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A comparative clinical trial of preoperative *vs.* postoperative transversus abdominis plane block for analgesia after elective cesarean delivery: A focus on efficacy and procedural feasibility

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SUMMARY

Background and aim: Intrathecal morphine is the gold standard for post-cesarean analgesia, with the Transversus Abdominis Plane (TAP) block being a key alternative when contraindicated; however, the optimal timing for TAP block administration remains uncertain. This study compared preoperative vs. postoperative TAP block in 223 patients undergoing elective cesarean delivery under spinal anesthesia.

Patients and methods: This study is a comparative clinical trial, conducted at Saudi German Hospital from January 1, 2021, to January 5, 2022, following institutional ethical approval [ECC 2021-06]. The study enrolled 248 ASA II parturients were randomized, and 223 were included in the final analysis for primary outcomes. Participants were assigned to receive either a preoperative (n=110) or postoperative (n=113) ultrasound-guided TAP block with 0.25% bupivacaine. Primary outcomes were 24-hour opioid consumption and pain scores at rest and movement assessed at 2, 4, 6, 8, 12, and 24 hours postoperatively using a Visual Analog Scale (VAS).

Results: The two groups were demographically comparable. No statistically significant differences were found in 24-hour meperidine consumption (preop 78.5 mg vs. postop 82.4 mg, p=0.301) or in VAS pain scores at any time point at rest or during movement (all p>0.05). The time to first analgesic request was also similar between groups (7.8h vs. 7.2h, p=0.187). However, the preoperative block was performed significantly faster (108.5s vs. 135.2s, p<0.001) and at a shallower depth (2.05 cm vs. 2.55 cm, p<0.001).

Conclusion: Preoperative and postoperative TAP blocks provide equivalent analgesia, offering clinicians flexibility in timing based on logistical preference.

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INTRODUCTION

Cesarean Delivery (CD) is one of the most commonly performed surgeries worldwide, with rates continuing to rise. Effective postoperative analgesia is crucial, not only for maternal comfort and recovery but also to facilitate early mobilization and bonding with the newborn. Inadequate pain control can hinder these processes and increase the risk of developing chronic pain. Therefore, establishing a safe and effective analgesic regimen is a fundamental component of postpartum care for the millions of women undergoing this procedure each year [1,2].

The Transversus Abdominis Plane (TAP) block, introduced by Rafi in 2001, is a technique involving local anesthetic injection between the internal oblique and transversus abdominis muscles. This blocks thoracolumbar nerves (T6–L1) supplying the anterolateral abdominal wall, providing somatic analgesia. Ultrasound guidance has since improved its safety and precision. Evidence supports its effectiveness in various abdominal surgeries, including cesarean section, as part of a multimodal analgesic regimen, despite its relatively short duration of action. It remains a valuable adjunct for postoperative pain management [3,4].

While numerous studies have established the TAP block's efficacy in postoperative pain management for cesarean section [5,6], its application has predominantly been studied post-incision. Our study hypothesizes that administering the TAP block preoperatively in pregnant women undergoing cesarean delivery offers unique advantages, including reduced intraoperative opioid requirements and potentially smoother maternal recovery. This specific timing and its comprehensive impact on the entire surgical and immediate postpartum experience represent a significant, previously unexplored area of clinical research. Our study aimed to compare the analgesic efficacy and feasibility of preoperative *vs.* postoperative TAP block in patients undergoing elective cesarean section under spinal anesthesia.

PATIENTS AND METHODS

A prospective comparative clinical trial was conducted at Saudi German Hospital from May 1, 2021, to April 30, 2022, following institutional ethical approval [ECC 2021-06]. The study enrolled 248 ASA II parturients scheduled for elective cesarean delivery under spinal anesthesia (10 mg bupivacaine + 25 µg fentanyl), who were assigned to two comparative groups: Group A (Preoperative TAP block) and Group B (Postoperative TAP block). Exclusion criteria comprised chronic pain conditions, opioid dependence, known local anesthetic allergies, anticipated prolonged surgery (>2 hours), significant blood loss (>2 L), or emergency procedures, and class II obesity, where BMI was more than 35 kg/m^2.

The primary outcome: Measure of total opioid usage over a 24-hour period, focusing exclusively on the quantity of meperidine rescue boluses administered within the first day post-surgery. Secondary outcomes involved measuring postoperative pain levels using a 10-cm visual analog scale (VAS; where 0 indicates no pain and 10 represents the worst pain possible) for both static and dynamic pain in the 1st 24 hours. Additional factors assessed were the time taken to the first request for analgesics, the duration of the nerve block procedure, the number of needle insertion attempts (pinpricks), and the depth of the Transversus Abdominis Plane (TAP) space.

Operative steps: Preoperative TAP block.

