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Original article

The Association between Coffee Consumption and Local Anaesthesia Failure

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Abstract
Some patients report inadequate numbness following local anaesthesia, requiring higher-than-normal doses. Caffeine consumption has been suggested to reduce anaesthetic effectiveness. This study aimed to evaluate the effect of caffeine intake on the effectiveness of local anaesthesia during dental treatment. A cross-sectional, self-reported survey was conducted in Zawia City, Libya, between April and June 2025 among patients attending dental clinics. The questionnaire assessed demographic characteristics, caffeine consumption, medical history, and perceived anaesthetic effectiveness. Validity and reliability were evaluated by specialists in anaesthesia, dentistry, epidemiology, and biostatistics. Of 150 distributed questionnaires, 94 were completed (62.7%). More than half of the participants required two or more local anaesthetic injections to achieve numbness. Higher coffee consumption and intake of other caffeinated beverages were significantly associated with reduced perception of anaesthetic numbness and increased injection requirements ($p < 0.005$). However, only 4.1% of participants self-reported that caffeine affected anaesthetic success. In conclusion, while most patients did not perceive caffeine as affecting local anaesthesia, higher caffeine intake was statistically associated with reduced anaesthetic effectiveness. These findings may relate to caffeine's effects on alertness, stress, and anxiety. The single-centre design and limited sample size restrict generalizability; therefore, larger multicentre studies are recommended.
Keywords. Coffee Consumption, Local Anaesthesia, Failure.

Introduction

In Libya, caffeine is predominantly consumed in the form of Arabic coffee, which constitutes an integral aspect of social life across Arab countries. Coffee-drinking culture reflects and reinforces values of ceremony, hospitality, and generosity within Arab society. Based on clinical practice and discussions with dental practitioners, it has been observed that some patients fail to achieve adequate numbness following local anaesthetic injections. These patients frequently report high coffee consumption and, as a result, often require increased doses of local anaesthesia during dental treatment. These observations led this research to investigate whether there is a relationship between coffee consumption and the failure of local anaesthesia.

Caffeine is one of the main active components of coffee, which is influenced by the form of coffee beans and roasting style, the way of preparing, and the serving size. Coffee roasting generates various complex bioactive ingredients with possible antioxidant, anti-inflammatory, and anticancer properties, which may be responsible for the epidemiological associations reported in the literature [1-3]. However, a study by Tavares et al [3] examining if coffee drinking has beneficial or harmful effects on health reported mixed conclusions. Caffeine (1,3,7-trimethylxanthine) is the world's most popular stimulant, which is a naturally found chemical alkaloid consumed by humans in the form of coffee, tea, cola beverages, energy drinks, in products containing cocoa or chocolate, and in different medications such as analgesics and in the form of psychoactive pills [4]. It influences several parts of the central nervous system and has both positive and negative impacts. The positive effects include enhanced ability to maintain consciousness, improved cognitive alertness, mood elevation, and increased work performance [5]. On the other hand, excessive caffeine intake has been associated with negative effects, including less sleep quality, anxiety, headaches, nausea, and restlessness.

The impact of caffeine on cognitive function via several mechanisms. One key mechanism is the inhibition of intracellular phosphodiesterase enzymes, leading to increased intracellular concentrations of cyclic adenosine monophosphate (cAMP). Caffeine's primary action on the nervous system is through antagonism of adenosine receptors, specifically the A1 and A2 subtypes. This results in increased neuronal activity and the stimulation of neurotransmitter release, including dopamine, norepinephrine, serotonin, acetylcholine, glutamate, and gamma-aminobutyric acid (GABA) [6-8].

Local anesthesia is an essential tool and a routine procedure in dental practice. It functions by blocking nerve conduction in a localized area of the body, thereby preventing the transmission of pain signals to the brain and allowing for a comfortable, pain-free experience during dental treatment. Local anesthetics achieve this effect by inhibiting the flow of sodium ions through voltage-gated sodium channels in the nerve membrane, which in turn prevents the propagation of nerve impulses [9,10]. However, the effectiveness of local anesthesia can be influenced by several factors, including the technique of administration, psychological, pathological, and anatomical conditions. There is a prevailing belief that excessive caffeine consumption can reduce the effectiveness of local anesthesia.

