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Impact of caffeine consumption on local anaesthesia failure: Study based in Hail region, Saudi Arabia

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ABSTRACT

Background: Many patients believe that drinking coffee reduces the effectiveness of local anaesthetic. Caffeine is widely used on a global scale in the form of coffee, tea, and chocolate. All through the day. It is also traditionally regarded as a show of societal charity, particularly in Saudi Arabia. Local anaesthetic acts by interfering with the inflow of Na channels across the neural membrane. *Methodology***:** Cross-sectional epidemiological observational research was conducted in Ha'il. The data was collected over two months from 1/7/2022 to 1/9/2022 and included people who attended dental facilities in the Hail region. *Result:* The current study included 131 persons, with 47.69% being female and 52.31% being male. However, when we assessed patients' knowledge and opinions, we discovered that 32% agreed that coffee can help prevent local anaesthetic failure. Only 10% were aware of the scientific evidence associating coffee consumption with local anaesthetic failure. *Conclusion*: Caffeine has been shown in trials to hasten the recovery from anaesthesia and to be effective even at high anaesthetic dosages. According to the only available evidence, caffeine reverses the effects of general anaesthesia. According to the existing scientific data, caffeine can affect cognitive function by boosting alertness, and sleep deprivation causes stress and anxiety, which helps to explain in part why coffee drinkers have trouble administering local anaesthetics. To lower the failure rate of local anaesthetic, a dentist should use stress reduction techniques on a regular basis.

Keywords: Caffeine, Anesthesia, coffee.

1. INTRODUCTION

On a global level, caffeine is consumed frequently in the form of coffee, tea, and chocolate throughout the day. It is also known traditionally as a sign of

generosity on a social level, especially in Saudi Arabia (Badkook, 2013). Many patients have thoughts that their coffee intake modifies the effectiveness of the local anaesthesia (Premnath et al., 2020). The dental pain signal that's originated in the pulp tissue is transmitted through myelinated fibers (A- fibers) which are responsible for the conducting of sharp pain, and 87% of which are unmyelinated fibers (C fibers) which are responsible for transmitting throbbing pain. Through these fibers the pain is transmitted into the spinal cord and form synapses in the thalamus which is responsible for organizing the pain signal and send it to the sensory cortex that defines the signal as pain then it travels to the motor cortex that sends information into to the thalamus which then send the signal to the spinal cord that which attribute to the motor response of the body during sensibility test (Sacerdote & Levrini, 2012). Coffee is a drink that's comprised of coffee beans which have been taken from the nature, coffee beans are taken from an alkaloid plant like toxin and it's induces the alertness by blocking the chemical neuroceptors for the sleep 'adenosine' that has a main function of binding to adenosine receptors that induce sleep. Water which contains around 98% of our coffee cup has a major function that is to extract the coffee beans ingredients and chemicals that mainly include: citric acid that is capable of dropping the Ph of the saliva, chlorogenic acid which has a role on the regulation of glucose level, acetaldehyde which is metabolized in the liver can increase the heartbeat and caffeine which will increase the alertness (Ashihara, 2006). Historically, caffeine has been used to treat congestive heart failure that is associated with edema through the diuretic action and it is also used as an adjunctive for analgesic drugs (Tavares & Sakata, 2012). Local anaesthesia works by interfering with Na channel influx throughout the neural membrane. General anaesthesia works by targeting the synapses of the central nervous system. However, the local anaesthesia affects the axonal membrane of the peripheral nerves, and the local anaesthesia works during the depolarization phase of the nerve impulse generation.

Objectives

The aim of this study to clarify whether caffeine consumption has a real perceptive on local anaesthetic failure in dental practice or it is only a fear of a psychological source.

2. MATERIAL AND METHODS

The Study design

Epidemiological observational study and Cross-sectional design done from July to September 2022.

Study area

Hail city is the study area. It is in the north of Saudi Arabia. It has a population of about 600,000.

Study population

Patients who are attending the college of dentistry at the clinics at the University of Hail.

