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Original Research Article

Comparison of Ultrasound Guided Transverse Abdominis Plane Block with Intrathecal Fentanyl in Patients Undergoing Spinal Anaesthesia for Lower Abdominal Surgeries

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Conflict of interest: Nil

Abstract:

Background: Effective postoperative pain control in lower abdominal surgeries remains a challenge. While intrathecal fentanyl enhances spinal anaesthesia, ultrasound-guided Transverse Abdominis Plane (TAP) block has emerged as an alternative opioid-sparing technique.

Aim: To compare the efficacy and safety of ultrasound-guided TAP block with intrathecal fentanyl in patients undergoing spinal anaesthesia for lower abdominal surgeries.

Methodology: This quasi-experimental study included 38 patients randomly divided into two groups: Group ST (spinal anaesthesia + TAP block) and Group SA (spinal anaesthesia + intrathecal fentanyl). Hemodynamic parameters, pain scores, rescue analgesia requirement, and side effects were assessed up to 36 hours postoperatively.

Results: Hemodynamic parameters were comparable between groups ($p>0.05$). The ST group showed significantly lower pain scores from 4 to 36 hours ($p<0.001$) and reduced need for rescue analgesia (15.8% vs. 57.9%, $p=0.007$). Side effects were higher in the SA group, with pruritus significantly more frequent.

Conclusion: Ultrasound-guided TAP block provides superior and prolonged postoperative analgesia with fewer side effects compared to intrathecal fentanyl, making it a safer and more effective option.

Keywords: TAP Block, Intrathecal Fentanyl, Spinal Anaesthesia, Postoperative Analgesia, Lower Abdominal Surgeries.

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Introduction

Lower abdominal surgeries constitute a significant proportion of elective and emergency surgical procedures performed worldwide, encompassing a wide range of interventions such as hernia repair, appendectomy, gynecological procedures, and urological surgeries [1]. Perioperative pain management functions as a vital component for these surgeries because insufficient analgesia results in higher patient suffering and extended recovery time and increased hospital duration and greater complication risks. The medical field has recently focused on multimodal analgesia techniques which doctors use to achieve better patient results while reducing opioid-related side effects.

Spinal anaesthesia is widely regarded as a safe and effective technique for lower abdominal surgeries because it provides fast results and produces dependable sensory and motor blockades while decreasing the need for systemic medications [2]. However, spinal anaesthesia does not provide sufficient postoperative pain relief because it fails to deliver complete pain control during the first hours after surgery when patients experience their most intense pain. The development of multiple adjuvant techniques has been studied to create solutions which extend pain relief time and improve patient comfort.

Intrathecal opioids, which include fentanyl, serve as extensive adjuvants for spinal anaesthesia according to research [3]. The highly lipophilic opioid fentanyl produces fast effects through its spinal cord opioid receptor binding which results in greater pain relief without extending motor function impairment. The implementation of this method with local anesthetics in spinal anaesthesia has demonstrated better surgical pain management combined with longer lasting relief after surgery. The application of intrathecal fentanyl comes with several disadvantages. The potential side effects which include pruritus and nausea and vomiting and urinary retention and respiratory depression become more likely to occur at higher doses which requires medical staff to observe patients closely.

The regional anaesthesia techniques which use fascial plane blocks have become popular because they function as components of multimodal analgesia programs [4]. The Transverse Abdominis Plane (TAP) block provides an effective and easy-to-use solution for delivering postoperative pain relief after lower abdominal operations. The TAP block uses local anaesthetic which doctors apply to the fascial plane that exists between the internal oblique and transverse abdominis muscles to achieve sensory nerve block of the anterior abdominal wall which includes intercostal, subcostal, iliohypogastric and ilioinguinal nerves [5].

The introduction of ultrasound guidance has led to better accuracy results and safer procedures for TAP block administration which researchers established in their study [6]. The ultrasound-guided TAP block enables doctors to see anatomical structures and needle movements and local anaesthetic distribution in real time, which decreases the chances of complications that include organ injury and local anaesthetic systemic toxicity. The procedure increases block success rates while providing patients with stable pain relief throughout the process.

