

Can Acupuncture Reduce the Induction Time of a Local Anaesthetic? - A Pilot Study

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Summary

We report on a pilot study we undertook to investigate if segmental acupuncture treatment, given two minutes prior to a regional inferior dental block (ID) with Prilocaine Hydrochloride, would reduce the onset time of a local anaesthetic.

Thirty healthy people, who needed a regional inferior dental block (ID) as part of dental treatment in the lower jaw, were randomly allocated to three groups. They received segmental acupuncture, heterosegmental superficial acupuncture, or standard treatment (regional inferior dental block) without acupuncture. In the segmental acupuncture group, acupuncture was given within the innervation of the trigeminal nerve. The needles were left in for two minutes, followed by a regional inferior dental block (ID). In the second group, acupuncture needles were inserted superficially in extra-segmental points and left in for two minutes without stimulation, followed by the regional inferior dental block. A control group received standard treatment only, of a regional inferior dental block.

The concept 'pain free for dental work' was defined as 'patients reporting pins and needles in the lower lip' and measured by a drilling test. Patients who reported no pain during the drilling test were included in the study. The time from administration of the injection to the patients' reporting pins and needles was recorded by an independent dental nurse.

All tested patients reported sufficient anaesthesia during the drilling test. In the segmental acupuncture group, anaesthesia was achieved after 62 seconds, compared to the heterosegmental superficial acupuncture group, who took 115 seconds and the control group, who received standard treatment only, and took 119 seconds. The difference between the segmental acupuncture group and the heterosegmental superficial acupuncture group was statistically significant ($p < 0.015$); the difference between the segmental acupuncture group and the control, who received a regional inferior dental block only, was also significant ($p < 0.032$). No significant difference was found between the heterosegmental superficial acupuncture group and the control group who received a regional inferior dental block only ($p < 0.84$).

It appears from this pilot study that the onset time of local anaesthesia is reduced if segmentally administered acupuncture is given prior to the regional inferior dental block. However, it needs to be reproduced including objective measurements.

Keywords

Acupuncture, dental anaesthesia, anaesthetic induction time.

Introduction

Acupuncture is a traditional technique that originated in China more than 3000 years ago, whereby diseases are either controlled or cured by inserting needles in various parts of the body. Until recently the professional community was sceptical about its value, but its use in pain

management is now well established.¹ It has also been suggested that acupuncture might improve the immune system,¹ and is useful in stress management.²

Acupuncture has also been used in dentistry. It has been used as anaesthesia;³⁻⁸ as an analgesic;⁴⁻¹³ in the management of postoperative pain;¹⁴⁻¹⁹ facial

pain;^{20,21} temporomandibular dysfunction (TMD);²²⁻³⁰ and xerostomia.³¹⁻³⁵ Finally, it has been suggested that acupuncture might be useful in controlling stress and anxiety and the gagging reflex.^{36,37} Two recent review papers conclude that acupuncture has something to offer in dentistry.^{38,39} In particular it was found that acupuncture could be useful in the treatment of painful conditions in and around the jaws and in the treatment of TMD.

The speed of action and effectiveness of a local anaesthetic depends on the rate at which it can reach the nerve fibres and then build up to a sufficient concentration to attain the critical level at which impulse transmission is prevented. The greater the solubility of the analgesic in both aqueous and lipid material, the less will be the delaying effect of the tissues and tissue fluids and the more rapid the onset of anaesthesia.

It has been shown that acupuncture can increase the blood flow locally after acupuncture.^{32,33} Several studies have shown that acupuncture can increase the pain threshold, largely via a release of endorphins.^{8,40-49} If this increase in the blood flow and the pain threshold contributes to a faster onset of local anaesthetic after acupuncture, this needs to be proved.

It has been observed in dental practice that the quality and the onset time of an ID block is faster if acupuncture is given a few minutes before the local anaesthetic is injected. However, this hypothesis has never been tested in a rigorous setting, and the aim of this study is to investigate if the onset time can be reduced if acupuncture is given two minutes before the local anaesthetic.