Sampling design

Sample size: 131 patients

Sampling procedure

The data was collected in two months time period including patients who will visit the dental clinics in Hail region. The questionnaire was translated into Arabic and approved by 1 dentist, thereafter, tested for both readability and comprehension by 20 subjects who were not included in the study. It consists of 15 questions which were guided by study objectives. The questionnaire includes three parts: The first part of questionnaire focused on 3 questions of demographic data. The second part consists of 7 questions related to the relationship between the caffeine intake and the anaesthesia effectiveness. The third part made of 5 questions and it's about medical history data.

Inclusive criteria

Random samples collected. Based on the following inclusive criteria:

- All patients from the college of dentistry in Hail who have been consuming caffeine.
- Non-disabled people and medically fit.
- This study is from 18 years old and above group.

Exclusive criteria

- All the patients from outside the college of dentistry in Hail
- Any person complains of medical problems especially heart diseases
- Any age under 18 years
- Disabled people

Data collecting tools

The samples collected from patients visiting dental clinics in hail region by doing a questionnaire.

3. RESULTS

Data were collected using Google forms service and entered into SPSS version 25.0 for data analysis. The frequencies and percentages were computed for describingthe statements. Chi-square (X^2) was conducted to test the relationship between not feeling numbness after being given a local anesthetic injection and coffee habits, a p-value of 0.05 was considered statistically significant.

Table 1 Demographic information, these statements show different genders, age, Education level

Statement		N	%
Gender	Male	62	47.69
	Female	68	52.31
Age	18-30	70	53.85
	31-40	46	35.38
	41-50	13	10.00
	51-60	1	0.77
Education level	General education	66	50.77
	Bachelor	42	32.31
	Postgraduate studies	9	6.92
	Not educated	13	10.00

As shown in Table (1), 131 people participated in the current study including 47.69% female and 52.31% male. More than half (53.31%) were aged between 18 and 30, followed by ages 31-40 with 35.85%. 50.77% held general education, followed by a bachelor degree with 32.31%.

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

Statement		N	%
Have you had an event in the dental clinic that you do not feel numbness after being given a local anesthetic injection?	Yes	40	30.77
	No	90	69.23
If the answer is "yes", do you believe thatyour excessive intake of coffee is the reason?	Always	13	32.50
	Often	14	35.00
	Sometimes	7	17.50
	Rarely	4	10.00
	Never	2	5.00
On average, how many injections do youtake in each visit so that the doctor can work and feel the numbness?	1	68	52.31
	2	51	39.23
	3	11	8.46

As shown in Table (2), only 30.77% of the patients did not feel numbness after being given a local anesthetic injection, and the majority believed that excessive intake of coffee is the reason. 52.3% of patients reported that they had one injection that the doctor can work and feel the numbness, while 39.23% need two times, and only 8.46% need three times (Figures 1 & 2).