The preoperative TAP block was performed immediately after spinal anesthesia administration and prior to skin incision. With the patient supine, and with proper disinfection and proper barrier precautions applied, the ultrasound linear probe was placed transversely on the anterolateral abdominal wall between the iliac crest and subcostal margin. The three muscular layers (external oblique, internal oblique, and transversus abdominis) were identified. Using an in-plane needle technique, a 20-gauge needle was advanced under real-time ultrasound guidance until its tip was positioned within the fascial plane between the internal oblique and transversus abdominis muscles. After negative aspiration, 20 ml of normal saline containing 25% Bupivacaine and 2 µg/ml fentanyl was injected per side, observing hydrodissection of the intended plane.

Operative steps: Postoperative TAP block.

The postoperative TAP block was performed in the recovery room after surgery completion, with the patient still supine. The same ultrasound-guided technique was employed: identifying the three abdominal muscle layers and advancing the needle into the transversus abdominis plane. The depth of the space was measured from the skin surface. Hydrodissection was observed to confirm correct local anesthetic deposition. Identical volumes and concentrations of bupivacaine (20 ml of normal saline containing 25% Bupivacaine and 2 µg/ml fentanyl were injected per side) were administered.

The number of skin punctures needed for proper needle placement and the total duration of the procedure (from probe application to the completion of the bilateral injection) were documented for each case. VAS scores were measured over the next 24 hours. If the VAS score exceeded 3, a bolus dose of 25 mg of meperidine was administered intravenously as a rescue analgesic. The time until the first request for analgesic and the total quantity of meperidine used were recorded for each patient.

Sample size justification

The sample size was calculated using PASS 11.0 software, based on data from a comparable study by Owen DJ, et al. [7]. This prior research demonstrated a mean 24-hour meperidine requirement of 23.4 mg (±11.0) for a control group and 14.1 mg (±8.0) for a TAP block group. To detect a similar mean difference of 9.3 mg between our study groups (Preoperative *vs.* Postoperative TAP block) with a power of 95% and a significance level (alpha) of 0.05, a minimum of 106 participants per group was required. Accounting for a potential 10% attrition rate, the final sample size was increased to 124 participants per group, for a total of 248 participants. The final analysis was performed on a per-protocol basis with 223 participants due to post-operative exclusions.

Statistical analysis

Data analysis was conducted using SPSS software (Version 29.0, IBM Corp.), with all outcome analyses performed on a per-protocol basis after excluding patients with major complications. The Shapiro-Wilk test confirmed normality for all continuous outcome variables. Consequently, Independent Samples t-tests were used to compare all continuous data (demographics, VAS scores, opioid consumption, time to first analgesic request, and procedural characteristics). Chi-square tests were used for all categorical variable comparisons (parity, surgical indications, need for rescue medication), as all cell counts were sufficient (>5). Results are reported as mean ± standard deviation or numbers and percentages. P value >0.05 was considered non-significant, and P<0.001 was considered highly significant.

RESULTS

The study groups were well-matched at baseline in terms of demographic and clinical characteristics. Statistical analysis confirmed no significant differences in demographic or clinical characteristics between participants receiving preoperative *vs.* postoperative TAP blocks, ensuring that subsequent outcome comparisons were not influenced by these variables **(Tab. 1.)**. A total of 248 participants were initially enrolled in the study. However, 25 of them were excluded from the final analysis regarding pain and analgesic results due to postoperative issues. This included two patients—one from each group—who developed Deep Vein Thrombosis (DVT), and twenty-three others who experienced postoperative fever that required non-steroidal anti-inflammatory drugs (14 from the Preoperative TAP group and 11 from the Postoperative TAP group). As a result, the final analysis for the primary and secondary pain outcomes included 110 patients from the Preoperative TAP group and 113 patients from the Postoperative TAP group **(Tab. 1.)**.

The evaluation of postoperative pain scores showed a consistent advantage for the preoperative TAP block group across all measured time points, both when at rest and during movement. However, the differences noted in visual analogue scale scores did not achieve the set threshold for statistical significance between the two intervention groups. No statistically significant differences

were observed in analgesic requirements between the groups. The proportion of patients requiring rescue medication, the time to first analgesic request, and the total opioid consumption were all comparable, with no significant differences detected **(Tab. 2. and Tab. 3.)**.

Analysis of the procedure showed significant differences in block performance across the groups. The TAP block conducted before surgery was completed significantly quicker than the one done after surgery. Additionally, the target fascial plane was found at a notably shallower

Tab. 1. Baseline demographic and clinical characteristics of the study groups.