Methods

The experiment was designed as a randomised controlled study involving 30 consecutive patients. The study took place in Copenhagen, Denmark, in the private practice of one of the authors (MB), who performed all treatments. The author (MB) is experienced in acupuncture, having achieved the standards set by the British Dental Acupuncture Society (BDAS).

Only healthy patients who needed an anaesthetic requiring treatment in the lower jaw were included in this study. Patients who might be considered as high risk patients, such as those suffering from insulin dependent diabetes

mellitus, those on chemotherapy treatment or oral steroid treatment, etc. were excluded. The protocol was approved by the local Ethics Committee (KA 0121g), Copenhagen, Denmark. All patients were informed that we were investigating whether acupuncture used in addition to the standard ID block, would have a beneficial effect. Moreover, patients were informed that they would receive either acupuncture or the standard treatment only. For those who were allocated to additional acupuncture, it would be given either in the face or in the hands, as both approaches have proved effective for dental pains.

Prior to the study, patients received verbal and written information, and gave their written consent before recruitment. Those volunteering were randomly allocated to segmental acupuncture, heterosegmental superficial acupuncture or a non-acupuncture group.

Randomisation

After inclusion, patients were randomly allocated to treatment by random number table, which was prepared by the first author (PR). In each case, the investigator (MB) contacted the first author (PR) by phone, and was advised which technique was to be used. This method was designed to ensure that the investigator (MB) did not have any control over the allocation of patients to treatment. After a positive drilling test the information was stored on an Excel spreadsheet by the main author (PR). The data were not accessible to the investigator.

Recording of the Time for Sufficient Anaesthesia

The concept 'pain free' is defined as patients being completely pain free during a drilling test. To ensure a uniform registration of the induction time, patients was instructed to indicate when they felt a numbness (pins and needles) in the lower lip. When they gave that information, a drilling test was performed as suggested by Andersson et al⁴¹ to ensure that the anaesthetic was sufficient for dental work, including extractions. The time from injection until patients reported pins and needles in the lower lip was recorded by an independent dental nurse. It was specified that a drilling test was required to confirm anaesthesia for the result to be included in the study. In the case of a

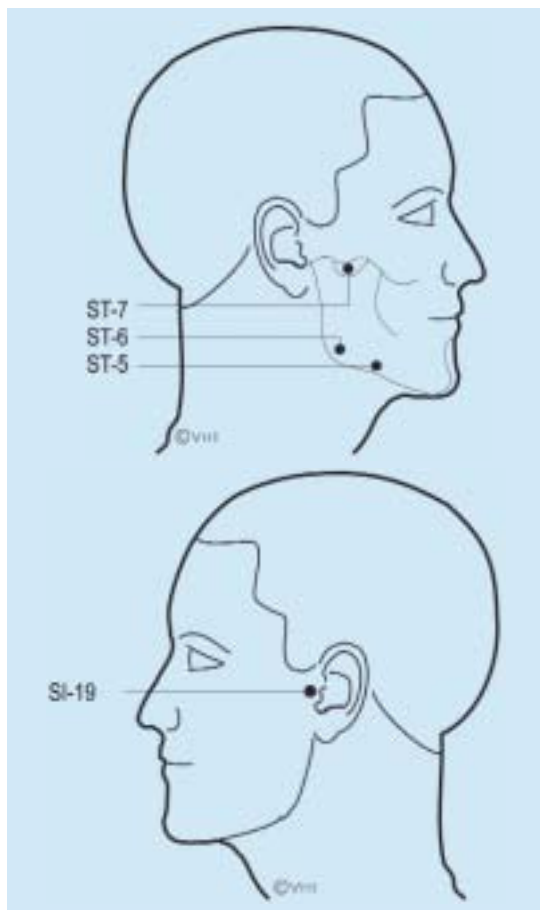


Figure 1 Acupuncture points used in group 1 (segmental acupuncture).

negative drilling test, the patient would be excluded from the study and additional local anaesthetic would be given. However, no patients required additional anaesthetic.

