Ref: Ro Med J. 2024;71(3)
DOI: 10.37897/RMJ.2024.3.3

Efficiency of dexamethasone in reducing the incidence of headaches after spinal anesthesia during caesarean section

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ABSTRACT

Background. A caesarean section is the delivery of a fetus through an abdominal incision (laparotomy) and a uterine incision (hysterectomy). The anesthesia method most often used for caesarean birth is spinal anesthesia, the prevailing complication of spinal anesthesia (SA) is post-dural puncture headache.

Aims of the study. To investigate the effects of dexamethasone in reducing the incidence of headache and pain in spinal anesthesia in caesarean section.

Subjects and methods. Clinical trial was conducted at Basra Maternity and Children Hospital from January 1, 2022 to July 1, 2023. The studied population was divided into two groups: Group I included 98 patients who received intravenous dexamethasone 0.2 mg/kg (maximum 16 mg) just after the spinal anesthesia, and Group II, the control group, which included 100 patients who received IV normal saline prior to spinal anesthesia. The average severity of headache was evaluated using the visual analogue scale (VAS) after recovery within the first hour, 24 hours, 48 hours, and 1 week.

Results. Dexamethasone usage significantly reduced postoperative pain (no pain: 89.7% vs. 68.0%), with a p-value equal to 0.001. No notable differences were found in sociodemographic characteristics, PDPH incidence (recovery time: 8.1% vs. 9.0%, 24 hours: 10.2% vs. 9.0%, 48 hours: 4.08% vs. 5.0%, one week: 0.0% vs. 0.0%).

Conclusion. Dexamethasone given intravenously had no discernible effect on headaches following a spinal puncture. It dramatically lowers pain after surgery, but it has no discernible impact on bradycardia, nausea or vomiting, shivering, or postoperative hypotension.

Keywords: anesthesia, spinal anesthesia, incidence, dexamethasone

INTRODUCTION

A caesarean section is the delivery of a fetus through an abdominal incision (laparotomy) and a uterine incision (hysterectomy). Since the first documented caesarean section in 2010 A.D., the procedure has undergone substantial development [1]. Each year, more than one million American women deliver by caesarean section (CS) [2]. The rates are anging from 4% in West and Central Africa to approximately 23% in the United Kingdom, nearly 32% in the United States, and over 44% in Latin America and the Caribbean [3,4]. Regarding the CS rate in Iraq, which is significantly higher than the recommended rate, from 2011 to 2018, the Kurdistan Region had the highest caesarean rate, at 58.5%, compared to the remainder of the country, which registered 45.1%. The increase was greatest among women under the age of 20, women with no education, women in the poorest and intermediate wealth quintiles, and rural women [5].

The safety and health benefits to the mother and fetus are an essential factor in selecting the anesthetic technique for caesarean delivery. With the improvement of anesthetic techniques, surgical procedures have become safer and more secure over time, but maternal and fetal mortality and morbidity are still significant [6]. Regional anesthesia (RA), such as spinal anesthesia (SA), epidural anesthesia (EA), or combined spinal-epidural anesthesia (CSE), or gener-

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Article History:
Received: 19 July 2024
Accepted: 13 September 2024

al anesthesia (GA) may be administered during a cesarean delivery.

Because regional anesthetic avoids the airway, lowers the danger of aspirating stomach contents, and is easier to administer, it has been suggested that spinal anesthesia is the best option for elective, straightforward cesarean birth [7]. Despite being a safe and efficient technique, regional anesthesia is linked to certain risks, including nerve damage, hypotension, post-dural puncture headache (PDPH), and local anesthetic toxicity [8,9]. However, general anesthesia is still employed, especially in cases when regional anesthetic is ineffective or inappropriate. A controlled ventilation system, a patent airway, and lessened cardiovascular depression are among the advantages of general anesthesia [10]. Frequent problems associated with gastric aspiration (GA) include aspiration of stomach content, discomfort, and fetal depression [11]. PDPH could be prevented and treated in a number of ways, such as bed rest, fluids, non-opioid painkillers, coffee, codeine, and corticosteroids [12]. A number of pharmaceutical treatments have been used to prevent postpartum depression in pregnant women, including aminophylline, hydrocortisone, magnesium, ondansetron, and propofol [13,14]. Furthermore, a number of research that sought to illustrate the effects of intravenous dexamethasone had inconsistent findings [15].

