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Assessment of pain threshold during local anaesthetic administration in dental patients: A cross-sectional study

Ranina Mohd Rom[1], Daena Aisyah Binti Bahri Zaipul[2], Rethish Elangovan[3], Wan Maria Nabillah Ghani[4], Anitha Krishnan Pandarathodiyil[4]*

[1]Dept. of Discipline of Paediatric Dentistry, University of Otago, NewZealand.
[2]Dept. of Oral Pathology, Pergigian Dental Cottage, Jenjarom, Selangor, Malaysia.
[3]Dept. of Oral Pathology, Faculty of Dentistry, Manipal University College, Malaysia.
[4]Dept. of Oral Pathology, Faculty of Dentistry, SEGi University, Petaling Jaya Selangor, Malaysia.

Abstract

Background: Proper wound healing after dental extractions is crucial for minimizing complications and enhancing patient wellbeing. Oxygene® gel has been proposed as a potential adjuvant treatment aid to improve wound healing.
Objective: This study aimed to evaluate the effectiveness of Oxygene® gel in accelerating wound healing following tooth extractions through a comprehensive randomized controlled trial.
Materials and Methods: A split-mouth design was conducted on 27 patients who required dental extractions, with a total of 56 extraction sites at the Oral Surgery Clinic, Faculty of Dentistry, SEGi University. After extraction, participants applied Oxygene® gel to the socket site twice daily for two weeks. Wound healing was assessed on the 3rd and 14th days post-extraction using the Wound Healing Index, and statistical analysis was performed using the Wilcoxon Rank Test.
Results: The test group demonstrated significantly better wound healing than the control group on both the 3rd and 14th days post-extraction ($p = 0.035$ and $p = 0.021$, respectively), indicating a positive effect of Oxygene® gel in accelerating healing.
Conclusion: The study confirms that Oxygene® gel significantly enhances post-extraction wound healing when compared to sites without the gel. Thus, the findings answer the research question affirmatively and support the use of Oxygene® gel as an effective adjunct in post-extraction care protocols.

Keywords: Oxygene® gel, extraction socket, Wound healing, Oral healing adjunct

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1. Introduction

Pain is a complex and subjective experience with both sensory and emotional dimensions. It is an inescapable part of several dental procedures. Local anesthetics are extensively used to manage intraoperative and postoperative pain. However, the local anesthetic itself is a painful procedure.[1] The perception and tolerance of pain are governed by an interplay of physiological, neurological, and psychological factors, all of which can vary significantly among individuals.[2]

Numerous studies have explored how age, gender, and ethnicity influence pain threshold. Some authors report that aging is associated with an increased pain threshold, suggesting that older individuals may be less sensitive to pain[3-4] *Considerable attention* has been given to the physiological, neurological, and psychological changes that accompany aging. Intraoral soft tissues undergo age-related degeneration, including thinning of the oral mucosa, reduced keratinization, sclerosis of blood vessels, and diminished collagen content in connective tissues.[5] The oral mucosa in elderly individuals often appears thin, taut, and prone to blanching[6]. These structural changes may heighten tissue

*Corresponding author: Anitha Krishnan Pandarathodiyil
Email: dranithakrishnan@yahoo.com

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susceptibility to injury, thereby affecting pain perception during procedures such as local anesthesia.[5-6] Conversely, age-related alterations in the central and peripheral nervous systems may counteract these effects and lead to reduced pain sensation.[7] Psychologically, elderly individuals tend to report pain less frequently than younger patients.[8-9].

Gender-based differences in pain perception have also been documented in the literature. Many studies indicate that women typically have lower pain thresholds and are more susceptible to clinical pain compared to men.[10-14] These differences have been attributed to various biopsychosocial factors such as sex hormones, endogenous opioid activity, genetic predisposition, pain coping behaviors like catastrophizing, and socially constructed gender roles.[13] *Cultural beliefs further shape these gender* differences in pain response. According to the biocultural pain model, individuals learn and internalize pain behaviors from others within their ethnic or cultural group.[13-15]

Ethnic background is another determinant influencing pain perception. A meta-analysis revealed that pain tolerance and ratings differ significantly across ethnicities, with some groups—such as Asians, non-Hispanic Whites, and Hispanics—reporting higher pain intensity and lower tolerance compared to others.[16] Research exploring ethnic differences in pain sensitivity within the Asian continent remains limited. A Malaysian study reported that individuals from the Indian community demonstrated the highest pain scores,[17] whereas a Singaporean study found no statistically significant difference in pain thresholds among Malays, Chinese, and Indians.[18]

In clinical dentistry, pain assessment and its effective management are essential elements of patient care. Beyond providing technically competent treatment, it is imperative for clinicians to minimize pain during procedures such as local anesthetic administration. Accordingly, the present study was conducted to investigate the influence of age, gender, and ethnicity on patients' pain threshold following the administration of local anesthesia across various dental treatment procedures.