TAP block delivers multiple advantages when evaluated against intrathecal opioid administration. The system provides targeted pain relief through TAP block without delivering opioids to the entire body which leads to fewer opioid-related negative effects. TAP block maintains its function by preserving central neuraxial pathways while eliminating all risks tied to intrathecal drug delivery systems [7]. The method provides effective treatment for somatic pain which affects the anterior abdominal wall but shows limited success in treating visceral pain which constitutes a major part of postoperative pain experienced after abdominal surgeries.

The choice between intrathecal fentanyl and ultrasound-guided TAP block as an adjunct to spinal anaesthesia remains a subject of ongoing research and clinical debate [8]. Although intrathecal fentanyl provides fast pain relief, its side effects require careful administration. The TAP block offers patients a more secure treatment option because it produces fewer body-wide impacts, though its pain relief effects and treatment time are restricted. The two methods need direct testing because it will show their respective power to deliver results and maintain safety and practical medical value.

The practice of opioid-sparing and opioid-free analgesia has gained increasing recognition because of changing anaesthetic methods. The regional blocks TAP block and similar treatments demonstrate their ability to decrease or completely remove opioid requirements according to this new treatment method [9]. The healthcare system benefits from decreased opioid use because it prevents opioid-related negative effects while enhancing patient satisfaction and supporting better recovery methods.

The evaluation of analgesic techniques requires assessment of patient-centered outcomes which include pain scores and the duration until patients request their first analgesic and their total analgesative intake and the number of side effects they experience. The assessment of these two treatment methods requires a complete evaluation which includes all relevant details because their clinical effects need to be examined in totality.

The rising application of ultrasound technology in regional anaesthesia together with the common practice of using intrathecal opioids necessitates the development of research-based guidelines which will determine their best usage in lower abdominal surgical procedures. The results of comparative studies in this field will provide anaesthesiologists with necessary information which they can use to create patient-specific treatment plans based on unique patient needs and surgical needs and institutional capabilities.

The current research will assess the effectiveness and safety of ultrasound-guided Transverse Abdominis Plane block together with intrathecal fentanyl which doctors use as a supplementary treatment for spinal anaesthesia during lower abdominal surgeries. The study aims to determine the best method for managing postoperative pain through evaluation of four parameters which include postoperative analgesia duration, pain scores, analgesic requirements, and incidence of adverse effects.

Methodology

Study Design: The present study was designed as a quasi-experimental study to compare the efficacy of ultrasound-guided Transverse Abdominis Plane (TAP) block with intrathecal fentanyl in patients undergoing spinal anaesthesia for lower abdominal surgeries.

Study Area: The study was conducted at Yenepoya Medical College Hospital, Mangalore, a tertiary care teaching hospital where spinal anaesthesia is routinely used for lower abdominal surgical procedures.

Study Duration: The study was carried out over a period from November 2018 to April 2020.

Study Participants: A total of 38 patients scheduled for elective lower abdominal surgeries under spinal anaesthesia were included in the study.

Inclusion Criteria

- Patients aged between 20 to 60 years
- Patients undergoing lower abdominal surgeries such as laparotomies, bilateral hernia surgeries, and hysterectomies
- Patients belonging to American Society of Anesthesiologists (ASA) Grade I, II, and III
- Patients willing to provide informed consent

Exclusion Criteria

- Pregnant women
- Patients undergoing emergency surgeries
- Patients with cardiovascular diseases
- Patients with coagulopathy
- Patients with known drug allergies

Sample Size: The total sample size consisted of 38 patients, who were randomly allocated into two groups of 19 patients each using the closed envelope randomization method:

- **Group ST:** Received spinal anaesthesia followed by ultrasound-guided TAP block
- **Group SA:** Received spinal anaesthesia with intrathecal fentanyl

Procedure: After obtaining ethical committee approval and written informed consent, all selected patients underwent a thorough pre-anaesthetic evaluation including relevant clinical and laboratory investigations. Patients were assessed for any history of drug allergies. Pre-medication was administered in the form of oral ranitidine (150 mg) and alprazolam (0.25 mg) on the night before and morning of surgery.