Group I: A segmental acupuncture group, where local acupuncture points SI19, ST5 and ST6 within the innervation of the 3rd branch of the trigeminal nerve were used as recommended by Brandwein (figure 1).⁵⁻⁷ The treatment was given on the relevant side of the face only. Needles were inserted in the selected points and after achieving the de qi sensation, the needles were manipulated manually for five seconds and left in situ for two minutes. Thereafter an ID block was given. Points were chosen in this region with the expectation that they would achieve the strongest effect. However, Andersson showed that a strict segmental approach is not necessary regarding the increase in the pain threshold, as stimulation of the second branch of the trigeminal nerve increased the pain threshold in both the upper and the lower

jaw.⁴¹ Blom showed that an increase in the local blood flow occurs after acupuncture, and we would expect to see the best effect after a local approach.^{32,33}

Group II: A heterosegmental superficial acupuncture group, where distant points LI4 and TE3 (figure 2) were used, located in the C6 to T1 segment. The acupuncture treatment was performed bilaterally. Needles were inserted superficially and left in situ without stimulation for two minutes. No attempt was made to achieve de qi sensation. Thereafter an ID block was given. In research it is normally accepted practice to compare a technique under investigation with a well defined standard treatment. However, acupuncture is different in this respect, as patients will know if needles are inserted or not. In an attempt to overcome this problem three groups were chosen, local segmental, heterosegmental and a control group. We chose those points because the point LI4 has been suggested as having a specific effect in dentistry as a pain relieving point.⁴⁰ In the segmental acupuncture group, three points were used on the treated site

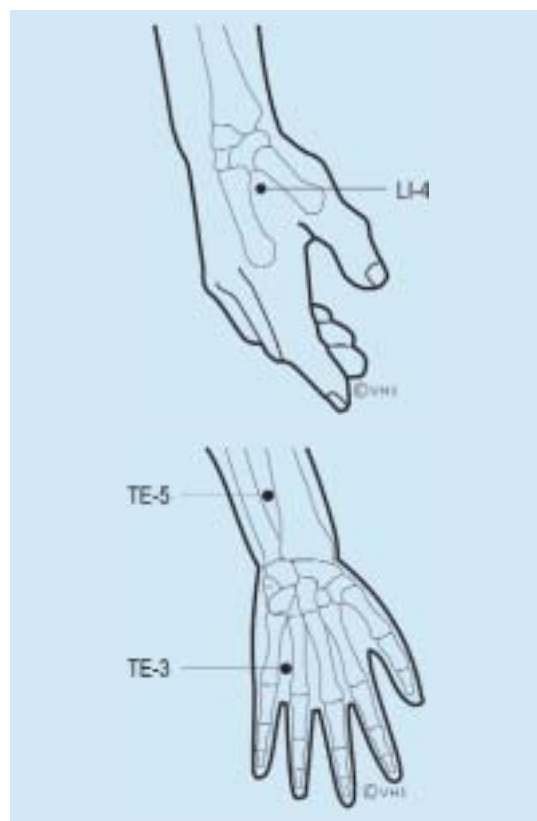


Figure 2 Acupuncture points used in group II (heterosegmental superficial acupuncture)

only. In the heterosegmental group, two points on each hand were chosen.

Group III: The control group received only the standard treatment, an ID block, with no acupuncture.

Two minutes after insertion of the needles a regional ID block with Prilocaine Hydrochloride 1.8ml. was given as described by Haglund.⁵⁰ Disposable acupuncture needles (Seirin) 0.20mmx15mm were used in all cases. In all cases prilocaine hydrochloride 3% octapressin (Astra) were used via 27G needles. Syringe needles 27G (0.4x35mm), morita turble injection with standard self-aspirating dental injection syringe Aspject®. In the case of insufficient analgesia, the practitioner (MB) was allowed to give additional anaesthesia, and this would be recorded.

Statistical Considerations

A preliminary test has shown that the onset time of local anaesthesia was reduced by 50%. Based on this preliminary result, a study including 10 patients in each group would have a power of 90% at the 5% significant level. Krauskal-Wallis analysis of variance was used to compare group medians. The level of significance was taken at $p < 0.05$.

Results

Summary results are given in table 1. The onset time of a local analgesia was 62 seconds after acupuncture was administered segmentally, compared to 115 seconds taken when acupuncture was given extra-segmentally. The time taken to achieve sufficient analgesia in the group who received an ID block only was 119 seconds. The

total amount of prilocaine hydrochloride given was in all cases 1.8 ml and no patient needed any supplement of local anaesthesia. No adverse effects were reported in any cases.

