

Evaluating Anxiety and Pain in Patients Receiving a Local Anaesthetic Injection: Traditional Syringe *versus* a Computer-Controlled Local Anaesthetic Delivery System

SUMMARY

Aim: To evaluate patient anxiety and pain experience to dental injection delivered prior to an extraction and to compare the measured results for 2 different local anaesthetic delivery systems.

Material and Methods: 100 patients referred for tooth extraction were included in the study. 50 patients were injected with a traditional syringe injection, and 50 with a computer-controlled local anaesthetic delivery system (the WAND®). Anxiety levels before the injection were measured using the Spielberger's State-Trait Anxiety Inventory (STAI). Individual pain experience was recorded by means of a visual analogue scale (VAS). Systolic and diastolic blood pressure, pulse rate and oxygen saturation levels were recorded for each patient. The Mann Whitney U, Pearson's correlation analyse, χ^2 test and Kruskal-Wallis test were used to determine differences in response between the 2 types of injection delivery.

Results. Statistically significant differences were recorded for both, STAI and VAS. Smaller changes in systolic and diastolic blood pressure, pulse rate and oxygen saturation were recorded following injection for the computer-controlled local anaesthetic delivery system group; however, the differences were not statistically significant.

Conclusions. The use of a computer-controlled local anaesthetic delivery system for infiltration injection prior to extraction resulted in a lower mean anxiety level for a group of 50 patients. Significantly lower pain response was recorded by the group of patients injected with the computer-controlled local anaesthetic delivery system when compared to a group injected with a traditional syringe.

Keywords: Anxiety; Local Anaesthesia; Blood Pressure; Pulse Rate; Oxygen Saturation

Oktay Dulger¹, Meltem Koray², Sinan Soley², Mehmet Yaltirik², Wayne P. Williams³, Esra Somturk⁴, Nazan Ogunc⁵

¹Department of Endodontics, Faculty of Dentistry, University of Istanbul

²Department of Oral Medicine and Surgery, Faculty of Dentistry, University of Istanbul

³Department of Restorative Dentistry, Faculty of Dentistry, University of Pretoria, South Africa and private prosthodontic practice, London, UK

⁴Department of Oral Diagnosis and Radiology, Faculty of Dentistry, University of Istanbul

⁵Department of Psychiatry, Faculty of Medicine University of Istanbul Istanbul, Turkey

ORIGINAL PAPER (OP)

Balk J Stom, 2007; 11:100-104

Introduction

Despite monumental clinical and technological advances that have led to the often used phrase of "modern dentistry" and of late, "dentistry in the new millennium" - anxiety and even fear remain as a common experience that patients communicate to their dentist prior to dental treatment. The mere sight of the anaesthetic needle, as well as the sight, sound and feeling of the dental drill, have been described as stimuli associated with dental anxiety¹. Several studies have examined the prevalence,

cause, symptoms and consequence of anxiety related to dental treatment¹⁻⁴.

Patients commonly report a fear of the dental injection⁵⁻⁷. This fear can be a significant impediment to dental care and may result in patients either delaying and even avoiding essential dental treatment. The use of general anaesthesia, sedation, hypnosis and a host of other behavioural techniques offer an useful alternative in selected cases. Despite the availability of these techniques, it is interesting to note the findings in a recent publication by Hill and Walker⁸. This study assessed stress in patients undergoing extraction of wisdom teeth and the authors

concluded that local anaesthesia is the preferred mode of pain control for patients who express no strong preference for type of anaesthetic.

An elevated state of anxiety prior to oral surgery is common and may be associated with an increased level of pain during delivery of the local anaesthetic injection. Elevated anxiety and intraoperative stress can be measured by specific means⁹. STAI (Spielberger's State-Trait Anxiety Inventory) distinguishes between anxiety as a general aspect of personality (STAI-T, trait anxiety) and anxiety as a response to a specific situation (STAI-S, state anxiety)¹⁰.

