Sensory	0	29.55±46.46	40.92±42.38	*†
	Pain	0	38.00±43.48	44.46±43.67	*†
ShamEAST	Sensory	0	9.54±29.64	16.28±26.89	NS
	Pain	0	5.25±24.21	6.96±22.45	NS

Unit : %

* : 95% significant difference between Before and During
† : 95% significant difference between Before and After
NS : Not significant

Table 6. Results of mutiple comparison test (Fisher's PLSD) for the sensory and pain thresholds of mandibular second molar.

		Before	During	After	
EAST	Sensory	0	11.14±36.08	45.52±65.55	†
	Pain	0	41.54±43.11	53.96±45.32	*†
ShamEAST	Sensory	0	5.62±39.67	10.59±37.02	NS
	Pain	0	-0.17±15.42	1.43±13.55	NS

Unit : %

* : 95% significant difference between Before and During
† : 95% significant difference between Before and After
NS : Not significant

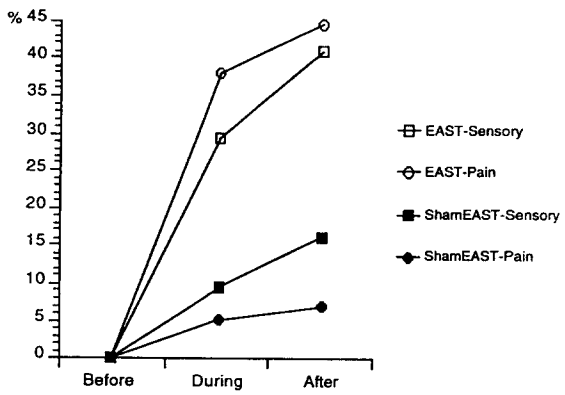

Fig. 5. Linear graph showing the changes of sensory and pain thresholds of mandibular first molar in the EAST and shamEAST groups.

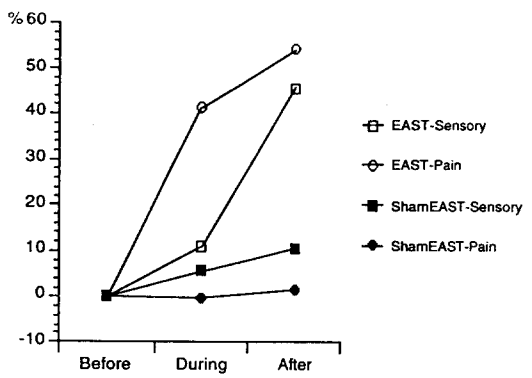

Fig. 6. Linear graph showing the changes of sensory and pain thresholds of mandibular second molar in the EAST and shamEAST groups.

Table 7. Results of paired t-test for the sensory thresholds of mandibular posterior teeth.

	L4		L5		L6		L7	
	During	After	During	After	During	After	During	After
EAST	47.57±47.06	57.38±52.55	45.72±76.98	58.35±89.87	29.55±46.46	40.92±42.38	11.14±36.08	45.52±65.55
Sham EAST	2.37±26.33	1.48±29.53	6.61±25.09	14.66±24.14	9.56±29.64	16.28±26.89	5.62±39.67	10.59±37.02
P-value	<.0001	<.0001	<.0003	<.0001	.0451	.0137	.5725	.0004

L4 : First premolar, L5 : Second premolar, 95% Significant difference
L6 : First molar, L7 : Second molar

Table 8. Results of paired t-test for the pain thresholds of mandibular posterior teeth.

	L4		L5		L6		L7	
	During	After	During	After	During	After	During	After
EAST	33.76±30.92	54.05±33.23	20.48±22.79	30.03±32.02	38.00±43.48	44.46±43.67	41.54±43.11	53.96±45.32
Sham EAST	-0.45±14.48	1.78±21.54	5.57±21.79	2.96±16.26	5.25±24.21	6.96±22.45	-0.17±15.42	1.43±13.55
P-value	<.0001	<.0001	.0175	<.0001	<.0001	<.0001	<.0001	<.0001

L4 : First premolar, L5 : Second premolar, 95% Significant difference
L6 : First molar, L7 : Second molar