Strong and selective glucocorticoid with low mineralocorticoid activity is dexamethasone. When administered intravenously, analgesia may be prolonged due to its systemic anti-inflammatory and immunosuppressive properties [16]. Doses between 4 to 10 mg have been used in adults [17].

Exact mechanism of action of dexamethasone to reduce pain and PDPH incidence and severity is unclear. Because inflammation is essential to the pain cascade system, intravenous dexamethasone may reduce pain and PDPH by suppressing it [18,19]. Regarding the efficacy of intravenous dexamethasone in treating and preventing post-traumatic pressure injury (PDPH), there have been mixed results. According to certain research, steroids lessen the frequency and severity of PDPH [20], whereas at different doses, dexamethasone is unable to lessen the frequency and severity of PDPH [21], and yet another study discovered that dexamethasone considerably raises the incidence and intensity of postpartum hemorrhage following cesarean delivery [22].

PATIENTS AND METHODS

The study setting

The study was conducted at Basra maternity and child hospital which is the main referral center that serves the southern part of Basra city from January 1, 2022 to July 1, 2023. All our patients were women who attended the operation room of Basra Maternity and Children Hospital for lower segment elective caesarian section.

Study population

The studied population was divided into two groups: Group I included 98 patients who received intravenous dexamethasone 0.2 mg/kg (maximum 16 mg) just after the spinal anesthesia (identical kind of injection from the same firm was given to each patient), and Group II, the control group, which included 100 patients who received IV normal saline prior to spinal anesthesia.

Inclusion criteria

Women aged 21-45 years old with willingness to participate in the study; women deemed suitable for a cesarean section under spinal anesthesia by the anesthesiologist and the intensive care specialist.

Exclusion criteria

Women with a history of heart diseases, neurological or psychiatric disorders; women with a history of chronic pain syndrome, vascular disease or any other painful injury; women with systemic diseases such as diabetes, thyroid disease, etc.; women with a history of taking any pain medication and sedatives in the 24 hours before surgery; women with bad obstetric history, such as repeated scar, APH, and PPH; women with a history of opiate abuse, drug abuse or alcohol dependence.

Ethical approval

All procedures in this study that involved human participants were performed in accordance with the ethical standards of the Ministry of Health, General Directorate of Basrah Health, Iraq, and the required agreement verbal consent from women before study.

Data collection

After approval to participate in the study a questionnaire form was developed. Data were collected from the participants through a direct interview done by the researcher herself including the following: age, educational level, working status, the parity, any history of chronic diseases, past surgical history and drug history. Next, all patients had a pre-anesthetic check-up, which included normal examinations, a description of the operation, and the acquisition of signed informed consent. Heart rate, systolic and diastolic blood pressure, and oxygen saturation were recorded as the patients' baseline clinical parameters. One of the researchers then checked the patients' systolic and diastolic blood pressure, pe-

ripheral oxygen saturation (SpO_2), electrocardiogram (ECG), pulse rate (PR), and other vital signs when they arrived in the operation room.

A 25-G Quincke needle was put intrathecally via the midline method at the L3–L4 or L4–L5 interspace while the patient was seated and using sterile techniques. Next, medication was administered: dexamethasone for the first group, and normal saline for the second group. The patients were then placed in the supine posture and nasal prongs were used to administer oxygen at a rate of 3 L/minute. Only one anesthesiologist performed the spinal anesthesia for all the participant women using same size needle, one attempt and similar gauge direction and any patients who did not achieved these criteria was excluded from the study. Regarding the occurrence of headaches, individuals who got dexamethasone IV contrasted favorably with those who received normal saline. Patients were admitted to the surgery ward following the procedure. Differentials were assessed through interviews during the first 24 hours following spinal anesthesia, and the average headache severity was assessed using the visual analog scale (VAS) following recovery during the first hour, 24 hours, 48 hours, and 1 week following the procedure at the time of surgical thread removal.

The headache was identified as an occipital or frontal headache, which was alleviated by lying flat and made worse by sitting or being upright, coughing, sneezing, and straining. A pain assessment scale that is used to gauge the severity or frequency of different symptoms is the visual analogue scale (VAS). The pain VAS is a unidimensional pain intensity measure that can be used to track a patient's pain evolution or to evaluate the severity of different pains that are associated with similar diseases.