In the operation theatre, an 18-gauge intravenous line was secured and patients were preloaded with Ringer's Lactate solution at 10 mL/kg over 10–20 minutes. Standard monitoring, including non-invasive blood pressure, pulse oximetry, and electrocardiography, was established and baseline parameters were recorded.

Spinal anaesthesia was administered at the L2–L3 or L3–L4 interspace using a 25-gauge Quincke spinal needle in the left lateral position. After confirming free flow of cerebrospinal fluid, patients in both groups received 2.5 mL of 0.5% hyperbaric bupivacaine. In Group SA, an additional 0.5 mL fentanyl was administered intrathecally. Patients were then positioned supine and monitored for sensory and motor block at regular intervals. Supplemental oxygen at 4 L/min was provided.

In Group ST, immediately in the postoperative period, an ultrasound-guided TAP block was performed. A high-frequency ultrasound probe was placed transversely in the mid-axillary line between the costal margin and iliac crest. A needle was inserted in-plane and advanced into the fascial plane between the internal oblique and transversus abdominis muscles. After confirming the correct position with 2 mL saline, 30 mL of 0.2% ropivacaine was injected. Proper spread of the drug was visualized as a hypoechoic expansion.

Postoperatively, patients were monitored in the recovery unit. Pain assessment along with vital parameters such as heart rate, mean arterial pressure, and oxygen saturation was recorded at 0, 4, 8, 12, 24, and 36 hours. Intravenous paracetamol was administered as rescue analgesia when required. Adverse effects such as nausea, vomiting, bradycardia, hypotension, arrhythmias, and allergic reactions were also recorded.

Statistical Analysis: Data were analyzed using SPSS version 25.0 and MedCalc software. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Normality of data was assessed using the Shapiro–Wilk test. The unpaired (independent) t-test was used for comparison of means between the two groups, and the Chi-square test was applied for categorical variables. A p-value < 0.05 was considered statistically significant with a 95% confidence interval.

Result

Table 1 shows the comparison of mean heart rate between the ST and SA groups at different time intervals. At baseline, the mean heart rate was slightly higher in the ST group (84.79 ± 7.14) compared to the SA group (83.42 ± 9.22), with a mean difference of 1.37, which was statistically non-significant (p = 0.612). Similarly, at 4 hours, 8 hours, 12 hours, 24 hours, and 36 hours, the mean heart rates between both groups remained comparable, with only minimal differences observed (mean differences ranging from -0.53 to 0.74). The p-values at all time intervals were greater than 0.05, indicating no statistically significant difference in heart rate between the ST and SA groups throughout the study period. Overall, both groups demonstrated stable and similar heart rate trends over time.

Table 1: Comparison of Heart Rate Among Study Groups

Time Interval	Group	Mean Heart Rate	Standard Deviation	Mean Difference	t-value	p-value
Baseline	ST	84.79	7.14	1.37	0.512	0.612
	SA	83.42	9.22			
4 Hours	ST	83.26	6.66	0.16	-1.177	0.247
	SA	83.11	8.16			
8 Hours	ST	83.42	6.80	-0.53	-1.121	0.270
	SA	83.95	6.81			
12 Hours	ST	82.42	7.46	0.47	-1.711	0.101
	SA	81.95	8.43			
24 Hours	ST	82.74	7.41	0.42	-1.75	0.1480
	SA	82.32	8.31			
36 Hours	ST	84.05	7.39	0.74	-1.776	0.151
	SA	83.32	8.23			