Hypoxia is a potential complication related to dental surgery and the condition requires a clinician to carefully monitor patient vital signs, specifically pulse rate and blood oxygen content. Pulse oximetry is a non-invasive technique allowing immediate, accurate and continuous monitoring of these parameters¹¹. Mean systolic and diastolic blood pressure can increase during dental surgery and it has been reported that dental anxiety and fear can be directly related to such an increase¹².

Pain is commonly measured and described by using the visual analogue scales (VAS) and although this provides a useful method of describing pain experience, it does not assess the multidimensional nature of this complex stimulus. More sophisticated techniques for this measurement include analysis of the sensory, affective and cognitive components of pain, as described in a number of scientific studies¹³⁻¹⁵.

The **aim** of this study was to evaluate patient anxiety and pain experience to a dental injection delivered prior to an extraction and to compare the measured results for traditional syringe and computer-controlled local anaesthetic delivery systems.

Material and Methods

100 healthy caucasian patients who were referred to the Department of Oral Medicine and Surgery, Faculty of Dentistry, University of Istanbul for mandibular anterior tooth extraction participated in the study. Each patient was informed that 2 local anaesthetic injection techniques were being studied: group 1 - a computer-controlled (using the WAND® - Milestone Scientific Inc, Livingston NJ, USA) (mean age=41.34±12.60; 23 female, 27 male) and group 2 - traditional syringe local anaesthetic delivery systems (using TRIXYLEST aspiration syringe, ESPE GmbH, Germany) (mean age=36.06±14.85; 26 female, 24 male). Each patient would receive only one or the other technique and selection was done randomly.

No patient had previously received a local anaesthetic injection using the computer-controlled and all patients had previously experienced a traditional syringe injection. Each patient completed the STAI survey sheet prior

to treatment. Physiologic stress was measured by the STAI-S and STAI-T. This self-reported questionnaire, comprised of 40 statements, 20 measuring state and 20 trait-anxiety, asks subjects to imagine they are to undergo dental treatment. Items are scored on 4-point scales, with response categories varying according to the nature of the question. This questionnaire has been tested extensively for reliability and validity¹⁰. STAI values were recorded before the injection.

Using a sterile cotton applicator, topical anaesthetic gel in the form of 20% benzocaine (Topex, Sultan Dental Products, Englewood NJ, USA) was applied for 1-minute at each of the 2-sites to be injected. Xylestesin (2% lidocaine hydrochloride and 0.048 mg epinephrine - ESPE Dental AG, Germany) was used for all injections. The anaesthetic cartridge was held in the hand of the operator for 2-minutes (to warm the solution to body temperature) before applicator loading.

Each patient received 2 suprapariosteal infiltration injections. Buccal injections were delivered first. Approximately 0.5 ml of anaesthetic solution was delivered into the buccal sulcus of the anterior mandible between the first incisor and the canine at a point approximately 10 mm inferior to the gingival margin. Directly following the buccal infiltration, a second injection of approximately 0.5 ml was delivered at the corresponding site on the lingual aspect of the mandible. All injections were delivered by the same operator.

Pain was measured using a visual analogue scale (VAS). Overall pain was assessed by using a 200 mm horizontal, ungraded visual analog scale onto which patients were asked to place a marking. The left side was marked "no pain" and the right side marked "worst pain imaginable". A 10-point verbal rating was also used and patients were asked to give a value to their pain experience, zero being "no pain" and 10 being "worst pain imaginable". VAS values were recorded after the injection and gave an indication of the pain experience for individual patients in each group.

Systolic and diastolic blood pressure was recorded immediately before the injections for each patient (ERKA blood-pressure-meter, Bad Tölz, Germany). Blood pressure measurements were recorded by a second operator. Pulse oximeters produce audible and visible signals to alert the practitioner to changes in pulse rate (bpm) and oxygen saturation (%SaO₂) during dental or surgical procedures. Pulse rate and oxygen saturation was recorded immediately before the injections for each patient (3304 Quick Reference, BCI-International Model 71200A1, Waukosha Wisconsin, USA). Readings were recorded by the second operator with the pulse oximeter placed on the patients right index finger.