2. Materials and Methods

2.1. Study design

This study was a cross-sectional observational study conducted using convenience sampling. It aimed to assess the influence of age, gender, and ethnicity on patients' pain thresholds during the administration of local anesthesia (LA). The study received ethical approval from the Lincoln University College's Ethics Committee (Medical Ethics Approval Code: LUCethics/FDent/009/2017), and informed consent was obtained from all participants.

2.2. Study population

The study population consisted of Malaysian patients aged between 21 and 50 years who attended the Lincoln University College Dental Centre for various dental procedures requiring local anesthesia. Inclusion criteria included patients scheduled to receive LA, free from systemic diseases, and without any other pain-related complaints on the day of treatment. Patients were excluded if they required multiple LA injections, were on analgesic medication, or had any systemic illnesses.

2.3. Sample size and sample size estimation

Convenience sampling was employed due to logistical constraints. Although no formal power calculation was performed, an initial calibration exercise was conducted on ten patients to ensure consistency in LA administration and pain measurement, and the final analysis included all patients who met the inclusion criteria within the data collection period.

2.4. Methodology

Before injection, the mucosa was dried with sterile gauze and air, and a topical anesthetic (20% benzocaine gel, GumNumb™) was applied using a cotton-tipped applicator. The gel was left in place for exactly 60 seconds. Local anesthesia was administered using 2% lidocaine hydrochloride with adrenaline (1:80,000) (Inibsa Xilonibsa™) with a non-disposable breech-loading metallic syringe. Needle selection (long 27G or short 30G; Terumo®) depended on the injection site. The solution was delivered over approximately 2 minutes per 1.8 ml cartridge, at a rate of 1 ml per 60 seconds, to allow for tissue buffering and minimize pain.

LA techniques used included conventional inferior alveolar nerve blocks and infiltrations for mandibular teeth, and supraperiosteal infiltration for maxillary procedures. All LA injections were administered by a single calibrated operator to ensure uniformity. An independent examiner observed and recorded pain behavior using the Modified Behaviour Pain Scale (MBPS), and patients self-reported their pain using the Numeric Pain Rating Scale (NPRS) immediately after the injection.

2.5. Assessments

Two validated pain measurement tools were used:

Modified Behaviour Pain Scale (MBPS): An observational scale that evaluates facial expressions, upper and lower limb movements, torso posture, and vocalization. Each item was scored from 0 to 2, with higher scores indicating greater pain behavior. The total score was calculated by summing individual item scores (**Table 1**).

Numeric Pain Rating Scale (NPRS): A self-reported scale where patients rated their pain on a scale of 0 to 10, with

0 indicating no pain and 10 indicating the most severe pain imaginable (**Figure 1**).

2.6. *Statistical Analysis*

Descriptive statistics were used to summarize demographic and pain score data, including mean ± standard deviation, frequencies, and percentages. Differences in MBPS and NPRS scores by age, gender, and ethnicity were assessed using the Mann-Whitney U test and Kruskal-Wallis test. A p-value of <0.05 was considered statistically significant. All analyses were performed using SPSS version 28.0.

3. Results

A total of 156 patients were recruited for the study. (**Table 2**) shows the pain scores for the patients according to the types of injections received. The pain score was highest when patients were given maxillary infiltration injection (8.0 ±5.3), followed by mandibular block (7.9 ±4.9), while patients receiving mandibular infiltration injection reported the lowest pain score (6.3 ±SD = 5.0).

Table 1: The description and scoring of the modified behaviour pain scale (MBPS)

Item	Description	Score
Facial Expression	Relaxed, no particular expression	0
	Occasional grimace or frown	1
	Frequent to constant frown, eyes squeeze	2
Upper Limbs	Normal position relaxed	0
	Uneasy, restless, tense	1
	Total movement	2
Torso	Normal position	0
	Squirming, tense	1
	Arched, rigid, or jerking	2
Legs	Normal position relaxed	0
	Uneasy, restless, tense	1
	Kicking or legs drawn up	2
Vocalization	No abnormal sounds	0
	Groan, moaning, occasional complains	1
	Cry, screams, or frequent complaints	2

Table 2: Pain score when injecting LA based on the type of injection

Type of injection	n (%)	Minimum score	Maximum score	Mean ± SD
Maxillary Infiltration	80 (51.3)	0	26	8.0 (5.3)
Mandibular Block	63 (40.4)	1	24	7.9 (4.9)
Mandibular Infiltration	13 (8.3)	1	17	6.3 (5.0)