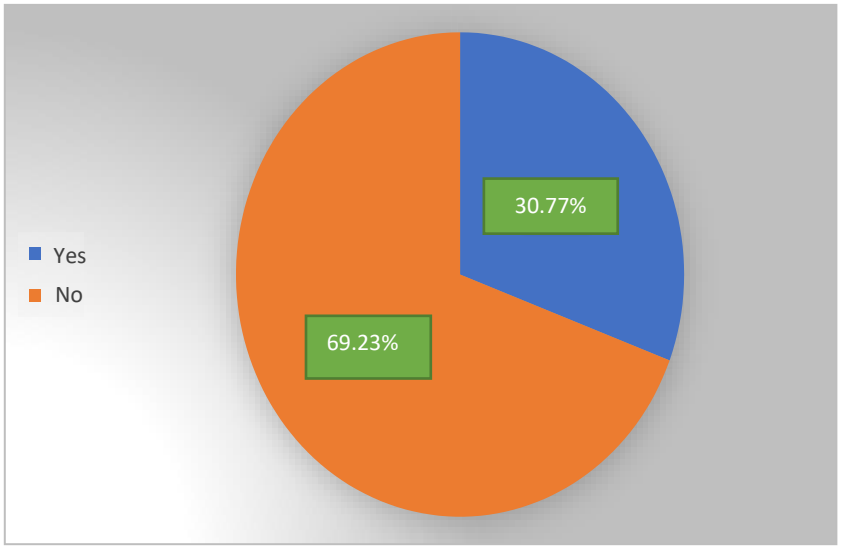

Figure 1 Shows the percentage of the people who felt numbness and those who didn't feel it after the local anesthesia was given.
Yes, means he didn't feel the numbness.
No, means he did feel the numbness.

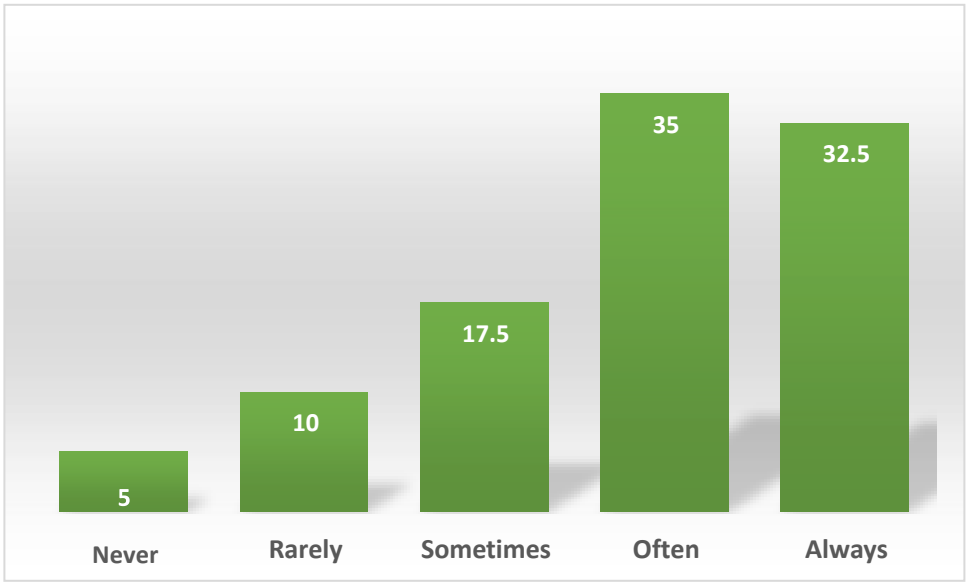

Figure 2 Shows whether the excessive intake of coffee is the reason (in %).

Table 3 Coffee drinking habits, it illustrates the number of cups, type of coffee, whether or not the patients consumed other caffeinated drinks, and how many times do they take it daily

Statement		N	%
How many cups of coffee do youdrink per day?	1	49	37.69
	2	43	33.08
	3 or more	28	21.54
	I don't daily drink coffee	10	7.69
What type of coffee do you usuallydrink?	Saudi coffee	79	60.77
	Espresso	18	13.85
	Cappuccino	33	25.38
	Black coffee	46	35.38
Do you usually drink other caffeinated drinks, for example: (Pepsi, tea, energy drinks)?	Yes	86	66.15
	No	44	33.85

If yes, how many times a day doyou drink this type of drink?	1	57	65.52
	2	23	26.44
	3	3	3.45
	4 or more	3	3.45

As shown in Table (3), 37.69% took one cup of coffee a day, while 33.08% took two cups, and 21.54% took three or more. Saudi coffee was the most popular coffee among the participants with 60.77%, followed by black coffee at 35.38%, then cappuccino at 25.38%, while espresso was the less popular with only 14.85%. 65.62% reported that usually drink other caffeinated drinks, for example: (Pepsi, tea, and energy drinks), and 65.52% reported drinking them once a time a day, while 26.44% twice a time (Figure 3).