The data are illustrated graphically in the boxplots in figure 3. Each box represents the extent of the 'middle half' of the data, the median is indicated by a horizontal line and the lines extending from the boxes indicate the general extent of the values. It is apparent that all three samples have a skewed distribution (the means are consistently higher than the medians). For this reason, noting also the relatively small numbers of subjects, it is appropriate to use non-parametric statistical analyses rather than methods relying on assumptions of normality.

Statistical Analysis

A non-parametric analysis of variance to compare the medians of the three groups gives a value of the Kruskal-Wallis statistic of 6.95, $p = 0.027$ (exact calculation, SPSS release 10.1.4). This indicates substantial evidence of differences between the three groups. Examination of the summary statistics in Table 1 and the boxplots in Figure 3, shows that the major difference is that the median of the times to anaesthesia of the segmental acupuncture group is substantially lower than the heterosegmental superficial acupuncture group and the non-acupuncture control group, but there is little difference between these latter two. This is confirmed by pairwise Mann-Whitney tests which give p-values as follows: segmental acupuncture vs. heterosegmental acupuncture ($p = 0.015$), acupuncture vs. control ($p = 0.032$), and

Table 1 Time in seconds from injection of a regional block until sufficient anaesthesia was achieved.

Group	Mean	Median	SD	Range
I (segmental acupuncture)	62.2	58.5	21.9	75.0 (30-105)
II (heterosegmental superficial acupuncture)	114.5	112.5	54.1	175.0 (35-210)
III (control)	119.0	90.0	74.9	230.0 (55-285)

Group I (n=10) received segmental acupuncture within the innervation of the trigeminal nerve 2 minutes prior to giving an ID block.

Group II (n=10) received heterosegmental superficial acupuncture within the innervation of C6 – T1 two minutes prior to giving an ID block.

Group III (n=10) received an ID block only.