Statistical analysis was applied to all the results obtained. The Mann Whitney U, Pearson's correlation analyse, χ^2 test and Kruskal-Wallis test were used to compare STAI and VAS values for each of the 2 injection

systems, to evaluate differences in blood pressure before injection, as well as to test for statistical significance for differences in pulse rate and oxygen saturation before the injections.

Results

The anxiety, pain, blood pressure, pulse rate and oxygen saturation levels of 100 patients were analysed. As indicated in table 1, the mean value of VAS from in group 1 were 1.41 (\pm 0.67) and 0.91 (\pm 0.57) in group 2 ($p < 0.001$). The mean STAI-S score of group 1 were 53.76 (\pm 5.01) and 71.34 (\pm 6.67) in group 2 ($p < 0.001$). The mean STAI-T score of the group 1 were 43.98 (\pm 56.1) and 43.74 (\pm 6.21) in group 2 ($p > 0.05$). A statistically significant difference in mean values was found for both the STAI-S as well as for the VAS. The STAI-T serves as a control in this study and the close proximity in values between the 2 groups confirms the alikeness of anxiety as a general aspect of personality between the 2 groups studied.

Table 1. Mean (\pm SD), median and Z values for STAI-S, STAI-T and VAS (n=50)

		Mean(\pm SD)	Median	Z value
STAI-S	Group 1	57.76 \pm 5.01	58.00	7.53 $p > 0.001$
	Group 2	71.34 \pm 6.67	75.00	
STAI-T	Group 1	43.98 \pm 5.61	43.00	0.38 $p > 0.05$
	Group 2	43.74 \pm 6.21	42.00	
VAS	Group 1	1.08 \pm 0.72	1.00	4.62 $p > 0.001$
	Group 2	2.58 \pm 1.71	2.00	

As indicated table 2, the mean systolic blood pressure of group 1 were 1.23 mmHg (\pm 0.68) and 1.37 mmHg (\pm 0.41) in group 2 ($p > 0.05$). The mean diastolic blood pressure of the group 1 were 1.06 mmHg (\pm 0.58) and 1.17 mmHg (\pm 0.63) in group 2 ($p > 0.05$). The mean pulse rate of group 1 were 1.25 bpm (\pm 0.18) and 1.41 bpm (\pm 0.73) in group 2 ($p > 0.05$). The mean oxygen saturation of the group 1 were 0.53% SaO₂ (\pm 0.05) and 0.60% SaO₂ (\pm 0.11) in group 2 ($p > 0.05$). Although the changes in blood pressure (systolic and diastolic), pulse rate and oxygen saturation measured before the injection were all smaller for the group injected with the computer-controlled local anaesthetic delivery system, these changes were not statistically significant. There were no statistically differences between sexes and groups ($\chi^2 = 0.36$; $p > 0.05$), similarly there were no stastically differences between ages and groups ($t = 1.91$; $p > 0.05$). There was no

correlation between age and anxiety levels (for STAI-S, $r = 0.17$ $p > 0.05$; for STAI-T $t = 0.008$, $p > 0.05$).

Table 2: Mean values (\pm SD) for differences in measurement before the injection: systolic and diastolic blood pressure, pulse rate and oxygen saturation (n=50)

Delivery system	Systolic BP (mmHg)	Diastolic BP (mmHg)	Pulse rate (bpm)	Oxygen saturation (% SaO ₂)
Group 1	1.23 (\pm 0.68)	1.06 (\pm 0.58)	1.25 (\pm 0.18)	0.53 (\pm 0.05)
Group 2	1.37 (\pm 0.41)	1.17 (\pm 0.63)	1.41 (\pm 0.73)	0.60 (\pm 0.11)

Discussion

Clinical observations with regard to pain and anxiety related to the dental injection are often reliant on subjective comments of patients, unsubstantiated claims by dental companies or by hopeful interpretations of results by dental clinicians. A need to scientifically measure both anxiety and pain related to a dental injection and the further need to investigate claims by manufacturers of new technology used for dental local anesthesia, prompted this study.