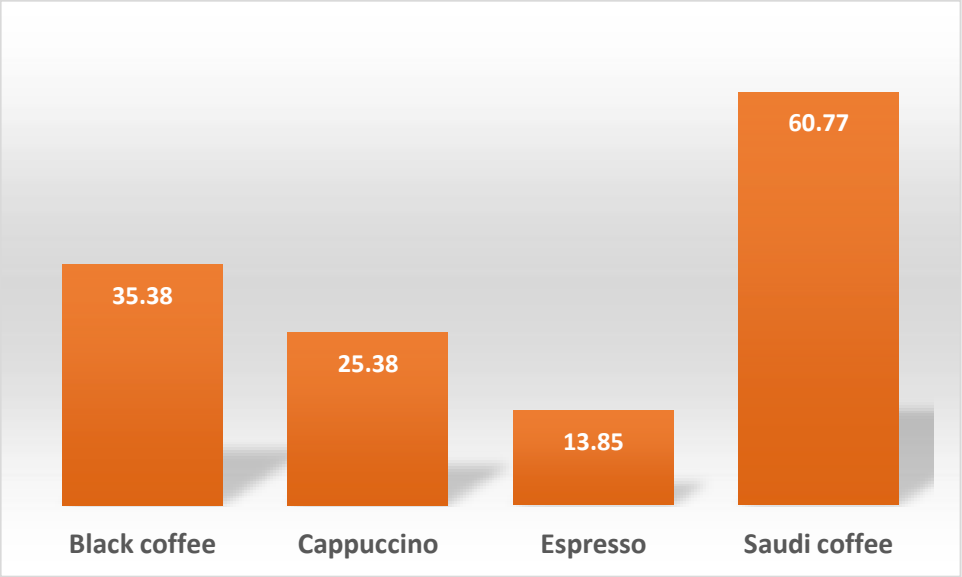

Figure 3 Consumption of different coffee types

Table 4 Problem history, it shows different medical status responses

Statement		N	%
Are you a smoker?	Yes	38	29.23
	No	92	70.77
If the answer is yes, mention theproblem you suffer from?	Yes	1	2.63
	No	37	97.37
If the answer is yes, mention theproblem you suffer from?	Not given	129	99.23
	Diabatic	1	0.77
Do you think that any of the medications you take may alter the effect of dental aesthetic?	No	11	8.46
	I am not currently taking any medications	121	91.54

As shown in Table (4), 29.23% were smokers, only one of them had a diabetic problem, and nobody reported any of the medications they take may alter the effect of dental anesthetic.

Table 5 The association between not feeling numbness after being given a local anaestheticinjection and coffee habits

Statement		*Not feeling numbness after being given a local anesthetic injection*						Chi squared	p value
		Yes		No		Total			
		N	%	N	%	N	%		
How many injections doyou take in each visit sothat the	1	5	12.50	63	70.00	68	52.31	40.74***	<0.001
	2	26	65.00	25	27.78	51	39.23		

doctor can workand feel the numbness?	3	9	22.50	2	2.22	11	8.46		
How many cups of coffeedo you drink per day?	1	4	10.00	45	50.00	49	37.69	27.90***	<0.001
	2	16	40.00	27	30.00	43	33.08		
	3 or more	18	45.00	10	11.11	28	21.54		
	I don't daily drink coffee	2	5.00	8	8.89	10	7.69		
Do you usually drink other caffeinated drinks, for example: (Pepsi, tea, energy drinks)?	Yes	36	90.00	50	55.56	86	66.15	14.67***	<0.001
	No	4	10.00	40	44.44	44	33.85		
*≤0.05; **≤0.01; *** ≤0.001, ns (not significant)									

As shown in Table (5) Chi-squared was conducted to test the relationshipbetween not feeling numbness after being given a local anesthetic injection and coffee habits. It was found a significant association between the number of injections and not feeling numbness, with 70% of whom feeling the injection only needed one injection, while 65% of whom not feeling numbness need twice injections (X^2=40.80, p=<0.001). It was found a significant association between the number of the taken cups of coffee and not feeling numbness, 45% of whom not feeling the injection only drank 3 times or more, while 11.11% of whom feeling numbness (X^2=40.80, p=<0.001). It was found a significant association between drinking fizzy drinks and not feeling numbness, 90% of whom not feeling the injection drank fizzy drinks, while 55.55% of whom felt numbness (X^2=40.80, p=<0.001). In sum up, it can argue the more having caffeinated drinks the less feeling of numbness.