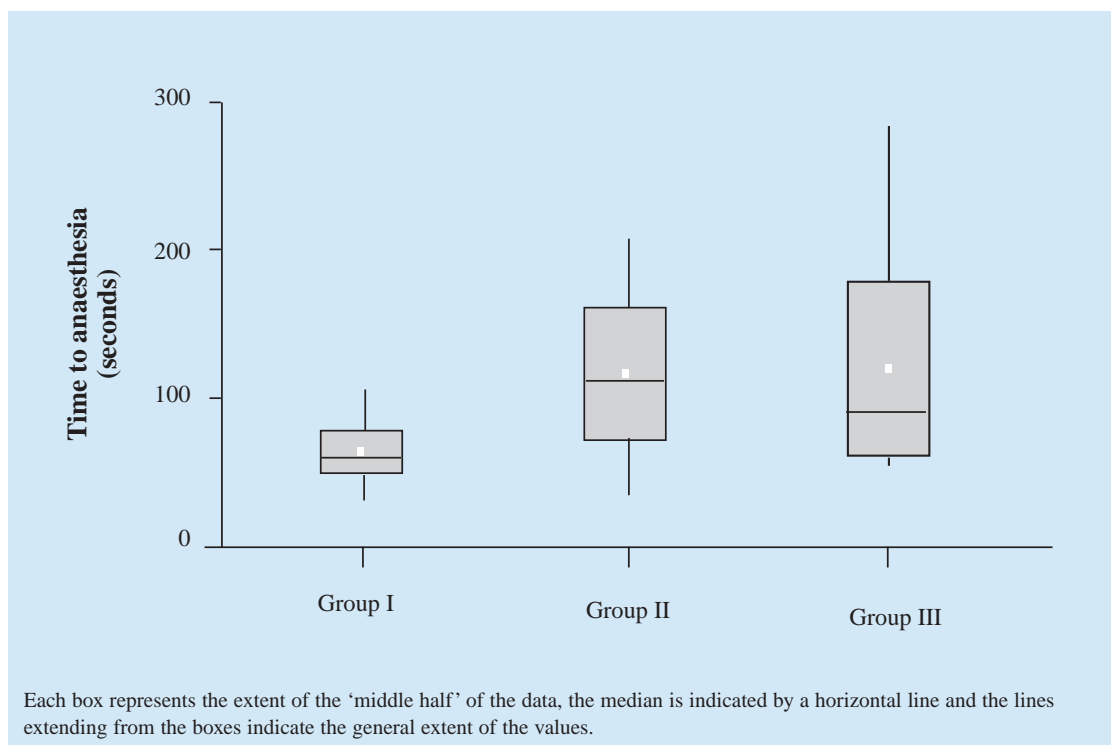


Figure 3 Boxplots of results

heterosegmental vs. control ($p=0.84$). In all cases the p values are obtained by exact calculations.

The data provide good evidence that the time to achieve sufficient anaesthesia in the segmental acupuncture group is lower than for either the heterosegmental superficial acupuncture group or the non-acupuncture control group. There is no evidence of a systematic difference in these times between these latter two groups.

Discussion

The aim of this study was to investigate if it was possible to reduce the onset time of local anaesthesia if acupuncture was given segmentally, prior to the ID block. In this pilot study we have shown that the onset time of a local anaesthetic is reduced to 62 seconds after acupuncture when administered segmentally, compared to 115 seconds when acupuncture was given heterosegmentally and 119 seconds in a non-acupuncture group. The onset time for regional anaesthesia following the administration of prilocaine hydrochloride is described in the literature as between 2.6 minutes,⁵¹ and 2 minutes,⁵² which is similar to the onset time found in the group treated extra-segmentally and in the non-acupuncture control group.

Borzecki found that the induction time before sufficient anaesthesia was achieved varied between

10 and 50 minutes,⁹ and Lee demonstrated sufficient anaesthesia after acupuncture in 16 out of 20 cases for various dental procedures, including exodontias, after three minutes of needle stimulation.⁸ In both studies, manual stimulation was used. In our study, it was not the intention to achieve an anaesthesia, but only to investigate the onset time.

In the two studies by Borzecki and Lee, local acupuncture points such as EX1, ST2, ST6 and ST7 were used.^{8,9} Moreover, distant points such as LI4 and ST44 were used. Regarding the points EX1 and ST2, they are normally used for treating sinusitis.⁴⁹ However, Andersson showed that electrical stimulation of LI4 and ST2 was able to increase the pain threshold in the teeth.⁴⁰ Regarding the points ST6 and ST7, they are both considered to have an effect in treatment of dental pain.⁴⁹ In our study the points were SI19, ST5 and ST6, all points which are believed to have a specific effect in dentistry.⁴⁹

The decisions by Borzecki and Lee to use the distant points LI4 and ST44 were probably based on tradition rather than neurophysiology.^{8,9} The teeth are innervated by the trigeminal nerve. The points LI4 and ST44 are located in C8/T1 and S2/3 spinal segment respectively, and it is difficult to understand how these points can have a

significant effect on the teeth. A possible explanation, is that in the study by Andersson electrical stimulation was used, and the point LI4 was used as a reference electrode.⁴⁰ This view is supported by a later study by Andersson, who showed that the electrical stimulation of ST2 and LI20 had exactly the same effect as electrical stimulation of ST2 and LI4, but interestingly, stimulation of the hands alone at LI4 did not change the pain threshold.⁴¹

In our study no distant points were used in the group that received segmental acupuncture, yet we demonstrated that the onset time was 62 seconds compared with the two groups, 115 and 119 respectively.

In the group which received heterosegmental superficial acupuncture, needles were inserted superficially in the points LI4 and TE3 and no effect was noticed. This finding is supported by Andersson, who did not find an effect after electrical stimulation of LI4 alone.⁴¹

The full rationale of acupuncture's mode of action is still not fully understood. However, it has been shown that acupuncture activates small myelinated nerve fibres in muscles, which send impulses to the spinal cord and then activate the midbrain and pituitary-hypothalamus. It has been shown that enkephalin, beta-endorphin, dynorphin, serotonin and noradrenalin are involved in this process.⁴⁹