Table 3: Pain scores according to age group

Age group		Overall Mean Rank	
	Max. only	Mand. block	Mand. infiltration
< 31 (n = 102)	44.5	31.7	8.8
≥ 31 (n = 54)	32.3	32.5	4.2
Sig.	0.03	0.87	0.04

Table 4: Pain scores according to gender

Gender		Overall Mean Rank	
	Max. only	Mand. block	Mand. infiltration
Male (n = 72)	37.1	30.3	7.2
Female (n = 84)	43.3	33.6	6.9
Sig.	0.24	0.48	0.89

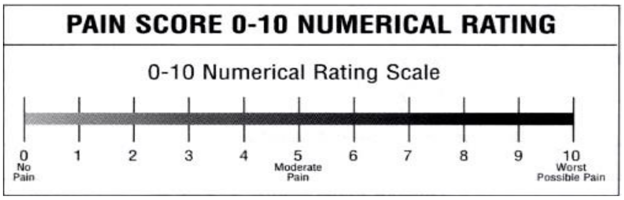

Figure 1: The scoring of the numeric pain rating scale (NPRS)

3.1. Pain score according to age group

The mean age of this study population was 30.5 years old (≈ 31). Patients were divided into two age groups for analysis using the mean age as the cut-off point. Group 1 is those who fall below the mean age (<31), whereas Group 2 consists of those who fall above the mean age, which is equal to or more than 31 years old. When analysis was stratified according to age group, it was observed that there was a significant difference in pain threshold (**Table 3**). Younger patients receiving maxillary and mandibular infiltration injections (pain scores of 44.5 and 8.8, respectively) had significantly lower pain thresholds as compared to older patients (pain scores of 32.3 and 4.2, respectively).

3.2. Pain score according to gender

Overall, males had a higher pain threshold for all three types of injections. However, this difference in pain threshold was not found to be statistically significant (**Table 4**)

3.3. Pain score according to ethnic groups

The Indian ethnic group had the highest pain score for maxillary (51.2) and mandibular infiltration injections (7.3). In contrast, the highest pain score for mandibular block was seen among the Indigenous group (44.7), followed by the Chinese (38.9). The Malays were shown to have the lowest pain score for maxillary (37.0) and mandibular block (27.3). However, for the mandibular infiltration, the Malays were observed to have the second-highest pain score (7.0), followed by the Chinese (6.7). Kruskal–Wallis test showed no significant difference in the pain score between the ethnic groups (**Table 5**).

Table 5: Pain scores according to ethnic groups

Ethnicgroup		**Overall Mean Rank**	
	Max. only	**Mand. block**	**Mand. infiltration**
Malay	37.0	27.3	7.0
Indian	51.2	7.9	7.3
Chinese	41.1	38.9	6.7
Indigenous	42.9	44.7	
Sig.	0.25	0.08	0.98

4. Discussion

Evaluation of the presence, severity, and persistence of pain following a nociceptive event is known as pain assessment.[22] Dental patients commonly receive infiltration anesthesia or nerve blocks depending on their treatment needs. The administration of LA involves puncturing the oral mucosal tissues and depositing the anesthetic solution into the underlying connective tissue, which, for apparent reasons, inflicts pain.[23] Various factors have been hypothesized to be linked with pain felt during the injection, which may influence the level of pain threshold. This study attempted to investigate the potential effects of age, gender, and ethnic background on the degree of pain threshold following the administration of LA.

Regardless of whether they had received maxillary or mandibular injections, we found in this study that younger participants had a much lower pain threshold, and older participants had a higher pain threshold. The findings of our current study are consistent with earlier studies, which reported increased pain threshold in older individuals compared to their younger counterparts[3-4] The age-related degenerative changes to the central and peripheral nerves and nerve endings could render *them* less sensitive to pain. These changes also extend to the dental apparatus's C and A delta fibers, which may influence pain threshold during LA administration in older adults.[7] Hence, it can be inferred that the neurological aspect has a dominant effect on the experience of pain despite the age-related degenerative physiological and anatomical changes that tend to increase pain sensitivity. Some studies have shed light on the psychological aspect of older people's pain tolerance. They reported that older people may assume pain to be an integral part of the aging process, and as a consequence, they prefer to handle the pain with various coping mechanisms rather than complaining for fear of burdening their caretakers.[8-9].

