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**Original Research Article**

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

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## Abstract

**Background:** Pain management during dental procedures is crucial for patient comfort and care. Local anesthetic (LA) administration, while essential for pain control, can also be a source of discomfort. Understanding pain thresholds in dental patients during LA administration and exploring the influence of age, gender, and ethnicity is essential for optimizing patient care.

**Objectives:** This cross-sectional study aimed to assess pain thresholds during LA administration for various dental treatment procedures and to evaluate the impact of age, gender, and ethnicity on pain sensitivity, with a clear focus on optimizing patient care.

**Materials and Methods:**

The study utilized convenience sampling and included Malaysian dental patients aged 21-50. Patients scheduled to receive LA for treatment without systemic diseases or complaints of pain on the treatment day were invited to participate. Pain thresholds were measured using the Modified Behavioural Pain Scale and Visual Analog Scale. Ethical approval was obtained, and informed consent was obtained from participating patients.

**Results:** The study findings will provide insights into pain thresholds during LA administration among dental patients and explore the influence of age, gender, and ethnicity on pain sensitivity. The results will contribute to a better understanding of pain management in dental care and may have implications for optimizing local anesthesia administration practices.

**Conclusion:**

The study's outcomes, which can significantly improve pain management strategies during dental procedures, are of paramount importance. They may contribute to individualized approaches to local anesthetic administration based on age, gender, and ethnicity. Understanding pain thresholds in dental patients can enhance patient comfort and contribute to the overall quality of dental care, providing a wealth of knowledge to the dental community.

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**Keywords:** Local anesthesia, Pain threshold, Dental practice, Cross-sectional study, VAS.

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## 1. Introduction

Pain is an unpleasant experience, both sensorily and emotionally, and a subjective phenomenon. It is ineluctable during specific dental procedures:[1] Local anesthetics are widely used for pain control during treatment procedures and post-operative pain management. However, ironically, the administration of the local anesthetic in itself is a painful procedure. A wide range of physiological, neurological, and psychological factors regulate the complex process of pain tolerance. There are various determinants to consider regarding why pain is felt and how it could vary between individuals.

Many studies have compared pain thresholds regarding age, gender, and ethnicity. Some authors have found that aging translates to an increased pain threshold; thus, older

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people are less sensitive to pain[3-4] When considering age, much thought has been put into the physiological, neurological, and psychological influences on older people. In general, various body systems have age-related physiological and biological changes. Regarding oral tissue, intra-oral soft tissues show age-related degenerative changes such as thinning of the oral mucous membrane, decreased keratinization, rather-sclerotic changes in the blood vessels, and a decrease in collagen fibers of the connective tissue.[5] The atrophic mucosa of the elderly is frequently thin, taut, and blanches easily.[6] These degenerative changes make the oral mucosa more susceptible to injuries, possibly affecting the pain threshold.[5-6]. Moreover, the thinning mucosa in aging patients may be more sensitive to needle penetration during local anesthetic administrations. However, neurological changes to an aging patient's central and peripheral nervous system might counteract these changes.[7] While considering the psychological aspects, it has been gleaned that aging patients tend to complain less about their pain when compared to younger ones[8-9] many studies on gender disparities in pain thresholds indicate that men and women react to pain differently, with women more frequently than males being found to have heightened pain sensitivity and a higher likelihood of developing clinical pain.[10-14] Many biopsychosocial reasons, such as sex hormones, endogenous opioid function, genetics, pain coping catastrophizing, & gender roles, have been proposed as contributing to these gender disparities in pain threshold[13-14] According to some researchers, the notable differences in tolerance for pain between males and females may also be due to cultural heterogeneity in stereotyped views about pain.[13-15] According to the biocultural pain model, people's responses to pain are determined by what they learn from and observe in other people of their ethnic group[15]. A more recent meta-analysis[16] found that they had worse pain tolerance and higher pain ratings when compared with Africans, Asians, non-Hispanic Whites, Americans, and Hispanics. There are very few researches that have evaluated the differences in pain tolerance amongst ethnic groups in the Asian continent. Significant ethnic disparities in pain tolerance were found in a Malaysian investigation; the Indian community allegedly had the highest score for pain.[17] On the contrary, in a similar study from Singapore, no significant difference in pain threshold was detected among Malays, Chinese, and Indians.

Besides providing skillful treatment to the patient, a dental professional also assesses and manages pain during and after treatment, a fundamental requisite in dental care. It is imperative to administer LA with as minimal pain as possible. Thus, this study aimed to determine the impact of gender, race, and age on pain threshold and the patient's pain threshold after administering local anesthetic over various dental treatment procedures.