The explanation for the reported reduction in the onset time is not obvious. We know that acupuncture can increase the pain threshold.^{40;41;45} It has been shown that the time needed for achieving sufficient anaesthesia after an ID block, is constant between 2 and 2.6 minutes.^{52;51} Lee was able to produce sufficient anaesthesia for dental procedures in 12 out of 16 patients.⁸

By giving a local anaesthetic, the pain threshold is gradually increased until a critical value is reached and the region is totally anaesthetised. By giving acupuncture before a local anaesthetic some or all nerve fibres are partly anaesthetised (the pain threshold is increased, probably because of a pre-synaptic inhibition) and one must expect that this reduces the time it takes to reach the critical value (total anaesthesia). This is probably the most logical explanation for our observation. However, other mechanisms might be involved as well. Blom was able to demonstrate an increase in

the blood flow locally, probably via vasoactive intestinal polypeptide (VIP), and one might speculate whether this increased blood flow could accelerate the uptake of the local anaesthetic or accelerate the transport of the injected local anaesthetic to the nerve endings.³³ However, our findings needed to be repeated in a study including objective measurements. If our findings in reducing the onset time from an ID block are correct, and if the nerve fibres are partly anaesthetised by increasing the pain threshold, one might query whether the quantity of local anaesthetic required to reach the critical value (total anaesthesia) might be reduced. In our study the standard volume was 1.8 ml, but patients were advised that they could have a supplement if required. It was unnecessary to give a supplement of local anaesthetic in any of the cases.

Regarding the time of onset, one might question whether registration of pins and needles is the right variable to measure, yet this is the variable used by all dentists. As soon as the patient reports pins and needle, the dentist starts work. The ideal situation, of course would be a more objective measurement, and we are planning to reproduce the study using a pulp tester. However, we are not expecting that it would increase the validity of this study significantly, as all patients were tested with a drilling test before dental treatment was performed. No patients registered any pain during the drilling test, and the pins and needle sensation seems to be a reliable measure for sufficient anaesthesia.

We cannot comment whether the lack of blinding of the dentist influenced the results.

Conclusion

It appears from this pilot study that segmental acupuncture can accelerate the induction time after a regional ID block. No differences in the onset time were found between the group that received an ID block alone and the group that received heterosegmental superficial acupuncture. However, before the practical consequences of these findings can be assessed, further research is needed to clarify the following questions: Is the duration of the anaesthesia reduced, increased or unchanged after acupuncture? Is it possible to reduce the amount of local anaesthetic required to achieve optimal analgesia? Could

acupuncture enhance the effect of an insufficient regional block?