The headache severity was assessed at recovery within the first hour, 24 hours, 48 hours, and one week after the surgery, as they have been given an appointment to come back for sutures removal. Other post-operative complications had been assessed also like nausea, vomiting, and bleeding were observed too.

Prior to commencing the study, the Basra Directorate of Health gave the approval for its execution. The study was approved by the Iraqi Board of Medical Specializations. The 198 women who were enrolled were fully briefed on the topic matter and its importance, and their written consent was obtained prior to their participation.

Statistical analysis

A computerized statistical program called the Statistical Package for Social Sciences (SPSS) version 26 was used to enter the data. Frequencies and percentages were used to represent qualitative data, whereas mean ± standard deviation was used to represent quantitative data. The relevant statistical tests were run: two samples of independent t-tests were used for the continuous variable, and a Chi-square test was used for categorical variables (Fisher's exact test was employed when the anticipated variable was less than 5). Tables are used to display the results of all statistical studies, with the level of significance (p-value) set at < 0.05.

RESULTS

It is a prospective case-control study conducted at Al-Basra Maternity and Children Hospital from 1 January 2022 to 1 July 2023. This study assessed and checked 223 pregnant women who were subjected to a caesarean section under spinal anesthesia. But around 25 participants were excluded from the study because 12 women did not meet the inclusion criteria, 8 refused to participate, while 5 were not allocated to be followed and checked postoperatively. Finally, the total number of participants in this study was settled at 198. Ninety eight women cases and 100 women control were assessed using the VAS scale during the first 24 hours, 48 hours postoperatively, and after the first week at the time of stitch removal for PDPH and pain severity variable. There was no statistical difference between the studied groups regarding their sociodemographic characteristics, as shown in (Table 1) .

TABLE 1. Sociodemographic characteristics of the study group

Demographic characteristics	Case (N = 98)	Control (N = 100)	P-value
Age (mean in years)	29.4± 3.9	28.6 ± 3.2	0.143
BMI (mean)	28.3 ± 2.6	29.1 ±1.6	0.435
Length (mean in cm)	164.5 ± 5.4	163.6 ± 4.8	0.872
Level of education			
Illiterate	30 (30.6)	32 (32.0)	0.932
Medium	42 (42.8)	39 (39.0)	
Educated	26 (26.6)	29 (29.0)	
Smoking			
Yes	16 (16.3)	19 (19.0)	0.622
No	82 (83.7)	81 (81.0)	
Parity			
Primi	31 (31.6)	29 (29.0)	0.687
Multi para	67 (68.4)	71 (71.0)	

Table 2 shows no statistical differences between the two studied groups regarding their clinical characteristics while the duration of anesthesia was prolonged within the group who received dexamethasone and the p-value = 0.001 which is significant.

TABLE 2. Clinical characteristics of the two groups

Clinical characteristics	Case (N = 98)	Control (N = 100)	P-value
History of previous CS			
Yes	45 (45.91)	48 (48.0)	0.769
No	53 (54.09)	52 (52.0)	
Time of surgery in minutes	51.2 ± 10.3	52.1 ± 8.3	0.287
Duration of anesthesia in minutes	199.2 ± 45.2	166.38 ± 39.7	0.001
Gestational age			
Preterm	12 (12.3)	14 (14.0)	0.958
Term	80 (81.6)	78 (78.0)	
Post-term	6 (6.1)	8 (8.0)	
Duration of sensory loss in minutes	99.28 ± 6.8	99.5 ± 6.3	0.786

TABLE 3. Comparison between the two studied groups with regard to the PDPH

PDPH	Case (N = 98)	Control (N = 100)	P-value
History of previous CS			
In recovery time	8 (8.1)	9 (9.0)	0.977
24 hours	10(10.2)	9 (9.0)	
48 hours	4 (4.08)	5 (5.0)	
One week	0 (0.0)	0 (0.0)	

TABLE 4. Comparison between the two study groups in regard to the incidence of adverse events

Adverse effect	Case (N = 98)	Control (N = 100)	P-value
No pain	88 (89.8)	68 (68.0)	0.001
Pain	10 (10.2)	32 (32.0)	
Mild	6 (6.1)	16 (5.0)	
Moderate	3 (3.06)	12 (12.0)	
Severe	1 (1.02)	4 (4.0)	
Hypotension	5 (5.1)	6 (6.0)	0.782
Bradycardia	6 (6.1)	7 (7.0)	0.803
Nausea and vomiting	7 (7.1)	7 (7.0)	0.968
Shivering	12 (12.1)	11 (11.0)	0.785

Table 3 shows there is no statistical difference between the two studies in regard to PDPH at recovery time, 24 hours, 48 hours and a week postoperatively.