Recent trends in legislation and the general decline in acceptance of general anesthesia for routine dental procedures has heightend the awareness of patients to the use of local anesthesia. The wider acceptance and increased use of computer technology within the dental environment is obvious and the extension of micro-chip technology to the art and science of safe drug delivery should not be excluded.

Pain can result from the penetration of the needle through the tissue and from the first few drops anesthetic¹⁶. Topical anaesthetic is widely used to reduce the pain associated with dental needle insertion. Most patients are accustomed to having a topical agent before injections and they can taste and feel the effect on their soft tissue^{17,18}.

A highly significant statistical difference was found between the VAS values recorded for the 2 groups with the computer-controlled injected group, recording a mean VAS value of 1.08 as opposed to 2.58 for the group injected with the traditional syringe.

Claims have been made by a number of papers with regard to the WAND[®] and it's ability to reduced pain and anxiety. Unfortunately, few scientific tests have been conducted to confirm this. Krochak and Friedman¹⁵ reported that fear levels decreased significantly when the WAND[®] was used and the authors presumed that continued use of the system could lead to virtual elimination or at

least minimization of dental injection anxiety in most patients. According to Levato¹⁹ who treats large numbers of patients with dental anxiety and needle phobia, these patients, as well as children in his practice, derive the greatest benefit from the use of the WAND[®]. Hochman et al²⁰ in their comparative clinical study on 50 patients, reported that the WAND[®] was 2 to 3 times less painful than the traditional syringe injection and that 48 of 50 patients recorded a more comfortable injection with the WAND[®]. They concluded that there was an optimal flow rate of anaesthetic at which the perception of pain during an injection is minimized.

Lipp et al²¹ suggested that basic information prior to dental local anesthesia could be a useful method for reducing anxiety and improving a patient's confidence in the dentist or surgeon. Lackey⁸ concluded that the WAND[®] was a viable alternative to traditional local anaesthetic administration and that this system reduced fear and anxiety in dental patients. Saloum et al²² suggested that the WAND[®] generally seemed to provide less painful injections; however, the mean ratings of pain were mostly mild pain for both injections.

To the contrary, Goodell et al²³ found that use of a conventional atraumatic syringe injection technique was superior to the WAND[®]. This study reported reduced pain perception, increased procedure tolerance, and reduction in post-injection dental anxiety when the conventional syringe was used. It should be pointed out that this study included predominantly males employed in the military service, and that different results could be expected in a more randomly selected group.

The objective of this study was thus to test some of these claims scientifically. The objective did not include a test for anaesthetic efficacy and as such this was not established for either of the injections.

Individual changes in blood pressure and pulse rate can be initiated by pain, anxiety and fear related to the dental injection. For adults, a diastolic pressure below 85 mmHg is considered to be normal and between 85 and 89 as high-normal. A systolic pressure below 130 mmHg is regarded as normal and between 130 and 139 mmHg as high-normal. Although both systolic and diastolic blood pressure increased slightly (high-normal), the increase in the traditional syringe group was slightly higher, but this was not statistically significant.

A mean increase in pulse rate following injections for both groups in this study was noted but the difference between the 2 groups was not statistically significant. It was also noted that the mean pulse rate for women was 80 and that for men 75.

Pulse oximeters have generally been found to be accurate between a range of 70 and 100 percent oxygen saturation (% SaO₂). In this study oxygen levels were between 98-100. Again, there was no statistically significant difference between the two groups.

Conclusions

Within the limitations of this study, the following conclusions are made:

Anxiety levels (STAI-S) measured before infiltration injection using a computer-controlled delivery system (the WAND[®]) were significantly lower than those measured when using a traditional syringe injection;

Differences in change (immediately before and directly after injection) for blood pressure (systolic and diastolic), pulse rate and oxygen saturation were smaller for the WAND[®] group, but differences were not statistically significant;

Pain response (VAS) to the WAND[®] was significantly lower than to that recorded for the traditional syringe group.