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Given the high prevalence of caffeine use and its potential to influence neural activity, there is growing interest in understanding how it may affect the pharmacological performance of local anesthetics. Clinical observations showed that regular caffeine intake may reduce the effectiveness of local anesthesia and heighten the perception of pain during dental procedures [11,12]. However, this topic has not yet been studied in Libya. Therefore, the present study aims to evaluate the effect of caffeine consumption on the onset, duration, and overall effectiveness of local anesthesia during dental treatment.

Methods

Ethics statement

Ethical approval was granted by the Libyan National Committee for Biosafety and Bioethics. It was also reviewed and approved by the Department of Anaesthesia and Critical Care, Zawai Medical Centre.

Settings and study population

A cross-sectional self-reporting survey was prepared to suit the aim of this study. It was designed and adopted from previous studies [12-14]. Some of the questions were modified to be favourable with Libyan culture. The questionnaire consisted of three parts: demographic data, the relationship between caffeine intake and the anaesthesia effectiveness, and the third section was about medical history data.
In terms of study validity and reliability, anaesthesia and dentists were asked to rate the questions based on a unipolar Likert scale. The experts in epidemiology and biostatistics who were not included in the study also assessed it.

Participants

The participants were patients attending dental clinics in Zawia city. The aim and content of the survey were explained to them, and those who agreed provided their consent and completed the survey.

Sample

A total of 94 patients participated in this study and provided written consent before taking part in the study.

Study period

The study was conducted over a two-month period, from April 1, 2025, to June 30, 2025.

Eligibility Criteria

The sample for this study was selected according to specific inclusion and exclusion criteria to ensure the accuracy and relevance of the data collected. Participants were required to be between 18 and 60 years of age, as this range was considered appropriate for providing reliable information pertinent to the study objectives. Eligible individuals were frequent consumers of caffeine and patients attending dental clinics in Zawia City who were undergoing local anaesthesia procedures.
To maintain the integrity of the research, several exclusion criteria were applied. Individuals younger than 18 years of age, pregnant women, and patients with medical conditions—particularly cardiac disease and autoimmune disorders—were excluded. In addition, patients with a known sensitivity to caffeine or local anaesthesia were not considered for participation. These criteria were established to minimize confounding factors and to safeguard the health and safety of the participants while ensuring that the study outcomes accurately reflected the target population.

Statistical analysis

The data were checked, cleaned, entered into Microsoft Excel, and analysed using R Studio. Descriptive data expressed as percentages and numbers. A chi-square (x2) test was conducted to investigate the relationship between not feeling numbness after receiving a local anaesthetic injection and coffee consumption habits. A p-value of less than 0.005 was considered statistically significant.

Results

94 out of 150 respondents completed the questionnaire. These respondents were from different clinics in Zawia city, Libya. The majority of them were female 73.4% and 26.6% were male. The findings also showed that the majority of participants were aged between 21-30, with 38.3%, followed by ages 31-40, with 19.1%. 67% held a bachelor's degree, followed by a postgraduate degree with 14.9%. Of the participants, 85.1% did not have chronic diseases. Besides, 80.6% of them were not smoking. The demographic characteristics of the study participants are displayed in (Table 1). (Figure 1) demonstrates that 40% of participants take Panadol for pain relief, 16% take Ibuprofen, 36% use other over-the-counter (OTC) medications, and 8% do not take any medication for pain management.

