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Original Research Article

A Comparative Study of Incidence of Post Dural Puncture Headache using 25 G Quincke Needle versus 25 G Whitacre Needle in Patients Undergoing Lower Limb Orthopaedic Surgeries

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Abstract

Introduction: Although spinal anaesthesia is a very common technique in anaesthetic care, it involves many complications, with post-dural puncture headache (PDPH) being one of the most common. Atraumatic pencil-point spinal needles are associated with a lower incidence of PDPH than cutting needles.

Methods: The hospital-based, observational comparative study included 144 patients, aged 18 to 60 years, of either sex, undergoing lower limb orthopaedic surgeries under spinal anaesthesia. Patients were assigned into two equal groups (n=72 each), who were consecutively sampled. 25 G Quincke needles in Group Q and 25 G Whitacre needles in Group W were used for administration of drug into the CSF. We evaluated the incidence and severity of PDPH, post-spinal backache, PDPH based on gender, PDPH based on any pre-existing headache before lumbar puncture, and perioperative side effects.

Results: Demographic and haemodynamic parameters were similar in both groups ($p>0.05$). PDPH was seen in 13.89% of the Quincke group and 4.17% of the Whitacre group, demonstrating a statistically significant decrease with Whitacre needles ($p=0.0419$). Incidence of PDPH was higher among the female patients and individuals with any pre-existing headache before lumbar puncture ($p<0.05$). The incidence of post-spinal backache and perioperative side effects, such as nausea, vomiting, hypotension, and bradycardia, was higher in the Quincke group, however, these differences were not statistically significant ($p>0.05$).

Conclusion: Although the use of both spinal needle designs provides comparable haemodynamic stability and procedural success rate, the 25 G Whitacre pencil-point spinal needle significantly lowers the incidence of post-dural puncture headache compared to the 25 G Quincke needle. Hence, the routine use of Whitacre needles for spinal anaesthesia in lower limb orthopaedic surgeries could be considered as a better choice.

Keywords: Spinal Anaesthesia, Post-Dural Puncture Headache, Quincke Needle, Whitacre Needle, Orthopaedic Lower Limb Surgery.

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Introduction

Spinal anaesthesia is one of the most regularly used regional anaesthetic techniques for the lower limb orthopaedic surgeries. It is highly appreciated for its simplicity, rapid onset, low cost, and the ability to produce a very effective sensory and motor blockade. The discovery of spinal anaesthesia went back to 1885 when James Leonard Corning, a neurologist from New York, accidentally punctured the dura mater while using cocaine on a dog model, which resulted in the discovery of spinal analgesia. [1] Then, in 1898, August Bier carried out the first intentional spinal anaesthesia on humans with intrathecal cocaine and later showed its use in clinical settings. Cocaine was finally discarded due to its harmful effects but Bier's groundbreaking work formed the basis for spinal anaesthesia as it is practiced today. [2] The use of spinal anaesthesia in current practice has become the modality of choice for lower limb orthopaedic procedures due to the adequacy of muscle relaxation, reduction of intraoperative blood loss and thromboembolic risk, and the avoidance of airway manipulation. [3]

These benefits provided better postoperative analgesia and overall patient satisfaction; however, as with all types of regional anaesthesia, certain complications had to be considered regarding their impact on postoperative recovery. [4]

Among these complications, post-dural puncture headache (PDPH) remained one of the most annoying side effects after spinal anaesthesia. PDPH was caused by the leakage of cerebrospinal fluid (CSF) from the dural puncture site, which led to intracranial hypotension and the stretching of pain-sensitive structures. [5] Several factors determined the occurrence and intensity of PDPH, such as the patient's age, sex, pregnancy, body mass index, any pre-existing headache before the lumbar puncture, the number of dural puncture attempts, and the type of spinal needle used. [1] Larger-gauge needles and cutting-tip needles were more likely to cause PDPH compared to smaller-gauge and atraumatic pencil-point needles. [6]

One of the ways to tackle PDPH was to change the design of spinal needles. In 1951, Hart and Whitacre introduced a pencil-point spinal needle featuring a blunt tip without any cutting edge, designed to separate dural fibers rather than cut them. [4] A number of studies documented that the use of Whitacre needles resulted in fewer cases of PDPH as well as other complications following spinal anesthesia compared to traditional Quincke needles, which had a cutting edge. Apart from PDPH, another significant yet subtle complication, which was often under-reported, was post-spinal backache, a pain distinct from PDPH that could impair mobility in the postoperative period. Post-spinal backache after neuraxial blockade was reportedly common, and patients frequently expressed concern regarding postoperative back pain following spinal anaesthesia. [5] The etiology remained uncertain; however, local trauma, post-puncture inflammation, ligamentous strain, muscle spasm, patient position, prolonged immobilization and needle-induced tissue injury were all thought to contribute. [7] Understanding the association between spinal needle characteristics and post-anaesthetic complications, such as PDPH and post-spinal backache, could help guide future clinical practice.