3. DISCUSSION

Many patients in ordinary clinical practice describe a history of failed local anaesthetic, which they assumed was due to excessive coffee drinking. Due to a lack of empirical proof for this notion, the purpose of this study was to investigate the patients experience, knowledge, and awareness of coffee drinking and its effect on the local anaesthetic. Caffeine, the active component of coffee and one of the most extensively researched food components, is a psychoactive stimulant that is frequently ingested in the form of beverages. Even though there are numerous published publications on the pharmacokinetics of caffeine and its effects on health. However, when we evaluated patients' knowledge and opinions, we discovered that 32% agreed that coffee has a beneficial influence on local anaesthetic failure. Only 10% were rarely aware of the scientific data linking coffee drinking to local anaesthetic failure. Caffeine reverses the effects of general anaesthesia, according to the sole known evidence (Wang et al., 2014).

The sodium channels at the nerve membrane are blocked by the local anaesthetic solution. However, in this case, the basic form (RN) of LA should pass the membrane whereas the charged acid form (RNH+) should attach to the sodium channel's inner pore. Molecular biologists discovered nine or more subtypes of voltage-gated sodium channels (VGSCs) that varied in their expression pattern, biophysical features, and involvement in pain mitigation (Lai et al., 2004). VGSCs are made up of an alpha and a beta subunit. When the channel senses an electrical field, the alpha subunit acts as a voltage sensor, resulting in channel activation and sodium ion transit. VGSCs are further subdivided into those that are easily inhibited by tetrodotoxin (TTX) and those that are resistant to tetrodotoxin (TTX-R), which is also resistant to local anaesthetic and easily sensitized by prostaglandin (Black et al., 2004). When delivered to patients with pre-endodontic symptoms, activation of such channels results in less effective anaesthesia.

Caffeine has been proven in studies to speed up the emergence from anaesthesia and to be beneficial even at high anaesthetic dosages. According to our study, only 30.77 did not feel numbness after being given a local anaesthetic injection and the majority believed that excessive intake of coffee is the reason. Caffeine primarily affects the central nervous system by blocking adenosine receptors, consequently controlling neurotransmitter release. Caffeine can counteract adenosine's effects by acting as an antagonist of adenosine receptors A1 and A2A. Caffeine works by increasing intracellular cAMP levels as well as inhibiting adenosine receptors. Caffeine's complex pharmacology makes it particularly helpful in hastening recovery from anaesthesia. Recent research suggests that intravenous caffeine accelerates recovery from general anaesthesia in both healthy people and patients with trisomy 10 disease. Caffeine administered intravenously has also been explored in pre-term newborns to aid in their recovery from anaesthesia (Hargreaves & Keiser, 2002).

When additional patient-related characteristics such as smoking status, medical condition, and drug intake were considered, 92% had no smoking habit and no other significant medical conditions or drug intake. As a result, these variables are potential

components that may have a masking impact. Both nicotine and caffeine have stimulant properties, although smoking improves caffeine clearance due to its influence on cytochrome P450 (CYP1A2) (Temple et al., 2017). As a result, smoking may reduce the effect of caffeine on adenosine receptors, ensuring that the action of local anaesthetic is not diminished or challenged.