References

1. Kleinknecht RA, Klepac RK, Alexander LD. Origins and characteristics of dental fear. *J Am Dent Assoc*, 1973; 86:842-848.
2. Stouthard MEA, Hoogstraten J. Prevalance of dental anxiety in the Netherlands. *Community Dent Oral Epidemiol*, 1990; 18:139-142.
3. Berggren U, Meynert TG. Dental fear and avoidance: causes, symptoms, and consequences. *J Am Dent Assoc*, 1984; 109:247-251.
4. Borea G, Montebugnoli L, Braiato A. The effect of patient anxiety on the cardiovascular stress of dentists. *Quintessence Int*, 1989; 20:853-857.
5. Milgrom P, Weinstein P, Getz T. Treating fearful dental patients. A patient management handbook. 2.nd Ed. Seattle: University of Wasington, 1995; p 14-20.
6. Kroeger R. Managing the apprehensive dental patient. Cincinnati: Heritage Communication, 1987; p 23-30.
7. Jeffcoat MK, Geurs NC, Magnusson I, MacNeill SR, Mickels N, Roberts F, Robinson P, Salamati A, Yukna R. Intrapocket anesthesia for scaling and root planing: results of a double-blind multicenter trial using lidocaine prilocaine dental gel. *J Periodontol*, 2001; 72(7):895-900.
8. Hill CM, Walker RV. Salivary cortisol determinations and self-rating scales in the assessment of stress in patients undergoing the extraction of wisdom teeth. *Br Dent J*, 2001; 191(9):513-515.
9. Fox E, O'Boyle C, Berry H, McCreary C. Repressive coping style and anxiety in stressful dental surgery. *Br J Med Psychol*, 1989; 62(Pt4):371-380.
10. Spielberger C, Gorsuch R, Lushene R. STAI manual for the State-Trait Anxiety Inventory. Palo Alto, CA: Consulting Psychologists Press, 1983.
11. Gandy SR. The use of pulse oximetry in dentistry. *J Am Dent Assoc*, 1995; 126(9):1274-1276.
12. Halstead CL, Blozis GG, Drinnan AJ, Gier RE. Physical evaluation of the dental patient. St. Louis: The CV Mosby Co, 1982.

13. Newton JT, Buck DJ. Anxiety and pain measures in dentistry: a guide to their quality and application. *J Am Dent Assoc*, 2000; 131:1449-1457.
14. Ramamurty S, Rogers JN. Pain management. Mosby-Year Book Inc, 1993; p 12.
15. Krochak M, Friedman N. Using a precision-metered injection system to minimize dental injection anxiety. *Compend Contin Educ Dent*, 1998; 19:137-148.
16. Keller BJ. Comparison of the effectiveness of two topical anesthetics and a placebo in reducing injection. *Hawaii Dent J*, 1985; 16:10-11.
17. Ram D, Petrez B. Administering local anesthesia to paediatric dental patients current status and prospects for the future. *Int J Pediatr Dent*, 2002; 12(2):80-89
18. Keogh E, Hatton K, Ellery D. Avoidance versus focussed attention and the perception of pain: differential effects for men and women. *Pain*, 2000; 85:225-230.
19. Levato C. Giving the Wand a shot. *Dental Practice & Finance*, 1998.
20. Hochman MN, Chiarello D, Lopatkin R, Pergola S. Computerized local anesthetic delivery vs. traditional syringe technique - Subjective pain response. *New York State Dental Journal*, 1997; 63:24-29.
21. Lipp M, Dick W, Daublander M, Bertram M. Different information patterns and their influence on patient anxiety prior to dental local anesthesia. *Dtsch Z Mund Kiefer Gesichtschir*, 1991; 15(6):449-457.
22. Saloum FS, Baumgartnar JC, Marshall G, Tinkle J. A clinical comparison of pain perception to the Wand and a traditional syringe. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*, 2000; 89:691-695.
23. Godell GG, Gallagher FJ, Nicoll BK. Comparison of a controlled injection pressure system with a conventional technique. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*, 2000; 90(1):88-94.

Correspondence and request for offprints to:

Meltem Koray
Istanbul University, Faculty of Dentistry
Department of Oral Medicine and Oral Surgery
Capa 34093, Istanbul
Turkey
E-mail: mkoray@istanbul.edu.tr