Therefore, the present study was carried out to evaluate the incidence of post dural puncture headache using 25 G Quincke needle versus 25 G Whitacre needle in patients undergoing lower limb orthopaedic surgery.

Material and Methods

Study Design and Setting: This hospital-based, observational study was carried out in the Department of Anaesthesiology at Assam Medical College and Hospital, Dibrugarh, from January 2024 to December 2024. The objective of the research was to evaluate and compare the incidence of PDPH and post-spinal backache occurring after spinal anaesthesia with 25 G Quincke cutting spinal needles versus 25 G Whitacre non-cutting spinal needles in patients undergoing orthopaedic surgeries of lower limbs.

Study Population and Sample Size: In total, the study involved 144 patients aged 18-60 years, classified as ASA physical status I and II, who were consecutively sampled. The sample size was calculated based on the reported incidences of PDPH with 25 G Quincke and 25 G Whitacre needles as 16% and 2.6% respectively.[3] With a confidence level of 90% and a power of 80%, the calculation indicated that each group required 72 subjects. Patients with history or symptoms of bleeding disorders and major systemic illnesses, spinal deformity, contraindications to neuraxial anaesthesia or those who refused to give consent were excluded from the study.

Ethical Consideration: The study was carried out after obtaining approval from the Institutional Ethics Committee (H) of Assam Medical College and Hospital, and written informed consent from each participant.

Anaesthetic Technique and Study Procedure: All patients underwent a pre-anaesthetic evaluation, and their ASA grade was confirmed. Baseline vitals, such as pulse rate, blood pressure, respiratory rate and oxygen saturation, were recorded. An 18 G intravenous (IV) cannula was inserted pre-operatively and hydrated with infusion of 10-15 mL/kg of crystalloid. Intravenous boluses of ondansetron (4 mg) and midazolam (1 mg) were administered before spinal anaesthesia.

Under strict aseptic and antiseptic precautions, a lumbar puncture was performed at L3-L4 intervertebral space with either a 25 G Quincke cutting spinal needle (Group Q) or a 25 G Whitacre non-cutting spinal needle (Group W).

Upon confirming the free flow of CSF, 12-17 mg of 0.5% hyperbaric bupivacaine was injected into the spinal canal. Sensory blockade was assessed by the pin prick method, and motor blockade was assessed by the Modified Bromage Scale. The operation was commenced once sufficient sensory and motor blockades were obtained. Oxygen supplementation at 5 L/min through a face mask was administered to all patients during the surgery.

Patients were observed for perioperative complications, such as hypotension, bradycardia, nausea, vomiting, dysuria, vertigo and failed spinal anaesthesia. Postoperatively, all patients were monitored until the 7^{th} post-spinal day for the occurrence of PDPH and post-spinal backache.

Outcome Measures: PDPH was diagnosed if the patient complained of postural headache in the frontal or occipital regions within 48 to 72 hours of spinal anaesthesia that worsened with sitting or standing and was relieved by lying down, and which could be associated with nausea, vomiting, diplopia, neck stiffness or tinnitus. The severity of headache was classified as mild, moderate and severe based on degree of activity limitation and analgesic requirement. Post-spinal backache was identified as localized discomfort at the puncture site without any radicular symptoms. The affected patients were treated with bed rest, adequate IV fluid, diclofenac, paracetamol, tea, caffeine and stool softeners, or with epidural blood patch (in severe cases).[8]

Demographic variables, perioperative haemodynamic parameters, incidence and severity of PDPH, post-spinal backache and other complications were recorded and analysed.

Statistical Analysis: Data analysis was performed using SPSS version 20.0 and Microsoft Excel 2010. Continuous variables were presented as mean standard deviation and compared using the Student's t-test, whereas the categorical variables were compared using the Chi-square test or Fisher's exact test. A p-value below 0.05 was considered statistically significant.