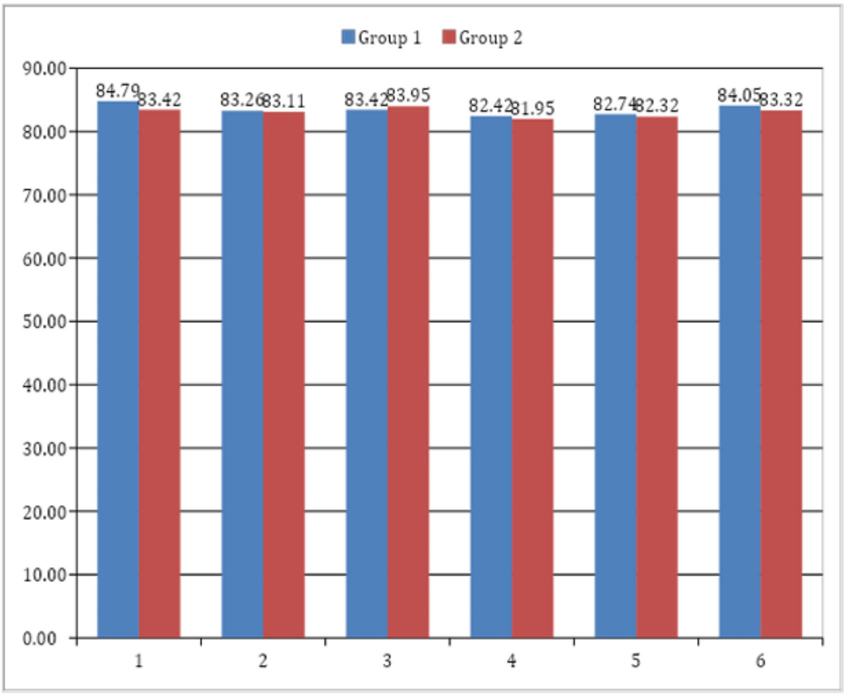

Figure 1: Comparison of Heart Rate Among Study Groups

Table 2 shows the comparison of Mean Arterial Pressure (MAP) between the ST and SA groups at different time intervals. At baseline, the mean MAP was comparable between the ST group (71.11 ± 9.4) and the SA group (70.74 ± 9.18), with a negligible mean difference (0.37) and no statistical significance ($p = 0.903$). At 4 hours, the SA group exhibited a slightly higher MAP (73.84 ± 7.4) compared to the ST group (69.32 ± 7.8), with a mean difference of -4.53; however, this difference did not reach statistical significance ($p = 0.075$). Similarly, at 8, 12, 24, and 36 hours, the SA group consistently showed marginally higher MAP values than the ST group, but the differences remained statistically non-significant, with p-values of 0.517, 0.559, 0.577, and 0.596, respectively. Overall, the findings indicate that there was no statistically significant difference in MAP between the two groups at any time interval.

Table 2: Comparison of Mean Arterial Pressure (MAP)

Time Interval	Group	Mean MAP	Standard Deviation	Mean Difference	t-value	p-value
Baseline	ST	71.11	9.4	0.37	0.122	0.903
	SA	70.74	9.18			
4 Hours	ST	69.32	7.8	-4.53	-1.836	0.075
	SA	73.84	7.4			
8 Hours	ST	71.05	8.81	-1.68	-0.654	0.517

	SA	72.74	6.97			
12 Hours	ST	70.26	7.79	-1.32	-0.589	0.559
	SA	71.58	5.83			
24 Hours	ST	71.79	7.69	-1.26	-0.564	0.577
	SA	73.05	6.02			
36 Hours	ST	74.32	7.62	-1.21	-0.535	0.596
	SA	75.53	6.25			