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Table 1. Demographic Data and Patient Health Condition

Statement		N	%
Gender	Male	25	26.6
	Female	69	73.4
Age	18-20	14	14.9
	21-30	36	38.3
	31-40	18	19.1
	41-50	17	18.1
	51-60	9	9.6
Education Level	Undergraduate	13	13.8
	Bachelor's Degree	63	67
	Postgraduate	14	14.9
	Illiterate	4	4.3
Chronic Disease	Yes	14	14.9
	No	80	85.1
Smoking	Yes	15	15.3
	No	79	80.6

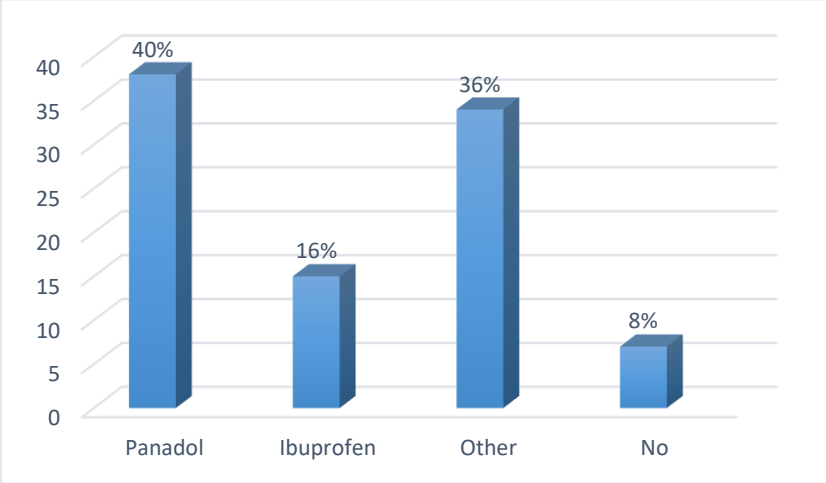

Figure 1. Consumption of different types of pain medication (in %)

(Table 2) demonstrates the dental background about anaesthesia affecting their caffeine and medication intake. Only 4.1% of the responses did not experience numbness after receiving a local anaesthetic injection, and the majority, 34.7%, had taken Panadol as pain relief. Almost all of the patients reported that they did not have any medications that may change the effect of the dental anaesthetic. 52% of participants reported that they had to have two injections to feel numbness and the doctor could work, while 18.4% needed three times or more injections, and 4.1% needed one injection. Participants also reported that the use of other medications had no significant impact on the effectiveness of dental anaesthesia.

Table 2. Dental background shows the response of the patients to the anaesthesia, concerning their caffeine intake

Statement		N	%
Have you experienced an event in the dental clinic where you did not feel numbness after receiving a local anaesthetic injection?	Yes	4	4.1
	No	89	90.8
On average, how many injections do you take in each visit so that the doctor can work and feel the numbness?	1	4	4.1
	2	51	52
	3 or more	18	18.4
What type of medication do you take for pain?	Panadol	38	40.4
	Ibuprofen	15	16.0
	Other	7	7.4
	No	34	36.2
Do you think that any of the medications you take may alter the effect of dental anaesthetics?	Yes	1	1
	No	93	94.9

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Table 3 summarizes the coffee consumption patterns of patients, including the type and quantity of coffee consumed, and whether or not they drink other caffeinated drinks. Arabic coffee was the most commonly consumed type of coffee, reported by 43.6% of participants. It was followed by Nescafé at 23.4%, cappuccino at 18.1%, and Espresso at 14.9% (Figure 2). Among the participants, 37.2% reported drinking one cup of coffee per day, and 27.7% consumed two types of coffee per day. However, 3.2% of the participants did not drink coffee.