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Reference list

1. Thomas K.J, Nicholl J.P, Fall M. Access to complementary medicine via general practice. *Br J Gen Pract* 2001;51(462):25-30.
2. Lundeberg T. Peripheral effects of sensory nerve stimulation (acupuncture) in inflammation and ischemia. *Scand J Rehab Med, Suppl* 1993;29:61-86.
3. Dong J.T. Research on the reduction of anxiety and depression with acupuncture. *Am J Acupunct* 1993; 21(4):327-30.
4. Brandwein A. Corcos J. Acupuncture analgesia in dentistry. *Am J Acupunct* 1975;3(3):241-7.
5. Brandwein A. Corcos J. Cutaneous and transcutaneous electroacupuncture. *Am J Acupunct* 1976;4(2):161-4.
6. Brandwein A. Corcos J. Acupuncture analgesia in dentistry: I. Treatment of asymptomatic dental caries. *Am J Acupunct* 1976;4(3):269-75.
7. Brandwein A. Corcos J. Acupuncture analgesia in dentistry: II. Pulp exposure and root canal. *Am J Acupunct*. 1976;4(4):370-5.
8. Lee M.H, Teng P, Zaretsky H.H, Rubin M. Acupuncture anesthesia in dentistry. A clinical investigation. *NY State Dent J* 1973;39(5):299-301.
9. Borzecki M, Borzecki M. Acupuncture applied as a method of analgesia for oral surgery with particular reference to dental operations. *Anaesth Resusc Intensive Ther* 1975;3(3):251-7.
10. Hansson P, Ekblom A, Thomsson M, Lundeberg T. Is acupuncture sufficient as the sole analgesic in oral surgery? *Oral Surg Oral Med Oral Pathol* 1987;64(3):283-6.
11. Jensen S.B, Jensen J.S, Jensen L.B. [Acupuncture analgesia]. *Tandlaegebladet* 1973;77(7):695-702.
12. Taub H.A, Beard M.C, Eisenberg L, McCormack R.K. Studies of acupuncture for operative dentistry. *JADA*. 1977;95(3):555-61.
13. Taub H.A, Mitchell J.N, Stuber F.E, Eisenberg L, Beard M.C, McCormack R.K. Analgesia for operative dentistry: a comparison of acupuncture and placebo. *Oral Surg Oral Med Oral Pathol* 1979;48(3):205-10.
14. Ekblom A, Hansson P, Thomsson M, Thomas M. Increased postoperative pain and consumption of analgesics following acupuncture. *Pain* 1991;44(3):241-7.
15. Lao L, Bergman S, Anderson R, Langenberg P, Wong R.H, Berman B. The effect of acupuncture on postoperative oral surgery pain: a pilot study. *Acupunct Med* 1994;12(1):13-7.
16. Lao L, Bergman S, Langenberg P, Wong R.H, Berman B. Efficacy of Chinese acupuncture on postoperative oral surgery pain. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 1995;79(4):423-8.
17. Lapeer G.L, Biedermann H.J, Hemsted J.J. Acupuncture analgesia for postoperative dental pain. *J Can Dent Assoc* 1987;53(6):479-80.
18. Scarsella S, Palattella A, Mariani P, Palattella G. Electroacupuncture treatment of post-operative pain in oral surgery. *Acupunct Med*. 1994;12(2):75-7.
19. Sung Y.F, Kuntner M.H, Cerine F.C, Frederickson E.L. Comparison of the effects of acupuncture and codeine on postoperative dental pain. *Anesth Analg* 1977;56(4):473-8.
20. Hansen P.E, Hansen J.H. [Acupuncture management of chronic facial pain. A double-blind cross-over study]. *Ugeskr Laeger* 1981;143(44):2885-7.
21. Johansson A, Wagersten C, Wenneberg B, Haraldson T, Carlsson G.E. [Acupuncture treatment for chronic pain in the face and head]. *Tandlakartidningen*. 1987;79(4):140-4.
22. Corcos J, Brandwein A. Treatment of temporomandibular joint pain by acupuncture. *Am J Acupunct* 1976;4: 157-60.
23. Ho V, Bradley P. Acupuncture for resistant temporomandibular joint dysfunction syndrome. *Acupunct Med*. 1992;10(2):53-5.
24. Johansson A, Wenneberg B, Wagersten C, Haraldson T. Acupuncture in treatment of facial muscular pain. *Acta Odontol Scand* 1991;49(3):153-8.
25. List T, Helkimo M. Acupuncture in the treatment of patients with chronic facial pain and mandibular dysfunction. *Swed Dent J* 1987;11(3):83-92.
26. List T, Helkimo M, Andersson S, Carlsson G.E. Acupuncture and occlusal splint therapy in the treatment of craniomandibular disorders. Part I. A comparative study. *Swed Dent J* 1992;16(4):125-41.
27. List T, Helkimo M. Acupuncture and occlusal splint therapy in the treatment of craniomandibular disorders. A 1-year follow-up study. *Acta Odontol Scand* 1992;50(6):375-85.
28. Raustia A.M, Pohjola R.T, Virtanen K.K. Acupuncture compared with stomatognathic treatment for TMJ dysfunction. Part I: a randomized study. *J Prosthet Dent* 1985;54(4):581-5.
29. Raustia A.M, Pohjola R.T, Virtanen K.K. Acupuncture compared with stomatognathic treatment for TMJ dysfunction. Part II: components of the dysfunction index. *J Prosthet Dent* 1986;55(3):372-6.
30. Raustia A.M, Pohjola R.T. Acupuncture compared with stomatognathic treatment for TMJ dysfunction. Part III: effect of treatment on mobility. *J Prosthet Dent* 1986;56(5):616-23.
31. Blom M, Dawidson I, Angmar-Månsson B. The effect of acupuncture on salivary flow rates in patients with xerostomia. *Oral Surg Oral Med Oral Pathol* 1992;73(3):293-8.
32. Blom M, Dawidson I, Angmar-Månsson B. Acupuncture treatment of xerostomia caused by irradiation of the head and neck region: case reports. *J Oral Rehabil* 1993;20(5):491-4.
33. Blom M, Lundeberg T, Dawidson I, Angmar-Månsson B. Effects on local blood flux of acupuncture stimulation used to treat xerostomia in patients suffering from Sjögren's syndrome. *J Oral Rehabil* 1993;20(5): 541-8
34. Blom M, Dawidson I, Fernberg J.O, Johnson G, Angmar-Månsson B. Acupuncture treatment of patients with radiation-induced xerostomia. *Eur J Cancer B Oral Oncol* 1996;32B(3):182-90.
35. List T, Lundeberg T, Lundström I, Lindström F, Ravald N. The effect of acupuncture in the treatment of patients with primary Sjögren's syndrome. *Acta Odontol Scand* 1998;56(2):95-9.