The study involved three different types of injections: supra-periosteal infiltration methods for the maxillary arch, localized infiltration methodologies for mandibular teeth, and standard inferior alveolar nerve block technique. Of these, maxillary injections demonstrated a significant difference in pain scores between the two age groups. Also, maxillary injections were perceived to be more painful than the mandibular ones. This may be explained by the anatomy of the hard palate, where the overlying mucosa is tightly adherent to the palatal bone and is highly innervated. As people age, alveolar bone resorption and possibly basal bone resorption occur, which could lead to the mucosa in the palate being less tacky than it is in younger adults.[23-24] Therefore, it is possible to administer LA with less force, causing the patients to feel less pain. Additionally, the degeneration and loss of nerve fibers in older individuals could contribute to the higher pain tolerance in this group.[7] Analyses of the difference in pain threshold between genders in our study yielded results consistent with previous studies.[11-14] Although our study showed differences in pain threshold among genders, with males exhibiting higher pain threshold than females, the difference was not statistically significant.

Some studies suggest biological and psychosocial mechanisms underlying these differences. The biological mechanisms behind gender differences include the impact of sex hormones, such as testosterone, progesterone, and androgen, on the nociceptive transmission, the endogenous opioid system, and differential activation of different brain regions throughout the incorporation of pain-related stimuli. Another theory that suggested a higher incidence of certain forms of clinical pain was the administration of exogenous hormones. It has also been shown that variations in pain perception between genders are related to genotype and genetic linkage.[13]

Psychosocial mechanisms such as pain coping strategies, catastrophizing, self-efficacy, gender roles, and social priming are among the factors that influence the pain threshold among genders. Men are said to have a more problem-focused pain coping mechanism and use behavioral distractions. They are also, as a sign of masculinity, expected to toughen up and not express pain openly. Contrarily, women are thought to utilize a more emotion-focused pain-coping strategy that focuses on attentional focus, cognitive reinterpretation, positive self-statements, and social support.[13] These factors may cause the results to be biased when it comes to reporting pain. As the results of this current study show no significant difference in the level of pain experienced between genders in all types of injections, there is a possibility that regardless of gender, an individual may describe pain felt to be higher than they are experiencing. They may react to pain more than they think.

The findings of the present study align with previous literature indicating the beneficial effects of aloe vera and chamomile in wound healing.[15-16] Moreover, the enhanced healing scores in the test group compared to the control group are consistent with observations reported in English-language studies evaluating herbal-based oral healing agents.

Similarly, biological and psychosocial mechanisms underlie the difference in pain threshold between different ethnic groups. A study by Rahim-Williams et al. found that biological factors such as endogenous pain control mechanisms, oxytocin level, and genetic makeup vary between different ethnicities.[25] However, studies on biological mechanisms influencing pain threshold between ethnicities are limited, and these factors do not explain the difference definitively. Further studies need to be done to elucidate the exact biological mechanisms underlying the variations in the pain level experienced among different ethnicities.

On the other hand, extensive studies have been done on psychosocial mechanisms. Many stated that psychosocial mechanisms do indeed play a significant role in the difference in pain threshold between ethnicities. The biocultural pain theory is one of these hypothesized models. Each ethnic group is thought to have unique cultural experiences with attitudes towards and meanings for pain. These differences may impact the neurophysiological processes involved in the perception of pain and tolerance and the psychological and behavioral reactions to pain.[15] Furthermore, according to the paradigm, people learn attitudes, expectancies, meanings for events, and suitable emotional expressiveness by watching how others who are similar to them behave.

The current study documented that the Malays, Chinese, Indians, and Indigenous groups in Malaysia do have different levels of pain threshold. The Malaysian culture is a combination of the various cultures of these ethnic groups, which differs in terms of social upbringing, educational experiences, and religious practices. In some cultures, such as the Chinese, expressing pain openly may be seen as a sign of weakness, and therefore, patients remain stoic despite pain and suffering. In contrast, in other cultures, such as Indians, pain and grief are expected to be expressed openly25. Followers of Islam see suffering and pain, the faith that the Malays follow, as God's way of trying someone's patience; those who have more extraordinary patience are said to have come closer to God.25 These cultural beliefs of the different ethnicities could significantly contribute to the patient's coping mechanisms and perceived level of pain experienced.

At present, limited studies are available to understand the underlying mechanisms behind pain threshold differences in terms of gender and ethnicity. A clear understanding of the various factors influencing pain threshold would enable dental practitioners to plan for a more effective local anesthetic administration, contributing significantly to patient comfort.

5. Conclusions

This study establishes that Oxygene® gel significantly accelerates wound healing after dental extractions when compared to untreated sites. The results validate the hypothesis and underscore the gel's utility as a practical adjunct in dental wound management. Future studies with larger sample sizes and extended follow-up are warranted to confirm these findings and explore additional applications of Oxygene® gel in clinical settings.

6. Source of Funding

None.

7. Conflict of Interest

None.

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