Table 3. Coffee drinking habits illustrate the number of cups, type of coffee, whether the patients consumed other caffeinated drinks, and how many times they take it daily

Statement		N	%
What type of coffee do you usually drink?	Arabic coffee	41	43.6
	Nescafe	22	23.4
	Espresso	14	14.9
	Cappuccino	17	18.1
How many cups of coffee do you drink every day	1	35	37.2
	2	26	27.7
	3 or more	30	31.9
	No	3	3.2
Do you usually drink other caffeinated drinks, for example: (Pepsi, tea, or energy drinks)?	Yes	62	66
	No	32	34

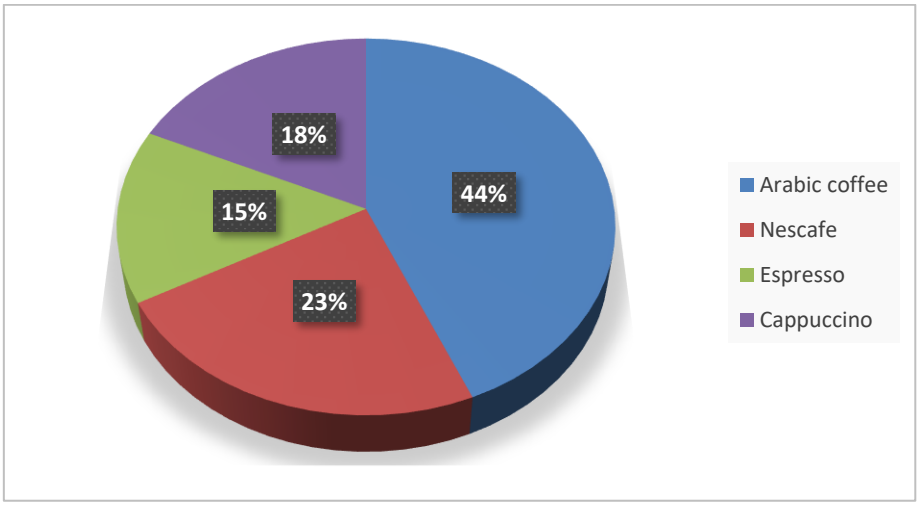

Figure 2. The participants did not drink coffee

Regarding the intake of other caffeinated drinks, like tea, energy drinks, or soft drinks. 66% of participants consumed other caffeinated drinks (Figure 3).