Results

The study enrolled 144 patients undergoing lower limb orthopaedic surgeries. Patients were consecutively sampled into two groups of 72 each. Patients were administered spinal anaesthesia using a 25 G Quincke spinal needle in Group Q and a 25 G Whitacre spinal needle in Group W.

Demographic characteristics, such as age, sex, weight, height and body mass index, were comparable between the two groups (Table 1), with no statistically significant differences (p>0.05). Haemodynamic parameters, including mean arterial pressure (MAP), heart rate (HR), respiratory rate (RR) and oxygen saturation (SpO_2) were also comparable between the two groups throughout the intraoperative and postoperative periods.

Table 1: Demographic and Baseline Characteristics

Parameters		Group Q	Group W	p-value
Age (years), Mean ± SD		38.61 ± 11.79	42.06 ± 14.08	0.1137
Sex	Male, N (%)	57 (79.17%)	50 (69.44%)	0.1821
	Female, N (%)	15 (20.83%)	22 (30.56%)	
Height (cm), Mean ± SD		162.60 ± 7.18	160.10 ± 9.18	0.2509
Weight (kg), Mean ± SD		62.61 ± 9.50	59.69 ± 9.62	0.0971
BMI (kg/m²), Mean ± SD		23.56 ± 2.25	23.18 ± 1.79	0.0629

Our findings revealed that 13.89 % of patients in Group Q and 4.17% of patients in Group W developed PDPH; and on comparison between the groups (Table 2), they were found to be statistically significant (p=0.0419).

Table 2: Incidence of PDPH

PDPH	Group Q		Group W		p-value
	N	%	N	%	**0.0419**
Present	10	13.89	3	4.17	
Absent	62	86.11	69	95.83	
Total	72	100	72	100	

***Chi-square test**

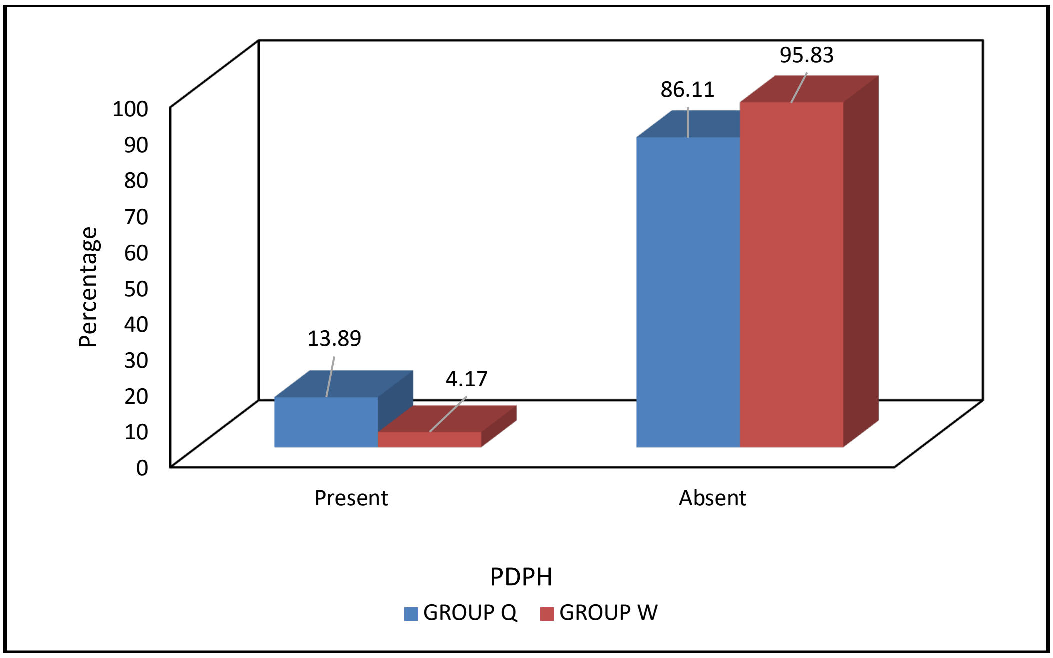

Figure 1: Incidence of post-dural puncture headache (PDPH)

Our study found that 9.72% in Group Q and 2.78% in Group W developed mild PDPH, while 4.17% in Group Q and 1.39 % in Group W developed moderate PDPH. This difference in severity was not statistically significant (p=0.5485) between the groups (Table 3).