Table 4 shows that dexamethasone with spinal anesthesia decrease the pain following the operation and the difference was statistically significant.

DISCUSSION

The anesthesia method most often used for Caesarean birth is spinal anesthesia, which has a prevalence ranging from 80% to 95%. The prevailing complication of spinal anesthesia (SA) is post-dural puncture headache, which arises from dural puncture and subsequent leakage of cerebrospinal fluid. The use of intravenous (IV) dexamethasone has been employed in an effort to diminish the occurrence and intensity of post-dural puncture headache (PDPH); however, the outcomes have been subject to debate [23]. Consequently, the objective of this research was to investigate the impact of dexamethasone on the mitigation of post-dural puncture headache.

We conducted a study in which we assessed a total of 98 pregnant women who had a caesarean section (CS) under spinal anesthesia and were administered intravenous (IV) dexamethasone. We compared this group with a control group of 100 women who were of a similar age and also underwent CS under SA but instead got a placebo of IV normal saline. The statistical analysis indicated that there was no significant difference between the two groups regarding their age, as shown by a p-value of 0.143. Age is considered a significant factor in the development of post-Dural puncture headaches. The majority of research have shown a negative correlation between extremes of age and the occurrence of PDPH. Specifically, young individuals between the ages of 18 and 50 years have been identified as having the greatest risk for PDPH, as reported by Khlebtovsky et al. (2015) and Amorim et al. (2012) [24,25] .Younger individuals typically have a thicker and more elastic dura mater compared to older individuals. The increased elasticity may contribute to a higher likelihood of cerebrospinal fluid leakage after a lumbar puncture, leading to PDPH [26].

In order to mitigate potential bias, we ensured that the two groups were matched based on their body mass index (BMI) (p = 0.435). The existing body of research pertaining to the impact of body mass index on the risk of post-dural puncture headache yields inconsistent findings. Several studies have shown an increased likelihood of post-Dural puncture headache in individuals with a body mass index of 25 kg/m2 or lower [27]. Conversely, a reduced risk of PDPH has been seen in obese patients (BMI ≥31.5 kg/m2) after inadvertent dural puncture [28]. In contrast, previous research has shown that BMI does not have a significant impact on the occurrence of post-Dural puncture headaches, as demonstrated by studies conducted by Gaiser et al. (2017), Khraise et al. (2017), and Gaiser et al. (2016) [29,30,31]. The obesity led to increased difficulty in accessing the intrathecal space which may lead to multiple attempts or a traumatic puncture, increasing the risk of CSF leakage and subsequent PDPH [32]. Also, obesity is often associated with alterations in cerebral blood flow and hemodynamics. Changes in blood flow dynamics may influence the likelihood and severity of

PDPH by affecting the compensatory mechanisms that maintain normal CSF pressure [33].

The two groups were also found to have similar smoking and parity statuses (p = 0.622 and 0.687, respectively), which contributes to reducing bias and enhancing the quality of data analysis. Nevertheless, the existing literature lacks substantial evidence about the correlation between tobacco consumption and post-dural puncture headache. Nonetheless, a study conducted by Dodge et al. (2013) revealed a significant decrease in the incidence of PDPH among smokers when compared to non-smokers [34]. There is limited evidence or literature suggesting that smoking reduces the risk of PDPH. Smoking, particularly due to its vasoconstrictive effects and impact on cerebral blood flow, is more commonly linked to increased risks of PDPH and other complications. Nicotine, a major component of cigarette smoke, has vasoconstrictive effects. Smoking leads to the constriction of blood vessels, including those in the brain. This vasoconstriction can affect cerebral blood flow and the compensatory mechanisms that regulate intracranial pressure, potentially increasing the risk of PDPH [35].