Caffeine has been demonstrated in studies to raise plasmatic levels of stress hormones, including catecholamines like adrenaline and cortisol. Furthermore, persistent caffeine consumption leads to tolerance to its adenosine receptor-dependent effects, generating receptor upregulation characterized by headache, anxiety, and flushing. This could be one of the causes of insufficient anaesthetic in this group of patients. Caffeine-induced anxiety and alertness may result in the failure of local anaesthetic due to stress (Wali, 1984)

4. CONCLUSION

Although some people believed that local anaesthesia can have a negative on the effectiveness of the anaesthetic solution, based on what the patient have experienced on dental clinics only 30.77% of the patients felt that their caffeine consumption was affecting their local anaesthesia success, while others do not. Other factors or variables that might play a role in the delivery of anaesthesia include Smoking, patient age, bone thickness of the area that the practitioner is working on, presence or absence of inflammation, and different pain threshold between patients. A dentist must be aware of the several factors that can increase or decrease the success rate of the local anaesthesia and treat each failed case according to the factor that might have reduced the anaesthesia delivery.

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Author's contribution

Each author contributed to the data analysis and interpretation, and they all contributed to the final draft's critical review and approval. They are also each accountable for the manuscript's content and similarity score.

Ethical approval

This study has been reviewed and approved by the Research Ethics Committee (REC) at the University of Ha'il. No. of Research: H-2022-292

Informed consent

Written & Oral informed consent was obtained from all individual participants included in the study. Additional informed consent was obtained from all individual participants for whom identifying information is included in this manuscript.

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Conflict of interest

The authors declare that there is no conflict of interests.

Data and materials availability

All data associated with this study are present in the paper.

REFERENCES AND NOTES

1. Ashihara H. Metabolism of alkaloids in coffee plants. Braz J Plant Physiol 2006; 18. doi: 10.1590/S1677-04202006000100001.
2. Badkook M. Arabic Coffee with Two Doses of Cardamom: Effects on Health Biomarkers in Healthy Women. Int J Food Sci Nutr 2013; 2:280. doi: 10.11648/j.ijnfs.20130206.13.
3. Black J A, Liu S, Tanaka M, Cummins T R, Waxman S G. Changes in the expression of tetrodotoxin-sensitive sodium channels within dorsal root ganglia neurons in inflammatory pain. Pain 2004; 108(3):237-247. doi: 10.1016/j.pain 2003.12.035.
4. Hargreaves K M, Keiser K. Local anaesthetic failure in endodontics. Endodontic Topics 2002; 1(1):26-39. doi: 10.1034/j.1601-1546.2002.10103.x.
5. Lai J, Porreca F, Hunter J C, Gold M S. Voltage-gated sodium channels and hyperalgesia. Annu Rev Pharmacol Toxicol 2004; 44:371-397. doi: 10.1146/annurev.pharmtox.44.101802.121627.

6. Premnath S, Alalshaikh G, Alfotawi R, Philip M. The Association between Coffee Consumption and Local Anesthesia Failure: Social Beliefs and Scientific Evidence. Cureus 2020; 12(4):e7820. doi: 10.7759/cureus.7820.
7. Sacerdote P, Levrini L. Peripheral mechanisms of dental pain: the role of substance P Mediators Inflamm 2012; 2012:951920. doi: 10.1155/2012/951920.
8. Tavares C, Sakata R K. Caffeine in the treatment of pain. Rev Bras Anestesiol 2012; 62(3):387-401. doi: 10.1016/s0034-7094(12)70139-3.
9. Temple J L, Bernard C, Lipshultz S E, Czachor J D, Westphal J A, Mestre M A. The Safety of Ingested Caffeine: A Comprehensive Review. Front Psychiatry 2017; 8:80. doi: 10.3389/fpsyt.2017.00080.
10. Wali F A. The effects and interactions of caffeine, lignocaine and carbachol at the chick neuromuscular junction. Pharmacol Res Commun 1984; 16(7):707-722. doi: 10.1016/s0031-6989(84)80049-1.
11. Wang Q, Fong R, Mason P, Fox A P, Xie Z. Caffeine accelerates recovery from general anaesthesia. J Neurophysiol 2014; 111(6):1331-1340. doi: 10.1152/jn.00792.2013.