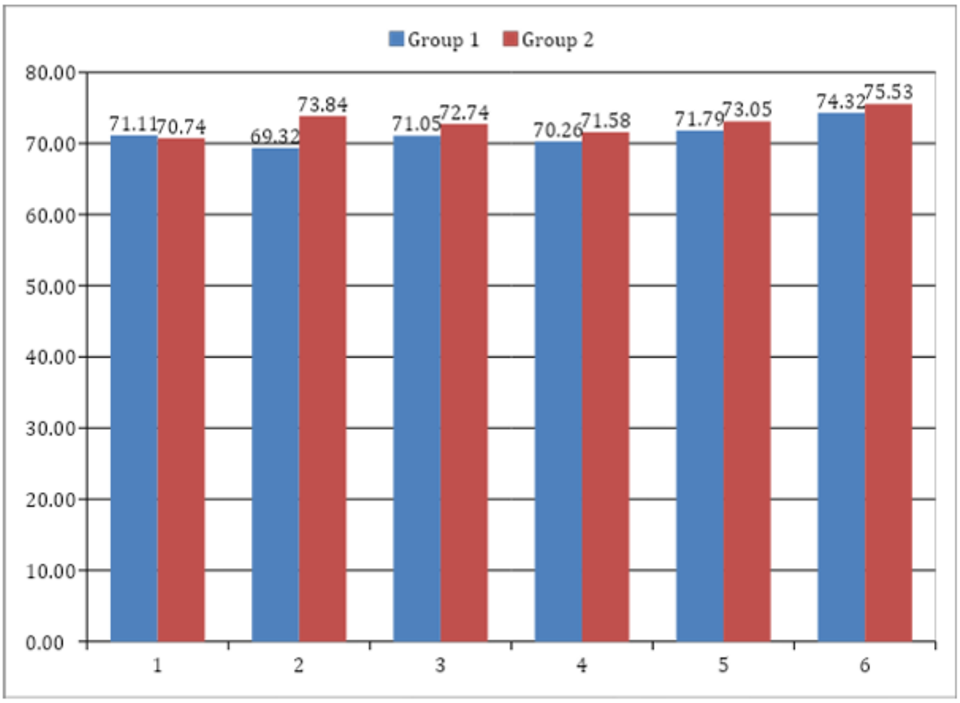

Figure 2: Comparison of Mean Arterial Pressure (MAP)

Table 3 shows the comparison of mean pain scores between the ST and SA groups at different time intervals. At baseline, the mean pain scores were comparable between the ST (4.99 ± 0.74) and SA (5.05 ± 0.85) groups, with a very small mean difference (-0.06) and a statistically non-significant result (p = 0.231), indicating similar initial pain levels in both groups. However, at 4 hours, the ST group demonstrated a significantly lower mean pain score (3.95 ± 0.62) compared to the SA group (5.79 ± 0.98), with a mean difference of -1.84 and a highly significant p-value (<0.001). This trend continued at 8, 12, 24, and 36 hours, where the ST group consistently showed lower pain scores than the SA group, with mean differences of -2.16, -2.00, -2.47, and -1.43 respectively, all being statistically highly significant (p < 0.001). These findings indicate that the ST group experienced significantly better pain control than the SA group at all post-operative time intervals.

Table 3: Comparison of Pain Scores Among the Study Groups

Time Interval	Group	Mean Pain Score	Standard Deviation	Mean Difference	t-value	p-value
Baseline	ST	4.99	0.74	-0.06	-0.491	0.231
	SA	5.05	0.85			
4 Hours	ST	3.95	0.62	-1.84	-4.386	<0.001*
	SA	5.79	0.98			
8 Hours	ST	4.47	0.9	-2.16	-5.233	<0.001*
	SA	6.63	1.07			
12 Hours	ST	4.84	0.96	-2	-5.654	<0.001*
	SA	6.84	1.3			
24 Hours	ST	3.84	0.96	-2.47	-5.007	<0.001*
	SA	6.32	1.29			
36 Hours	ST	3.88	0.96	-1.43	-4.237	<0.001*
	SA	5.32	1.29			