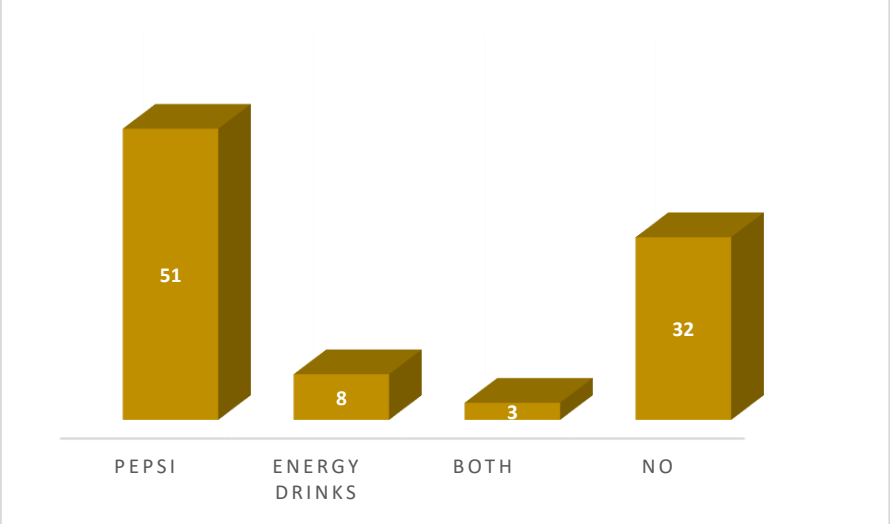

Figure 3. Consumption of different caffeinated drink types

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A Chi-squared test was done to assess the relationship between the awareness of numbness after receiving a local anaesthetic injection and individuals' coffee consumption habits. It was observed that a very strong association exists between the number of injections and whether patients feel numbness. Among those who did not feel numbness, 50.1% required two injections, while 24.7% of those who felt the injection only needed one ($x^2 = 101.57$, $p < 0.001$). It was also found that a higher coffee intake is significantly associated with not feeling numbness. 29.6% of participants who did not feel numbness consumed coffee 3 times or more per day, while only 1% of those who felt numbness (X2=98.74, p=<0.001).
It was found a significant association was found between the consumption of caffeinated fizzy drinks and not feeling numbness, 90% of whom did not feeling the injection drank fizzy drinks, while 55.55% of whom felt numbness (X2=98.087, p=<0.001). Additionally, 60.2% of participants who regularly drank other caffeinated drinks (like tea, Pepsi, energy drinks) were less likely to feel numbness. It may suggest that the higher the intake of caffeinated beverages, the less the effectiveness or perception of local anaesthetic numbness (Table 4).

Table 4. The association between not feeling numbness after being given a local anaesthetic injection and coffee habits

Statement		**Not feeling numbness after being given a local anaesthetic injection**						**Chi squared**	**P value**
		Yes		No		Total			
		N	%	N	%	N	%		
How many injections do you take in each visit so that the doctor can work and feel the numbness?	1	22	24.7	3	3.1	25	25.5	101.57*	<0.001
	2	49	50.1	2	2	51	52		
	More	18	18.4	0	0	18	18.4		
How many cups of coffee do you drink per day?	1	33	33.7	2	2	35	35.7	98.74*	<0.001
	2	24	2	24	24.5	26	26.5		
	3 or more	29	29.6	1	1	30	30.6		
	I don't drink coffee daily	3	3.1	0	0	3	3.1		
Do you usually drink other caffeinated drinks, for example: (Pepsi, tea, or energy drinks)?	Yes	59	60.2	3	3.1	62	63.3	98.087*	<0.001
	No	30	30.6	2	2	32	32.7		

Discussion

In routine clinical practice, patient safety principles and values are fundamental to all healthcare systems, ensuring that care is delivered effectively and safely [15]. Several patients believe that excessive caffeine consumption contributes to the failure of local anaesthesia, although scientific evidence supporting this assumption is limited. Therefore, the present study aimed to examine patients' experiences, knowledge, and awareness regarding coffee consumption and its effect on local anaesthesia. Caffeine is the active ingredient of coffee and one of the most widely studied food constituents. It is also used as an adjuvant in pain-relief medications and is readily available in pharmacies without a prescription [16]. However, recommended daily limits of caffeine intake should always be considered [17].
In this context, several studies have explored the pharmacological effects of caffeine from various perspectives. Nevertheless, only a limited number of investigations have specifically examined its potential influence on the success of local anaesthetic procedures, and their results have not been proven [18]. Understanding the underlying causes of local anaesthetic failure is essential for ensuring adequate anaesthesia. The literature indicates that these failures can be patient-related—such as anatomical variations, pathological conditions, or psychological influences—or operator-dependent, including the choice of injection technique or the volume of anaesthetic administered [19, 20].
Local anaesthetics exert their pharmacological effect by inhibiting voltage-gated sodium channels (VGSCs) in the neuronal membrane. This process requires the uncharged base form of the anaesthetic (RN) to first diffuse across the lipid bilayer; once inside the axoplasm, the protonated form (RNH^+) binds to the intracellular pore of the sodium channel, preventing sodium influx and subsequent nerve depolarization [21]. To date, at least nine VGSC isoforms have been identified, each distinguished by specific structural features, physiological roles, and contributions to nociceptive signalling. These channels are composed of α- and β-subunits, with the α-subunit functioning as both the voltage sensor and the primary conduit for sodium ion passage.

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VGSCs are broadly classified into tetrodotoxin-sensitive (TTX-S) and tetrodotoxin-resistant (TTX-R) subtypes. TTX-R channels exhibit reduced susceptibility to local anaesthetics and are more readily activated by inflammatory mediators such as prostaglandins. Therefore, in patients presenting with pre-endodontic symptoms or inflamed tissues, upregulation and activation of TTX-R channels can significantly diminish the clinical effectiveness of local anaesthesia [22].