Moreover, the state of having given birth several times, known as multiparity, has been linked to a heightened risk of post Dural puncture headache during the postpartum period, as shown by the findings of Orbach-Zinger et al. (2016) and Franz et al. (2017) [36,37]. With each pregnancy, changes occur in the spinal structures and surrounding tissues, including alterations in the epidural and intrathecal spaces. These changes can affect the dynamics of cerebrospinal fluid (CSF) and may increase the likelihood of leakage following a lumbar puncture, leading to PDPH [38]. Multiparty has been associated with epidural fibrosis, a condition characterized by the development of fibrous tissue around the spinal nerves. Epidural fibrosis may make the Dural puncture site less pliable and more prone to complications such as CSF leakage and subsequent PDPH [39].

In the present investigation, no statistically significant difference was seen in terms of the previous CS between the two cohorts (p = 0.769). There is a lack of documented evidence in the existing literature that evaluates whether a prior caesarean section is a risk factor for an increased incidence of post-Dural puncture headache. Nevertheless, according to Amorim et al. (2012) [25], pregnancy introduces an added susceptibility to post-Dural puncture headache, perhaps attributed to heightened cerebral vasodilation in reaction to cerebrospinal fluid hypotension, which is associated with elevated levels of circulating estrogen. There is also a prevailing belief that elevated cerebrospinal fluid pressure during the labor process contributes to a greater occurrence of CSF leakage and an increased susceptibility to post-Dural puncture headache [23].

The length of anesthesia in the case group was found to be considerably longer compared to the duration of anesthesia in the control group (p = 0.001). The potential presence of a confounding factor arises from the extended duration of anesthesia, which may result in the development of intracranial hypotension due to cerebrospinal fluid leakage. This, in turn, may lead to the drooping of intracranial structures and the stretching of sensory intracranial nerves, ultimately resulting in the experience of pain and this was explained according to the evidence from Ljubisavljevic et al. (2019) [40].

There were no significant differences in gestational age between the two groups, as shown by a p-value of 0.938. There is a lack of existing research that examines the correlation between gestational age and the likelihood of post-dural puncture headaches. Additionally, there is no significant difference in the length of sensory loss between the two groups (p = 0.786). There is no apparent correlation between the duration of sensory loss and the occurrence of post-dural puncture headaches. Other variables, such as the amount of cerebrospinal fluid extracted and the length of bed rest after lumbar puncture, as well as the enhancement of hydration via increased fluid intake, have been identified as potential influencing factors [41].

The present study also observed that there was no statistically significant difference in the incidence of post-Dural puncture headache between the patients and controls at various time points, including the recovery period within the first hour, 24 hours, 48 hours, and one week (p = 0.977). The present investigation demonstrates that post-dural puncture headache manifests at a rate of about 8–9% during the recovery period, increases to 9–10% on the first day, and thereafter decreases to around 4-5% by the second day. Notably, none of the individuals reported experiencing headaches beyond one week. The observed prevalence of post-Dural puncture headache in this study is notably lower compared to the published figures in existing literature. Previous research has documented a wide range of incidence rates for PDPH after spinal anesthesia, ranging from 0% to 42.6% [42-44]. Nevertheless, previous studies conducted by Khraise et al. (2017), Oberhofer (2013), and Mohammed et al. (2017) have shown varying rates of post-Dural puncture headache among their various study populations, with incidences of 6.3%, 14.3%, and 15.8% seen, respectively. The results obtained by the researchers were in good agreement with our own findings [30,45,46]. The primary factor contributing to this disparity may be attributed to variations in needle size. However, this factor was fixed in our study as all of the patients underwent spinal anesthesia using same needle size.

The administration of intravenous dexamethasone has the potential to decrease the occurrence and

intensity of post-Dural puncture headache (PDPH) and associated pain. This effect is achieved by the activation of glucocorticoid steroid receptors, which induce vasoconstriction and hinder the absorption of locally given anesthetics. Consequently, the synthesis of inflammatory mediators is inhibited. The study conducted by Rosenfeld et al. (2016) yielded contentious findings in relation to the impact of intravenous dexamethasone on the reduction of both the frequency and intensity of post-Dural puncture headache (PDPH) [47]. The present investigation demonstrates a lack of efficacy of corticosteroids in mitigating the occurrence of post-Dural puncture headaches. The study conducted by Yousefshahi et al. (2017) has demonstrated a positive association between the administration of intravenous dexamethasone and the occurrence of post-Dural puncture headache [22]. Conversely, Yang et al. (2015) and Mahmoud et al. (2014) have reported no statistically significant benefit in terms of both the occurrence and severity of PDPH with the use of intravenous dexamethasone, which aligns with our own findings [21,48]. However, Alam et al. (2012) and Basurto et al. (2015) have shown that the use of steroids actually reduces the incidence and severity of PDPH [49,50].