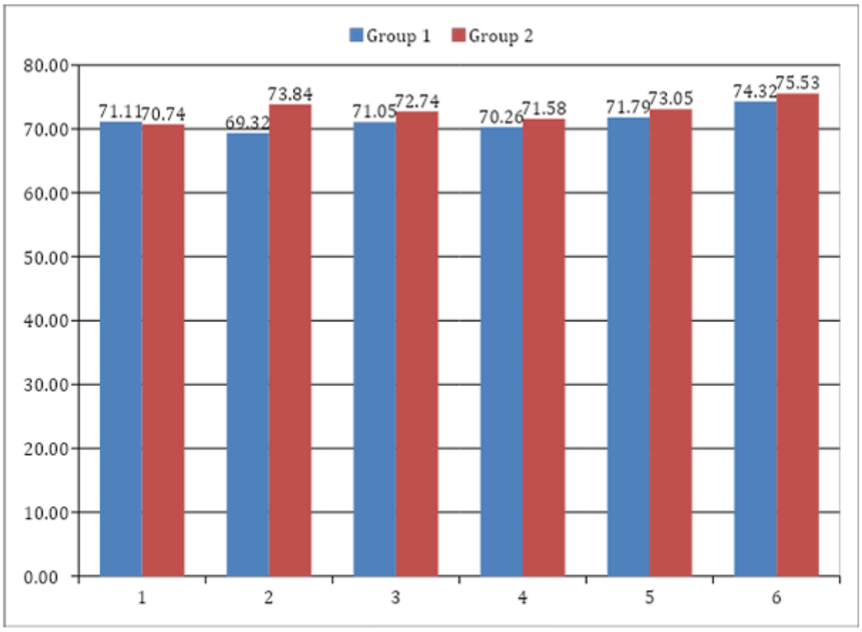

Figure 3: Comparison of Pain Scores Among the Study Groups

Table 4 shows the comparison of requirement of rescue analgesia between Group ST and Group SA. It was observed that only 3 patients (15.8%) in Group ST required rescue analgesia, whereas a significantly higher number, 11 patients (57.9%), in Group SA required it. Conversely, the majority of patients in Group ST, 16 (84.2%), did not require rescue analgesia compared to only 8 patients (42.1%) in Group SA. Overall, out of 38 participants, 14 required and 24 did not require rescue analgesia. The difference between the two groups was found to be statistically significant (χ^2 = 7.238, p = 0.007), indicating that Group ST had a significantly lower requirement of rescue analgesia compared to Group SA.

Table 4: Comparison of Requirement of Rescue Analgesia

Requirement of Rescue Analgesia	Group ST (n=19)	Group SA (n=19)	Total
Required	3 (15.8%)	11 (57.9%)	14
Not Required	16 (84.2%)	8 (42.1%)	24
Total	19	19	38
χ2 value = 7.238, p-value = 0.007*			

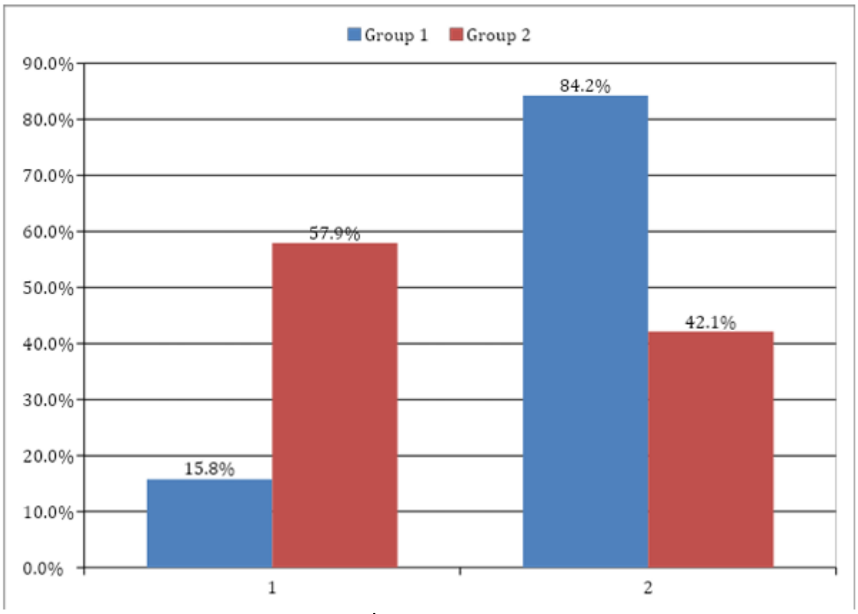

Figure 4: Comparison of Requirement of Rescue Analgesia

Table 5 shows the comparison of side effects among the two study groups, ST and SA, each comprising 19 participants. The overall incidence of side effects was higher in Group SA (10 patients) compared to Group ST (3 patients). Nausea, vomiting, and hypotension were observed more frequently in Group SA (2 cases each) than in Group ST (1 case each), although these differences were not statistically significant (p>0.05). Bradycardia was reported only in Group SA (1 case) and was absent in Group ST, but this difference was also not statistically significant (p>0.05). Notably, pruritis was observed exclusively in Group SA (3 cases) and was absent in Group ST, with the difference being statistically significant (p<0.05). Overall, the findings indicate that while most side effects were comparable between the groups, pruritis was significantly more common in Group SA.