Table 3: Severity of PDPH

Severity of PDPH	Group Q		Group W		p value
	N	%	N	%	0.5485
Mild	7	9.72	2	2.78	
Moderate	3	4.17	1	1.39	
Severe	0	0	0	0	
Total	10	13.89	3	4.17	

***Chi-square test**

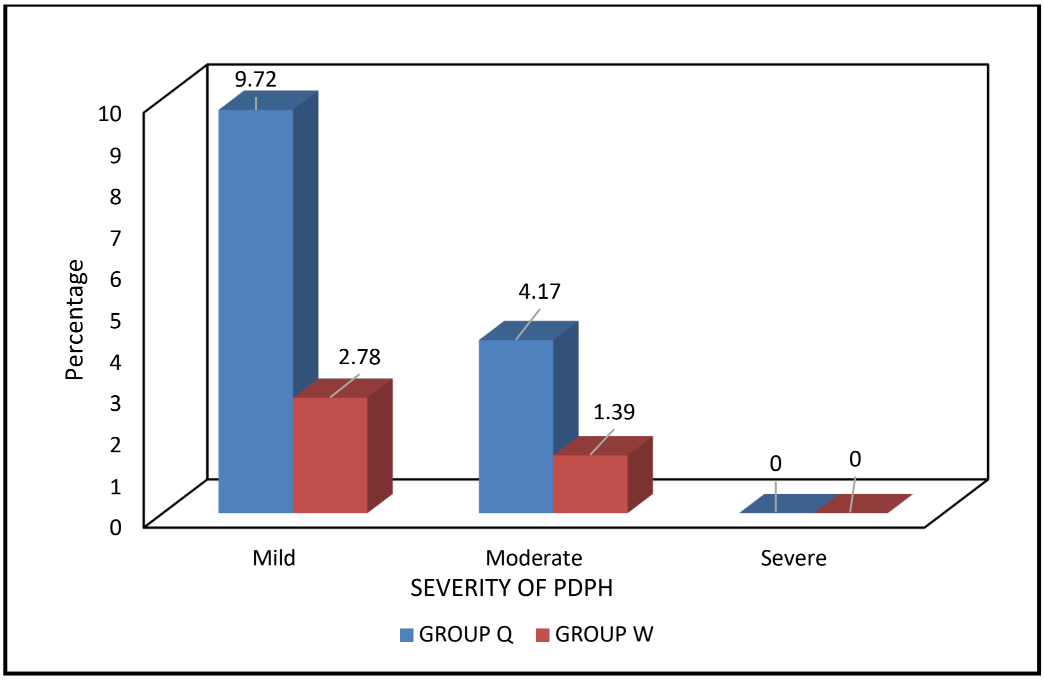

Figure 2: Severity of post-dural puncture headache (PDPH)

The study cohort comprised of 107 male patients and 37 female patients in both groups. An analysis based on gender showed that 18.92% of female patients developed PDPH compared to only 5.61% of male patients. Conversely, 81.08% of female patients and 94.39% of male patients did not develop PDPH. This higher incidence of PDPH among female patients was statistically significant (p=0.0355); (Table 4).

Table 4: Proportion of PDPH based on gender

Gender	Total (N=144)	PDPH				p value
		Present		Absent		
		N	%	N	%	0.0355
Male	107	6	5.61	101	94.39	
Female	37	7	18.92	30	81.08	

***Chi-square test**

With respect to history of headache, 11 patients had pre-existing headache before the lumbar puncture, while 133 patients did not. Notably, 63.63% of patients with pre-existing headache before the lumbar puncture had developed PDPH after the lumbar puncture while only 4.51% of patients with no pre-existing headache before the lumbar puncture had developed PDPH after the lumbar puncture. Conversely, 36.37% of the patients with pre-existing headache before the lumbar puncture and 95.49% of the patients with no pre-existing headache before the lumbar puncture did not develop PDPH. This variation was highly statistically significant (p<0.001); (Table 5).