While it is evident that intravenous corticosteroids have shown significant efficacy in reducing postoperative pain, it is worth noting that only 10.2% of the cases that received IV dexamethasone reported experiencing pain, with the majority (6.1%) reporting mild pain. In contrast, it was seen that 32% of the control group, who were administered normal saline intravenously, encountered discomfort. Among this group, the majority (12% overall) reported experiencing moderate pain rather than mild pain, with 4% reporting severe pain. It is worth noting that just one instance exhibited severe pain alone (p=0.001). According to the study conducted by Shahraki et al. (2013), it was postulated that any surgical procedure induces bodily stress and tissue damage, resulting in pain and associated complications. To address this issue, the researchers suggested that glucocorticoids, specifically dexamethasone, which possess potent anti-inflammatory properties, could be utilized for a limited duration following surgery to effectively manage post-operative pain in diverse surgical interventions. The mechanism of action of glucocorticoids is not entirely known; however, the proposed possibilities include: The suppression of the synthesis of inflammatory mediators, such as prostaglandin and bradykinin, serves to impede the decrease in the "pain threshold" that often arises during surgical procedures. Additionally, this inhibition of inflammatory responses leads to a reduction in tissue swelling, therefore decreasing nerve compression caused by inflamed tissue [51]. While earlier research conducted by Hval et al. (2007) suggested a limited analgesic impact of dexamethasone with a relatively slow onset of action, our present investigation demonstrates the efficacy of intravenous administration of dexamethasone in reducing pain [52]. The findings of Jokela et al. (2009) and Romundstad (2016) align with the outcomes seen in our investigation [53,54]. Two comprehensive meta-analyses conducted by Waldron et al. (2013) and De Oliveira et al. (2011) have indicated that the administration of a single intravenous dose of dexamethasone to general surgical patients may potentially provide analgesic advantages [55,56].

In relation to the postoperative issues experienced by the patients, the present investigation did not observe a statistically significant impact of corticosteroid administration on the reduction of hypotension, bradycardia, nausea and vomiting, or shivering (p>0.05). Our results do not align with the findings of Ashoor et al. (2021), as they observed a lower incidence of post-spinal anesthesia hypotension, nausea, vomiting, and shivering in patients who received a single preoperative dose of intravenous dexamethasone 8 mg compared to the control group. However, it is important to note that the differences in patient demographics and types of surgery between our study and Ashoor et al.'s study may have contributed to these disparate findings [57].

CONCLUSION

From the current study we concluded the following: Intravenous dexamethasone has no significant effect on reducing post-dural puncture headaches, the postoperative pain is significantly reduced (no pain: 89.7% vs. 68.0%), with a p-value equal to 0.001, and it tends to be more mild pain than moderate or severe among those who received intravenous dexamethasone, and intravenous steroid has no significant effect on the reduction of postoperative hypotension, bradycardia, nausea or vomiting, or shivering. No notable differences were found in sociodemographic characteristics, PDPH incidence (recovery time: 8.1% vs. 9.0%, 24 hours: 10.2% vs. 9.0%, 48 hours: 4.08% vs. 5.0%, one week: 0.0% vs. 0.0%).

Authors' contributions:
Conceptualization, Noor Sabri Ali; methodology, Sajidah al -Rubaai; software, Tishreen Sabri Ali; validation, Noor Sabri Ali; formal analysis, Tishreen Sabri Ali; investigation, Sajidah al-Rubaai; resources, Tishreen Sabri Ali; data curation, Noor Sabri Ali; writing—original draft preparation, Tishreen Sabri Ali; writing—review and editing, Noor Sabri Ali ; visualization, Noor Sabri Ali; supervision, Sajidah al -Rubaai; project administration, Noor Sabri Ali; funding acquisition, Sajidah al -Rubaai . All authors have read and agreed to the published version of the manuscript.

Financial support: none declared

Conflict of interest: none declared

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