IV. Discussion

Since the presentation of the "gate control theory" numerous reports have been published concerning various methods for the treatment of pain based upon activation of afferent nerve fibers by electrical stimulation. There are considerable evidences that the analgesic effects of acupuncture are mediated by an endogenous opiate-like mechanism, although this idea also remains somewhat controversial.[1,2,9,18]

In recent years, many investigators have hypothesized mechanisms to explain the effects of acupuncture on pain. One popular explanation is that acupuncture acts as a counter irritant, reducing pain in one area of the body by introducing a competing pain in another area. Another explanation for the effects of acupuncture is based on the gate control theory. Stratton[19] proposed that a high frequency/low intensity TENS application stimulates the A-delta and A-beta fibers, blocking the transmission of painful stimuli by the small unmyelinated C-fibers in the spinal cord; this is in accord with Melzack and Wall's gate control theory.[1] According to Melzack and Wall, an increase in the activity of the large fibers can act upon the gate in such a way that the information carried by small fibers is gate out, and the pain is not experienced. Melzack[20] has introduced a another pain concept, the central biasing mechanism which a portion of reticular formation in the brain stem exerts an inhibitory effect on neural activity in all parts of the body. Acupuncture stimulation acts on the brain stem to increase this inhibitory effect, thus preventing the experience pain. Richard et al.[3] found that electroacupuncture analgesia induced by low frequency stimulation may be mediated by endorphins while high frequency stimulation is not endorphinergic but may be partly due to serotonin. A number of data indicate that the analgesic effect of acupuncture therapy is mediated by an increased the release of beta-endorphins into the circulation.[16,17,21]

An acupuncture point may merely be a term applied to a highly innervated(neural and circulatory) region that frequently overlies peripheral nerves at their superficial aspects and not a mystical point.[22] Many textbook of acupuncture therapy demonstrate the specific acupoints which have the analgesic effect of specific area.[23,24] Use of distal point include LI4 and S36(Jok Sam Ri) have been known to be effective on dental analgesia, but the author used LI4 only in this study because there were some difficulties to take acupionts of the leg in the dental chairs. LI4 point is a acupoint of

Large Intestine Meridian(LI) which have been effective on headache, dental pain, ENT(ear, nose and throat) and eye disease, and fever. In a small study by Lapper[25] six patients diagnosed with myofascial pain dysfunction syndrome(MPD), and four with migraine headaches were treated by application of transcutaneous nerve stimulation to an LI4 point. Melzack[26] reported that ice massage of the hand(LI4 point) has decreased the intensity of the dental pain by 50% or more in the majority of acute dental pain patients comparable to those of transcutaneous electrical stimulation and acupuncture. He suggested that why the Hap Gok area is particularly associated with dental pain is not clear, but it is reasonable to assume that fibers from this area activate brainstem cells that project impulses particularly strongly to pain-signalling neurons in the trigeminal system.

There is evidence that acupuncture analgesia sometimes has a delayed onset and long outlasts in the actual period of stimulation.[27] Hansson et al.[4] reported that 35% who receiving TENS had maximal pain relief within 15 minutes while 65% had maximal pain relief after 15-30 minutes of TENS. Andersson et al.[28] reported that the onset of the effect, when present, was gradual and reached the maximal level after about 30 minutes. According to the traditional acupuncture treatment, treatment time was set at 20 minutes.

Andersson et al.[28] reported that stimulation by the surface electrodes gave an onset and a decline of the effect upon pain threshold which were very similar to those obtained via needles. The surface electrodes were used in this study. The advantages of surface electrode are that they are not invasive so the patient acceptance is better, and has less possibilities of infection.

The effect of electroacupuncture stimulation applied to a unilateral LI4 point on the human tooth pain thresholds was studied by electrically stimulating bilateral canines.[29] In six of ten subjects tested, the tooth pain threshold was elevated ipsilaterally but was unchanged contralaterally during and after the electroacupuncture, in the remaining four, neither the ipsilateral nor the contralateral canine showed any changes in the pain threshold by the electroacupuncture. This finding was not exactly coincided with our results. In this study, the positive electrode was attached right side LI4 point and negative one was attached left side. But there was no significant difference according to polarity of electrodes.