Table 5: PDPH depending on pre-existing headache before the lumbar puncture

Pre-existing headache		PDPH				p-value
		Present		Absent		
		N	%	N	%	
Present	11	7	63.63	4	36.37	0.0001
Absent	133	6	4.51	127	95.49	

***Chi-square test**

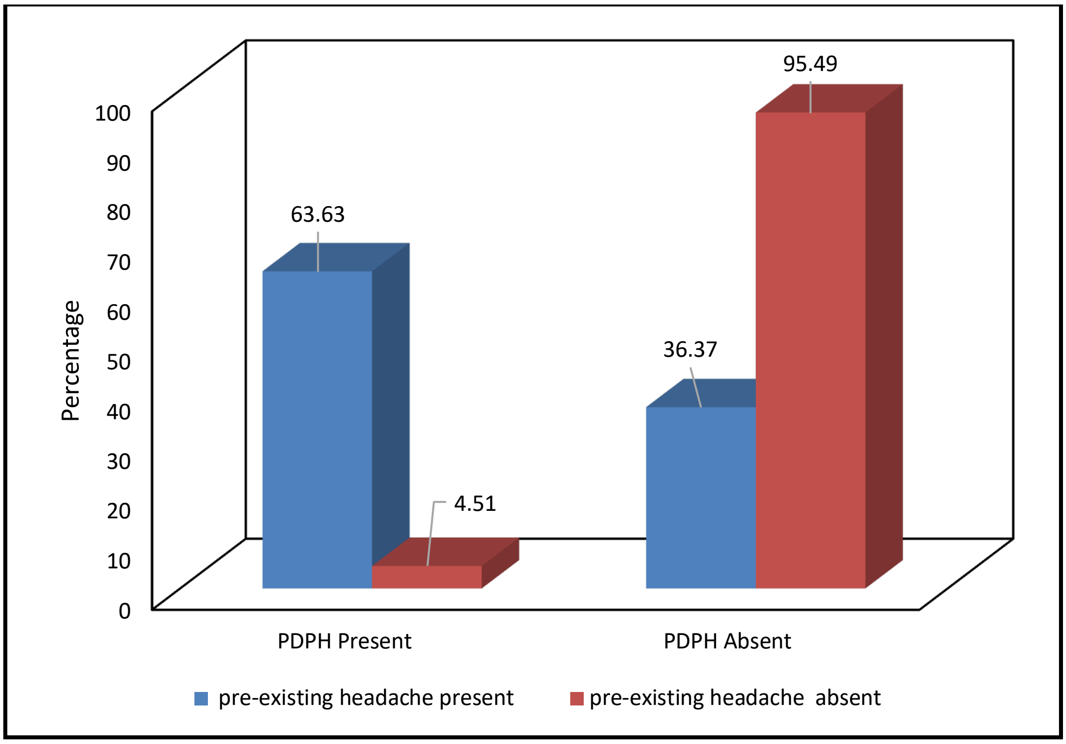

Figure 3: Incidence of post-dural puncture headache (PDPH) based on pre-existing headache before the lumbar puncture

In our study, 11.11% of patients in Group Q and 6.94% of patients in Group W developed post-spinal backache, whereas the remaining 88.89% of patients in Group Q and 93.06% of patients in Group W did not, which was not statistically significant (p=0.3833) on comparison (Table 6).

Table 6: Post-Spinal Backache (PSB)

Post-Spinal Backache	Group Q		Group W		p-value
	N	%	N	%	0.3833
Present	8	11.11	5	6.94	
Absent	64	88.89	67	93.06	
Total	72	100	72	100	