In the present study, paracetamol (Panadol) was the most frequently reported analgesic (38.8%), followed by ibuprofen (15.3%). Of note, 34.7% of participants reported not using any pain medication, which may reflect a higher pain threshold or limited prior exposure to dental pain. Only 7.1% reported using other types of analgesics. When participants were asked whether they believed their medications could influence the effect of dental anaesthesia, the majority (94.9%) responded negatively, while only 1% responded affirmatively. This indicates a substantial lack of awareness regarding potential interactions between systemic medications and local anaesthetic agents. Although commonly used over-the-counter analgesics rarely alter the pharmacodynamics of local anaesthetics directly, chronic use, underlying medical conditions, or concurrent physiological changes may produce subtle modulatory effects.

In the present study, a statistically significant association was observed between coffee consumption and the perceived sensation of numbness following local anaesthetic administration. Participants who reported inadequate numbness were more likely to consume higher quantities of coffee and other caffeinated beverages. These results suggest that caffeine intake may reduce anaesthetic sensitivity or shorten the duration of anaesthesia, warranting further investigation to elucidate underlying mechanisms and clinical implications. These findings align with previous research on anaesthetic caffeine–anesthetic interactions. Fredholm et al [23] reported that caffeine, as a central nervous system stimulant and non-selective adenosine receptor antagonist, might reduce the efficacy of sedatives and anaesthetics by increasing alertness and modulating pain thresholds. Similarly, Alfaraj et al [11] demonstrated that habitual caffeine consumption upregulates pain-related sodium channels in the dorsal root ganglion, potentially altering responsiveness to local anaesthetics. Consistent with these findings, our data indicate that higher consumption of coffee and other caffeinated beverages may be associated with reduced local anaesthetic sensitivity, reflected by an increased need for supplemental injections and a higher frequency of reports of incomplete numbness.

Certain factors, such as smoking status, existing medical conditions, and medication use, may act as contributors that produce a masking effect. In the present study, more than 80% of the participants reported having no smoking habits and no other significant medical conditions or medication use. Therefore, these variables are potential components that may have a masking effect on the smokers' experienced local anaesthesia failure. Previous research has reported an association between smoking and caffeine consumption and has shown that smoking can double the rate of caffeine clearance by raising liver enzyme activity cytochrome P450 (CYP1A2) [24,25]. As a result, smoking may reduce the effect of caffeine on adenosine receptors and, therefore, the action of local anaesthesia may not be significantly minimised.

Patients with heightened anxiety or stress are poorer applicants for procedures performed under local anaesthesia. Elevated adrenaline levels triggered by fear or pain may delay the onset, reduce the depth, or shorten the duration of anaesthesia [26]. Koga et al [27] reported that anxiety is normally higher before dental surgery, and patients experiencing increased anxiety in the treatment environment feel more pain. Therefore, it is crucial to minimize anxiety to improve the pain level during treatment. Hence, patient psychology factors could also contribute to the failure of local anaesthesia. In addition, caffeine consumption has been shown to increase circulating stress hormones, particularly catecholamines such as adrenaline and cortisol [7]. Furthermore, a large amount of caffeine beverages can cause a tolerance to their adenosine receptor-dependent effects, leading to upregulation of the receptors that are associated with headache, anxiety, and flushing [7]. This may partially represent explanation for the lower-than-expected response observed in this group of patients. Together, these factors may lead to failure of local anaesthesia.

Conclusion

Although some individuals believe that caffeine can harm the effectiveness of local anaesthesia, only 4.1% of patients reported, based on their experiences in dental clinics, that their caffeine consumption affected the success of local anaesthesia, while the majority did not. Current evidence has shown that caffeine may change cognitive performance through increased awareness and by inducing sleep disruption, stress, and anxiety, factors that may partially explain the occurrence of local anaesthetic failure among coffee consumers. This study was limited to a single area and sample size. A similar multicentre study with a large sample size is highly recommended, and it should focus deeply on specific variables, such as anatomical, pathological, and biological responses.

Conflict of interest. Nil

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