Chapman et al.[30] observed that the placebo acupuncture group showed no positive responses to treatment, it was therefore suggested that acupuncturally induced dental hyperalgesia requires stimulation of specific loci. In the comparison of sensory thresholds of EAST and ShamEAST, all but "during" of mandibular second molars, showed significant difference. In the comparison between pain thresholds of EAST and ShamEAST, there was significant difference in all cases.

Analgesic effects have been statistically significant, but weak, in most studies which have examined the responses of subjects receiving acupuncture at the LI4 point.[30,31,32] A more powerful effect has been reported,[33] and repeatedly,[28] by Andersson, Holmgren, and their associates, who stimulated acupuncture sites in the second trigeminal nerve division in addition to the LI4 points. Further studies on comparison of using local point simultaneously with the LI4 points are needed.

The results of this study showed increased sensory and pain threshold of mandibular posterior teeth in EAST groups, and compared previous study,[8] it is concluded that LI4 points

had a dental analgesic effect on all mandibular teeth. Although the actual mechanism of EAST has still not been explained by this study, these results suggested that it should be useful in the control of mandibular posterior dental pain for some patients. EAST might be, therefore, used for some patients who can not receive the routine dental treatment due to severe stress and serious medical problems. In addition, it is believed that EAST can be used in general dental practice in order to reduce a uncomfortable sensation during treatment.

V. Conclusions

This study was performed to identify the effect of electroacupuncture stimulation therapy (EAST) on the pain and sensory thresholds of mandibular posterior teeth using LI4(Hap Gok) points. EAST was undertaken at the LI4 points of 15 subjects. Measurements of sensory and pain thresholds of mandibular posterior teeth were taken before EAST, during EAST and after EAST. 2 days later, measurements of sensory and pain thresholds of mandibular posterior teeth were taken before, during and after shamEAST. The result was that the sensory and pain thresholds of mandibular posterior teeth were significantly increased during and after EAST at both LI4 points. it is therefore concluded that EAST at LI4 points would be helpful in pain control of mandibular posterior teeth.

REFERENCES

1. Melzack, R. and Wall, P. D.: Pain mechanism: a new theory. Science 15 0:971, 1965.
2. Terenius, L. and Wahlstrom, A.: Search for an endogenous lignad for the opiate receptor. Acate Physiol Scand 94:74, 1975.
3. Richard, S., Cheng, S. and Pomeranz, B.: Electroacupuncture analgesia could be mediated by at least two painrelieving mechanism: Endorphin and Non-endorphin systems. Life Science 25:1957, 1979.
4. Hansson, P. and Ekbolm, A.: Transcutaneous electrical nerve stimulation(TENS) as compared to placebo TENS for the relief of acute orofacial pain. 15:157, 1983.
5. Roth, P. M. and Thrash, W. J.: Effect of transcutaneous electrical nerve stimulation for controlling pain associated with orthodontic tooth movement. Am J Orthop 90:132, 1986.
6. Mumpford, J. M.: Influence of transcutaneous neural stimulation on the pain threshold of human teeth. In Bonica J. J, Able Fessard D. G.(editore): Advances in pain research and therapy, 1. New York. Raven Press. 1976.
7. Kim, K.B.: The effects on the pain thresholds of mandibular anterior teeth of electroacupuncture stimulation therapy on S5(Dae Yeoung) and CV24(Seung Jang) points. DanKook University Thesis, 1995.
8. Han, D.J.: The effects on the pain thresholds of mandibular anterior teeth of electroacupuncture stimulation therapy on LI4(Hap Gok) point. DanKook University Thesis, 1995.
9. Chapman, C. R., Colpitts, Y.M., Benedetti, C.and Gehring, J.D.: Letter to Editor. Pain 11:277, 1981.
10. Mayer, D. J. and Price, D. D.: Letter to the Editor. Pain 11:273, 1981.
11. Mayer, D. J., Price, D. D. and Rafii, A.:Antagonism of acupuncture analgesia in man by the narcotic antagonist naloxone. Brain Res 121:368, 1977.
12. Watkins, L. R. and Mayer, D. J.: Organization of endogenous opiate and nonopiate pain control systems. Science 216:1185, 1982.
13. Willer, J. C., Roby, A.,Boulu, P. and Boureau, F.: Comparative effects of electroacupuncture and transcutaneous nerve stimulation on the human reflex. 14:267, 1982.
14. Sjolund, B., Terenius, L. and Eriksson, M.: Increased cerebrospinal fluid levels of endorphins after eletroacupuncture. Acta physiol scand 100 : 382, 1977.
15. Cheng, R. S., Pomeranz, B.: Electroacupuncture Analgesia is mediated by stereospecific opiate receptors and is reversed by antagonists of type 1