*Chi-square test

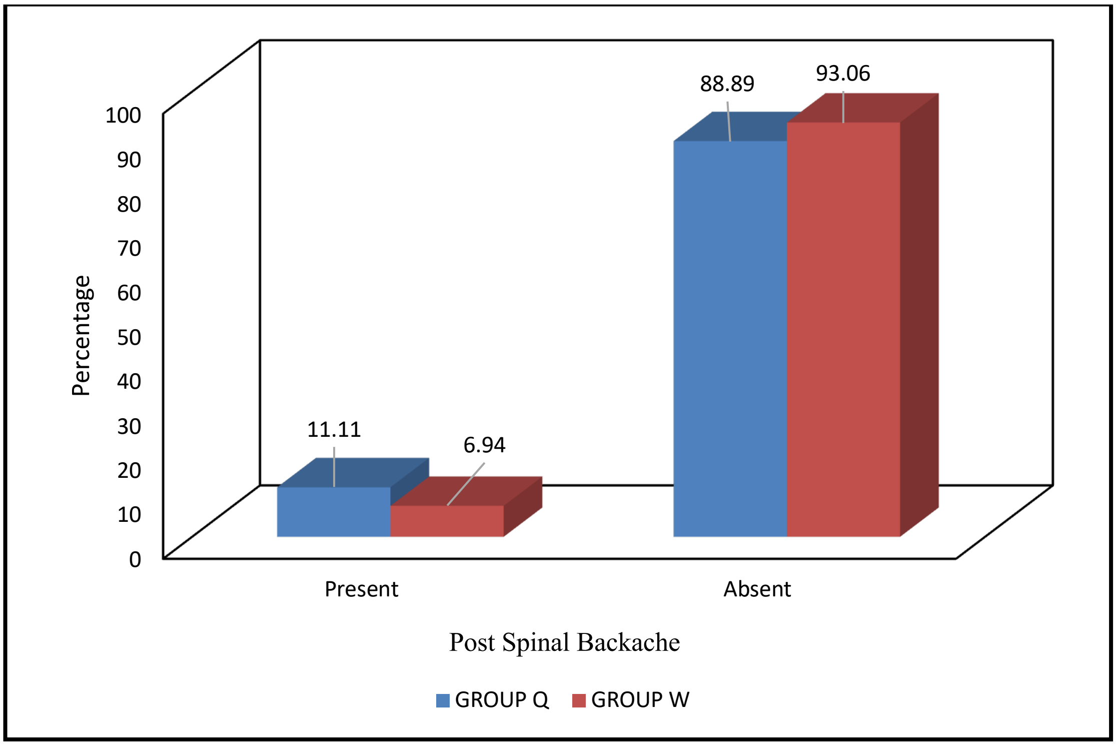

Figure 4: Incidence of post-spinal backache

In our study, some side effects, such as nausea (12.50% vs 11.11%), vomiting (5.56% vs 4.17%), dysuria (4.17% vs 2.78%), hypotension (37.50% vs 33.33%), bradycardia (5.56% vs 2.78%) and vertigo (4.17% vs 1.39%), were seen in both groups (Group Q vs Group W, respectively), which were not statistically significant (p>0.05) on comparison between the groups (Table 7).

Table 7: Side Effects

Side Effects	Group Q		Group W		p value
	N	%	N	%	
Nausea	9	12.50	8	11.11	0.7193
Vomiting	4	5.56	3	4.17	0.6985
Dysuria	3	4.17	2	2.78	0.6468
Hypotension	27	37.50	24	33.33	0.5839
Bradycardia	4	5.56	2	2.78	0.6892
Vertigo	3	4.17	1	1.39	0.6242

*Chi-square test

Discussion

Spinal anaesthesia is a widely used regional anaesthesia technique due to its affordability, ease of use, safety and cost-effectiveness. It provides sufficient analgesia and deep muscular relaxation while maintaining consciousness and spontaneous respiration. However, spinal anaesthesia is accompanied by perioperative adverse effects, including PDPH, post-spinal backache, and hypotension, nausea, vomiting and shivering. These adverse effects can cause patient discomfort, delayed hospital discharge, increased expenses, morbidity and overall patient dissatisfaction.

Effective management of these side effects is crucial to minimize their impact and ensure optimal patient outcomes. Despite these risks, spinal anaesthesia remains a popular choice due to its distinct clinical benefits across various surgical procedures. This study examined whether the incidence of PDPH and other complications differed following the use of 25 G Quincke cutting needles and 25 G Whitacre pencil-point needles for spinal anaesthesia during lower limb orthopaedic surgeries. Both groups exhibited similar baseline demographic characteristics, such as age, height and weight (Table 1), as well as comparable perioperative haemodynamic profile, confirming that they were well-matched for the study (p>0.05).

Our findings revealed that the incidence of PDPH was significantly higher in Group Q (13.89 %) than in Group W (4.17%); (p=0.0419); (Table 2, Figure 1). Other studies have similarly demonstrated a higher incidence of PDPH with Quincke needles compared to Whitacre needles. [1,3,8,9,10] Furthermore, the incidence of the severe cases of PDPH was higher in Group Q than in Group W (Mild: 9.72% vs 2.78%, Moderate: 4.17% vs 1.39%, respectively; p=0.5485; (Table 3, Figure 2), which was similar to findings from the other studies. [8,11]

The cutting tip design of Quincke needle causes more extensive mechanical injury to the dura mater. This leads to greater amount of CSF leakage and subsequent reduction in CSF pressure. Consequently, traction is exerted on pain-sensitive intracranial structures, such as the meninges, arteries and cranial nerves, which precipitate the PDPH. In contrast, the pencil-point tip design of Whitacre needle separates rather than cuts the dural fibers, causing less structural injury to the dura mater. This difference in the needle-tip design is the primary mechanism behind the varying rates of PDPH between the two needle types. [3] Therefore, employing Whitacre needle for lumbar puncture over Quincke needle provides a better choice for reducing the risk of PDPH in patients.