Table 5: Comparison of Side Effects Among Study Groups

Side Effects	Group ST (n=19)	Group SA (n=19)	Total	p-value
Nausea	1	2	3	>0.05
Vomiting	1	2	3	>0.05
Bradycardia	0	1	1	>0.05
Hypotension	1	2	3	>0.05
Pruritis	0	3	3	<0.05*
Total Patients with Side Effects	3	10	13	

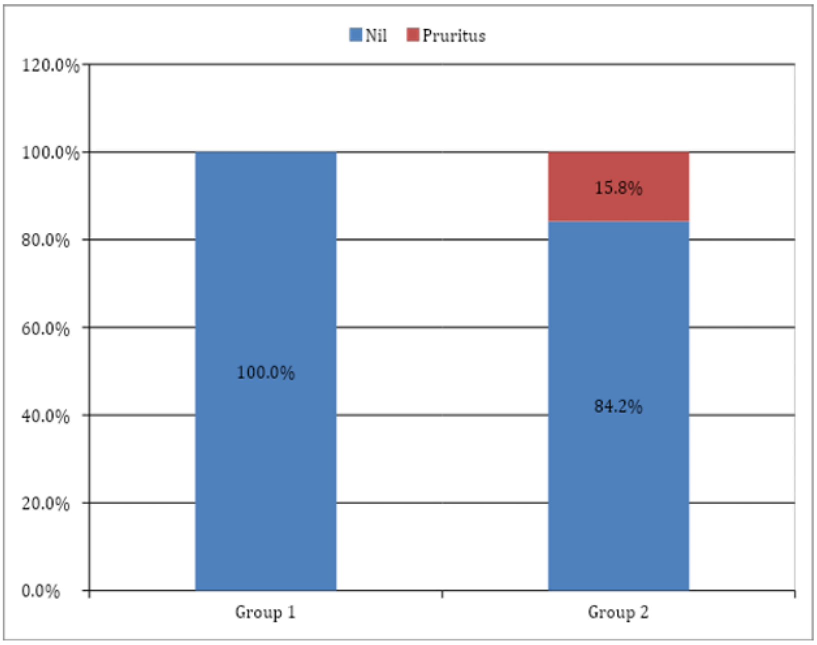

Figure 5: Comparison of Side Effects Among Study Groups

Discussion

The present study demonstrates that both ultrasound-guided Transversus Abdominis Plane (TAP) block (ST group) and intrathecal fentanyl (SA group) provide comparable hemodynamic stability, which is consistent with findings from previous literature. The study observed that heart rate and mean arterial pressure maintained their stability throughout all time intervals while showing no significant difference between the two groups. McDonnell et al. (2007) [10] found that TAP block did not cause any major hemodynamic changes, which proved its safety. The research showed that intrathecal fentanyl had minimal impact on cardiovascular function because its systemic distribution remained restricted (Singh et al., 1995) [11]. Our research findings support previous studies which demonstrated that both regional methods guarantee safe results while maintaining stable hemodynamic conditions during surgical procedures.

The study results showed that treatment methods for postoperative pain relief between the two groups produced opposite results. The ST group showed lower pain levels throughout the entire 36 hours after surgery when compared to the SA group. The TAP block produced continuous advantages which lasted until 36 hours when the pain score difference between groups reached 4 hours with a value of −1.84 and a p-value below 0.001. TAP block group postoperatively maintained their decreased Visual

Analogue Scale (VAS) scores according to the findings which match the results reported by McDonnell et al. (2007). Carney et al. (2008) [12] showed that TAP block delivered effective pain relief after abdominal hysterectomy because patients experienced lower pain levels than they did under regular pain management methods. The research conducted by Niraj et al. (2009) [13] showed that TAP block improved pain management results for patients who underwent open appendicectomy. Our research demonstrated that analgesic effects lasted until 36 hours after treatment whereas previous studies confirmed effects only until 24 hours because the combination of ultrasound guidance and precise drug delivery mechanisms extended analgesic duration.