receptors. Life Sci 26:631, 1979.
16. McLennan, H.: Some pharmocological observations on the analgesia induced by acupuncture in rabbits. Pain 3:229, 1977.
17. Teenius, l. and Wahlstrom, A.:Search for an endogenous lignad for the opiate receptor. Acta Physiol Scand 94:74, 1975.
18. Lovacky, S., Lodin, Z., Tauber, O., Thmas, K., Zizkovsky, J., Dvorak, P. and Srajer, l.: Acupuncture treatment and its effect on low back pain: correlation with beta-endorphin immunoactivity. Am J Acupuncture 15:245, 1987.
19. Stratton, S.A.: Role of endorphins in pain modulation. J Orthologic pain. Anesthesiology 35:409-419, 1971.
20. Melzack, R.: Phantom limb pain: Implications for treatment of pathologic pain. Anesthesiology 35: 409-419, 1971.
21. McLennan, H. et al. : Some pharmocological observations on the analgesia induced by acupuncture in rabbits. Pain 3, 229-238, 1977.
22. Mannheimer, J. S., Lampe, G. N.: Clinical transcutaneous electrical nerve stimulation. 8 eds, 1988. 284p. F.A. Davis Co. Philadelphia
23. Hyodo, M.: Silver Spike Point therapy. Seoul, Hynmoon Press. 1991.
24. Choi, Y.T. and Lee, S.H.: Textbook of acupuncure therapy. Seoul, Hanglim Press, 1974.
25. Lapeer, G. L.: High-intensity transcutaneous nerve stimulation at the Hoku acupuncture point for relief of muscular headache pain Craniomandb Prac 4:164, 1986.
26. Melzack, R.: Guite, S. and Gonshor, A.: Relief of dental pain by ice massage of the hand. CAM Journal 122:26, 1980.
27. Melzack, R.: Myofascial trigger point: relation to acupuncture and mechanisms of pain. Arch Phys Med Rehab 62:114, 1981.
28. Andersson, S. A. Ericson, T., Holmgren, E. and Lindqvist, G.: Electro-acupuncture. Effect on pain threshold measured with electrical stimulation of teeth. Brain Research 63:393, 1973.
29. Yukizaki, H.: Electroacupuncture increases ipsilaterally tooth pain threshold in man. Am J Chin Med 14:68, 1986.
30. Chapman, C. R., Wilson, M. E. and Gehrig, J. D.: Comparative effects of acupuncture and transcutaneous stimulation on the perception of painful dental stimuli. Pain 2:265, 1976.
31. Chapman, C. R., Gehrig, J. D. and Wilson. M. E., Acupuncture compared with 33 percent nitrous oxide for dental analgesia. Anesthesiology 42:532, 1975.
32. McBurney, D. H.: Acupuncture, pain and signal detection theory. Science 189:66, 1975.
33. Andersson, S. A., Erickson, J., Holmgren, E. and Lindqvist, G.: Electroacupuncture and pain threshold. Lancet 2: 564, 1973.

국문초록

합곡에 대한 전기침술자극요법시 하악구치의 동통역치에 미치는 효과에 관한 연구

단국대학교 치과대학 구강내과학 교실

정 애 리 · 김 기 석

합곡에 전기침술자극요법이 하악구치에 미치는 동통역치에 관한 효과를 알아보고자 본연구를 시행하였다. 전기침술자극요법시행전과 시행중 10분, 시행후에 하악구치의 감각과 동통역치를 측정하였으며 2일후 같은 검사자들을 대상으로 위전기침술자극요법시행전, 위전기침술자극요법시행중 10분, 위전기침술자극요법시행후에 하악구치의 감각과 동통역치를 측정하여 다음과 같은 결과를 얻었다.

합곡에 전기침술자극요법을 시행시 하악구치의 감각역치와 동통역치가 유의성있게 증가하였다. 따라서 합곡에 대한 전기침술자극요법이 하악구치의 동통완화에 효과적이라 사료된다.