36. Sokol DJ, Sokol S, Sokol CK. A review of noninvasive therapies used to deal with anxiety and pain in the dental office. *J Am Dent Assoc* 1985;110(2):217-22.
37. Fiske J, Dickinson C. The role of acupuncture in controlling the gagging reflex using a review of ten cases. *Br Dent J* 2001;190(11):611-3.
38. Ernst E, Pittler MH. The effectiveness of acupuncture in treating acute dental pain: a systematic review. *Br Dent J* 1998;184(9):443-7.
39. Rosted P. The use of acupuncture in dentistry: a review of the scientific validity of published papers. *Oral Dis* 1998;4(2):100-4.
40. Andersson S.A, Ericson T, Holmgren E, Lindquist G. Electro-acupuncture. Effect on pain threshold measured with electrical stimulation of teeth. *Brain Res* 1973;63:393-6.
41. Andersson SA, Holmgren E, Roos A. Analgesic effects of peripheral conditioning stimulation II. Importance of certain stimulation parameters. *Acupunct Electrother Res* 1977; 2(3-4):237-46.
42. Bakke M. Effect of acupuncture on the pain perception thresholds of human teeth. *Scand J Dent Res* 1976;84(6):404-8.
43. Chapman CR, Gehrig JD, Wilson ME. Acupuncture compared with 33 per cent nitrous oxide for dental analgesia: a sensory decision theory evaluation. *Anaesthesiology* 1975;42(5):532-7
44. Chapman CR, Wilson ME, Gehrig JD. Comparative effects of acupuncture and transcutaneous stimulation on the perception of painful dental stimuli. *Pain* 1976;2(3):265-83.
45. Chapman CR, Chen AC, Bonica JJ. Effects of intrasegmental electrical acupuncture on dental pain: evaluation by threshold estimation and sensory decision theory. *Pain* 1977;3(3):213-27.
46. Chapman CR, Benedetti C, Colpitts YH, Gerlach R. Naloxone fails to reverse pain thresholds by acupuncture: acupuncture analgesia reconsidered. *Pain* 1983;16(1):13-31.
47. Ha HC, Tan EC. Effect of acupuncture on pain threshold measurement of tooth pulp in the monkey. *Am J Chin Med* 1982;10(1-4):92-100.
48. Oleson TD, Kirkpatrick DB, Goodman SJ. Elevation of pain threshold to tooth shock by brain stimulation in primates. *Brain Res* 1980;194(1):70-95.
49. Stux G, Pomeranz B. *Acupuncture Textbook and Atlas*. Berlin: Springer-Verlag; 1987. p. 1-34.
50. Evers H, Haegerstam G. *Håndbog i Odontologisk Lokalanalgesi*. Copenhagen: Schultz Medical Information; 1981.
51. Bedi A, Carabine U. Peribulbar anaesthesia: a double-blind comparison of three local anaesthetic solutions. *Anaesthesia* 1999;54(1):67-71.
52. Chng HS, Pitt Ford TR, McDonald F. Effects of prilocaine local anaesthetic solutions on pulpal blood flow in maxillary canines. *Endod Dent Traumatol* 1996; 12(2):89-95.