Factors influencing the incidence and severity of PDPH12 are (a) Patient-related factors: Younger age, female sex, pregnancy, a previous history of PDPH and a history of chronic headaches or migraine (b) Procedure-related factors: Larger needle diameter (which increase CSF leakage), cutting-tip designs, multiple dural puncture attempts, bevel end orientation (alignment parallel to longitudinal dural fibers reduces leakage) and operator experience (c) CSF dynamics: A greater volume and prolonged duration of CSF loss are directly related to severity of headache.

In our study, the incidence of PDPH was higher in female patients (18.92%) than in male patients (5.61%), showing statistically significant association (p=0.0355) between female gender and PDPH (Table 4). This finding is consistent with another study.[3] Female patients tend to experience higher incidence of PDPH due to several physiological and hormonal differences. [13] One key factor is that females often exhibit higher baseline CSF pressure, rendering them more susceptible to persistent CSF leakage. Additionally, smaller average dural sac diameter in female may increases the structural risk of CSF leakage. Hormonal fluctuations, particularly changes in oestrogen levels, may modulate dural sac elasticity, influence intracranial vascular compliance and intracranial pressure, and thereby exacerbating CSF leakage.

We also observed that the incidence of PDPH was significantly higher (p<0.001) in patients with any pre-existing headache prior to the lumbar puncture (63.63%) compared to those without any pre-existing headache prior to the lumbar puncture (4.51%); (Table 5, Figure 3), and this was similar to findings from other studies.[14,15] Patients with pre-existing headache are more likely to develop PDPH due to several underlying factors.[14] The pre-existing headache may indicate underlying dural weakness and increased intracranial pressure which can exacerbate CSF leakage, and contribute to PDPH. Genetic predisposition may also play a role due to inherited traits. Furthermore, pre-existing headaches might have caused changes in CSF dynamics, making it more challenging for the dural defect to seal spontaneously after puncture.

Our study found the incidence of post-spinal backache (PSB**)** was 11.11% in Group Q and 6.94% in Group W (Table 6, Figure 4) with no significant association (p=0.3833) and was similar to the finding from other study.[5] Post-spinal backache is a common complication that can occur due to several reasons:[16] (a) The dural puncture cause localized inflammation and irritation of the meninges (b) Decreased CSF pressure causes traction on the meninges and nerves (c) Spinal anaesthesia causes muscle relaxation which can lead to strain on the back muscles (d) The positioning of the patient during surgery can cause strain on the back muscles (e) The needle used for spinal anaesthesia can cause trauma to the ligaments and muscles in the back (f) The local anaesthetic used for spinal anaesthesia can cause chemical irritation to the meninges and nerves.

The side effects, such as nausea, vomiting, hypotension, bradycardia, dysuria and vertigo, were observed in both groups without statistical significance (p>0.05); (Table 7). Hypotension was the most common perioperative adverse event observed in both groups (37.50% in Group Q vs 33.33% in Group W; p=0.5839).

Similar to the findings from other studies, [8,10] the comparable profile regarding the overall side-effects observed in our study has signified that both needle designs are equally safe about perioperative complications, with the primary distinction being in the incidence of PDPH. To summarize, our study has demonstrated that the use of 25 G Whitacre spinal needle significantly lowers the incidence of

PDPH than 25 G Quincke spinal needle without compromising the procedural success. So, it is highly advisable to routinely use Whitacre atraumatic needles in patients undergoing lower limb orthopaedic surgeries under spinal anaesthesia to minimize PDPH and enhance postoperative patient comfort.

Conclusion

In conclusion, this study has demonstrated that the 25G Whitacre pencil-point spinal needle significantly decreases the incidence of PDPH compared to the 25G Quincke cutting needle in patients undergoing lower limb orthopaedic surgeries under spinal anaesthesia.

Both spinal needles have provided comparable haemodynamic stability, dural puncture success rates and perioperative side effects. The female sex and pre-existing headache prior to spinal anaesthesia were identified as the most significant risk factors for the development of PDPH. Therefore, the routine use of a 25G Whitacre needle offers a safer and more effective way to decrease the burden of PDPH and enhancing the comfort of patients after surgery.

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