The duration of intrathecal fentanyl analgesic effects in our study showed shorter results. The SA group showed increased pain scores after surgery even though their initial pain levels matched those of their counterparts. Singh et al. (1995) demonstrated that intrathecal fentanyl extends sensory block duration but its pain relief lasts for about 4 to 6 hours. Bogra et al. (2005) [14] documented that intrathecal fentanyl provides quick pain relief however its effect lasts for a much shorter period than peripheral nerve blocks. The TAP block group in our study demonstrated better pain relief which lasted longer than the existing research shows.

The requirement of rescue analgesia in our study further strengthens the superiority of TAP block. Only 15.8% of patients in the ST group required rescue analgesia whereas 57.9% of patients in the SA group needed additional pain relief. The difference between two groups shows clinically important results which researchers can measure statistically. McDonnell et al. (2007) showed similar results which proved that TAP block decreased postoperative opioid use during the first 24 hours. Carney et al. (2008) showed that patients who received TAP block required fewer analgesics to manage their pain. Niraj et al. (2009) found that TAP block patients needed very little postoperative pain medication which proved that TAP block treatment was effective. Neither standard care nor intrathecal opioid treatment provides adequate pain relief which our research showed and previous studies confirmed. The study results show patients experienced better pain management which led to fewer rescue analgesia needs and reduced opioid-related complications while their recovery process improved.

Research results demonstrated that the SA group experienced more side effects than the ST group. Although individual side effects such as nausea, vomiting, hypotension, and bradycardia were not statistically significant, pruritus was observed exclusively in the SA group and was statistically significant. The discovered result confirms the expected side effect pattern that occurs with intrathecal opioid treatment. Rosow et al. (1982) [15] documented that fentanyl and other opioids produce histamine release which leads to pruritus. Ben-David et al. (2000) [16] discovered a greater occurrence of pruritus and nausea among patients who received intrathecal fentanyl. TAP block produces minimal systemic side effects because its drug effects occur only at specific treatment sites. McDonnell et al. (2007) and Carney et al. (2008) found that TAP block groups experienced fewer postoperative complications which included nausea and vomiting. The ST group showed almost no side effects which our study results confirmed while these studies proved that TAP block works safely and effectively.

The meta-analyses conducted by Johns et al. (2012) and Baeriswyl et al. (2015) found that TAP block provides better postoperative pain relief while decreasing the need for opioids and their related side effects according to [17,18]. Our study results demonstrate that TAP block provides better pain relief than opioid-based methods according to the broader evidence from companion studies.

The current study results show complete agreement with previous research results while providing additional evidence for their results. The TAP block and intrathecal fentanyl both maintain hemodynamic stability, yet TAP block establishes better pain management through its longer-lasting effects which provide pain relief for 36 hours compared to the 20 hours or shorter duration of relief that fentanyl groups offer and users need less emergency pain relief at 15.8% compared to 57.9% of users who need emergency treatment after fentanyl use. The research results exist based on evidence from multiple randomized controlled trials which combine with meta-analyses to demonstrate that ultrasound-guided TAP block serves as an effective and patient-centered method for delivering postoperative pain control in lower abdominal surgical procedures.

Conclusion

The present study demonstrates that both ultrasound-guided TAP block and intrathecal fentanyl provide comparable hemodynamic stability in patients undergoing lower abdominal surgeries under spinal anaesthesia. However, the TAP block proved to be significantly more effective in terms of postoperative pain management, as evidenced by consistently lower pain scores up to 36 hours and a markedly reduced requirement for rescue analgesia. Additionally, the incidence of side effects was lower in the TAP block group, with pruritus occurring exclusively in patients receiving intrathecal fentanyl. These findings highlight the superiority of ultrasound-guided TAP block as a safer and more effective modality for prolonged postoperative analgesia, supporting its role as a preferred component of multimodal and opioid-sparing pain management strategies in clinical practice.

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