## 2. Materials and Methods

### *2.1. Study population*

This cross-sectional study adopted convenience sampling, and Malaysians aged between 21 and 50 years who visited the Lincoln University College Dental Centre for dental treatment made up the sampling frame for this study. Patients who met the following inclusion criteria were offered a role in the study: they had to be scheduled to receive LA as part of their treatment, had no systemic disorders, and had no additional complaints related to pain upon the day of treatment. Exclusions from the study were patients who needed more LA injections, were on pain medication, or had systemic diseases. Patients who offered to participate gave their informed permission. The study received ethical approval from the Lincoln University College's Ethics Committee [Medical Ethics Approval Code: LUCethics/FDent/009/2017].

### *2.3. Measurement tools*

Pain thresholds were measured using two scales, namely the Modified Behaviour Pain Scale (MBPS) and the Numeric Pain Rating Scale (NPRS).[19-20] Modified Behaviour Pain Scale (MBPS). The MBPS is a modification of the Behavioural Pain Scale (BPS). MBPS is the observer's discretion of the patient's pain tolerance, whereby pain is measured by observing patients' facial expressions and body movements.[19] The sum of the scores for all the different items in the scale is considered the total MBPS score of the patient. The description and scoring of these facial expressions and body movements are given in ***Table 1***, ***Table 2*** and ***Table 4***. below. Methodology. *ii) Numeric Pain Rating Scale (NPRS)*

The Numerical discomfort Rating Scale (NPRS) is a variation of the Visual Analogue Scale (VAS) wherein an individual chooses a whole number (0–10) that most accurately represents the degree of their discomfort.20[20]. In this study, NPRS is the patient's discretion towards the pain experienced and was used to obtain quantitative data, with "0" being the least painful and "10" being the most painful (**Figure 1**).

### *2.4. Data collection*

Before data collection, a calibration exercise for the administration technique of the local anaesthesia and pain measurement using the two scales was conducted with ten patients. At first, the injection site was thoroughly dried using sterile gauze and air from a 3-way syringe before applying a topical anesthetic gel. Topical anesthetic gel with 20% benzocaine (GumNumb™) was applied to the injection site for all patients using a cotton-tipped applicator. The gel was left on the site for exactly 60 seconds before administering the local anesthetic injection. Patients were administered local anesthesia (LA) with 2% lidocaine hydrochloride solution with adrenaline in the ratio of 1:80,000 (Inibsa

XilonibsaTM) using a non-disposable breech-loading metallic syringe. Both non-aspirating and aspirating types were used depending on the jaw involved. The needles used were long (41 mm) 27-gauge needle, and short (22mm) 30-gauge (Terumo®). The duration of injection of the solution was standardized to roughly 1 minute 30 seconds per cartridge of LA. Necessary measures to minimize pain upon injection were taken as recommended by Strazar & Lalonde, albeit with slight modifications 21. However, no additional buffering agent was added. The anesthetic solution was injected at a rate of 1 ml in not less than 60 seconds, and a 1.8 ml cartridge was administered in approximately 2 minutes to allow time for the tissues to buffer the solution to minimize the pain or burning sensation during injection.

All procedures on the mandibular teeth used a conventional Inferior alveolar nerve block technique or local infiltration techniques. In contrast, supra-periosteal infiltration techniques were used for all procedures on the maxillary arch. One researcher consistently administered the LA injections, and another researcher observed and recorded the patients' pain thresholds while receiving the LA using MBPS. The subjects were asked to rate their level of discomfort using the NPRS after receiving a local anesthetic.

*2.5. Statistical analysis*

The descriptive data was displayed using mean ± standard deviation, frequencies, and percentages. The MBPS and the NPRS results were added up to determine the pain scores. Using the Mann-Whitney and Kruskal-Wallis tests, differences in pain scores by age, gender, and ethnicity were examined. The cutoff point for statistical significance was $p<0.05$. Version 28.0 of the SPSS was used for all statistical analysis.

## 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 |

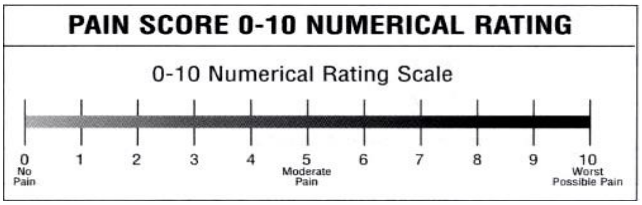


**Figure 1:** The scoring of the numeric pain rating scale (NPRS)

*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).

## 4. 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

| **Ethnic group** | | **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 |

## 5. 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 prescription opioid system, and differential activation of different brain regions throughout the incorporation of pain-related stimulus. 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.

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 openly.25. 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.[25,26]. 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.

## 6. Conclusions

The highest level of pain is experienced when local anaesthesia is administered at the maxillary infiltration. Pain threshold is influenced by age. Although variations were observed in pain thresholds regarding gender and ethnicity, no significant differences were ascertained.

## 7. Source of Funding

None.

## 8. Conflict of Interest

None.

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