Items	Measure	Preoperative TAP (N=110)	Postoperative TAP (N=113)	P-value
Age (years)	Mean ± SD	31.8 ± 3.8	32.2 ± 4.1	0.421[a]
	Range	22.0–40.0	23.0–39.0	
BMI (kg/m^2)	Mean ± SD	29.1 ± 2.6	28.9 ± 2.7	0.538[a]
	Range	22.5–35.0	23.1–34.8	
Parity, (n, %)	Primigravida	43 (38.4%)	40 (36.0%)	0.687[b]
	Multigravida	69 (61.6%)	71 (64%)	
Indications, (n, %)	Repeated CS	41 (36.6%)	43 (38.7%)	0.852[b]
	Postdate	47 (42%)	44 (39.6%)	
	PROM	15 (13.4%)	17 (15.3%)	
	IUGR	19 (8%)	7 (6.3%)	
Gestational age (Week)	Mean ± SD	39.5 ± 1.2	39.6 ± 1.3	0.512[a]
	Range	37.0–41.0	37.0–41.0	
[a]Independent Samples t-test, [b]Chi square test, p>0.05 is not significant				

Tab. 2. Postoperative pain scores (VAS-10) during rest and movement among the study groups.

Time	Measures	Preoperative TAP (N=110)	Postoperative TAP (N=113)	P-value	Mean Difference (95% CI)
Patients' pain perception (VAS-10) during rest					
Hour-2	Mean ± SD	0.6 ± 0.7	0.8 ± 0.8	0.085	-0.2 (-0.4 to 0.0)
	Range	0.0–3.0	0.0–3.0		
Hour-4	Mean ± SD	1.5 ± 1.0	1.7 ± 1.1	0.208	-0.2 (-0.5 to 0.1)
	Range	0.0–4.0	0.0–5.0		
Hour-8	Mean ± SD	2.6 ± 0.8	2.8 ± 0.9	0.101	-0.2 (-0.4 to 0.0)
	Range	1.0–4.0	1.0–5.0		
Hour-12	Mean ± SD	2.7 ± 0.7	2.9 ± 0.8	0.072	-0.2 (-0.4 to 0.0)
	Range	1.0–4.0	2.0–5.0		
Hour-24	Mean ± SD	1.4 ± 0.6	1.6 ± 0.7	0.058	-0.2 (-0.4 to 0.0)
	Range	0.0–3.0	1.0–3.0		
Patients' pain perception (VAS-10) during movement					
Hour-2	Mean ± SD	1.0 ± 0.8	1.1 ± 0.9	0.443	-0.1 (-0.3 to 0.1)
	Range	0.0–4.0	0.0–4.0		
Hour-4	Mean ± SD	2.2 ± 1.0	2.4 ± 1.1	0.192	-0.2 (-0.5 to 0.1)
	Range	0.0–5.0	1.0–6.0		
Hour-8	Mean ± SD	3.6 ± 0.9	3.8 ± 1.0	0.145	-0.2 (-0.4 to 0.1)
	Range	2.0–5.0	2.0–7.0		
Hour-12	Mean ± SD	3.7 ± 0.8	3.9 ± 0.9	0.095	-0.2 (-0.4 to 0.0)
	Range	2.0–5.0	3.0–6.0		
Hour-24	Mean ± SD	2.2 ± 0.7	2.4 ± 0.8	0.069	-0.2 (-0.4 to 0.0)
	Range	1.0–4.0	1.0–4.0		
Independent Samples t-test, p>0.05 is not significant					

Tab. 3. Analgesic requirements among the study groups.

Findings	Preoperative TAP (N=110)	Postoperative TAP (N=113)	P-value	Effect size RR (95% CI)
Patients requiring rescue meperidine (n, %)				
Required	46 (41.8%)	54(47.8%)	0.361[a]	0.88 (0.67 to 1.16)
Not required	64 (58.2%)	59(52.2%)		
Time to first analgesic request (hours) in patients that required analgesia				
Measures	**Preoperative TAP (N=46)**	**Postoperative TAP (N=54)**	**P-value**	**Mean Difference (95% CI)**
Mean ± SD	7.8 ± 2.0	7.2 ± 2.1	0.187[b]	0.6 (-0.3 to 1.5)
Range	5.0–12.0	4.0–11.0		
Total meperidine dose (mg) in patients that required analgesia				
Measures	**Preoperative TAP (N=46)**	**Postoperative TAP (N=54)**	**P-value**	**Mean Difference (95% CI)**
Mean ± SD	78.5 ± 18.3	82.4 ± 19.5	0.301[b]	-3.9 (-11.3 to 3.5)
Range	50.0–120.0	50.0–130.0		
[a]Chi square test, [b]Independent Samples t-test, p>0.05 is not significant				

Tab. 4. Procedural characteristics of TAP block performance.

Characteristic	Preoperative TAP (N=110)	Postoperative TAP (N=113)	P-value	Effect size (95% CI)
Duration of procedure (seconds)				
Mean ± SD	108.5 ± 25.4	135.2 ± 30.1	<0.001	-26.7 (-33.8 to -19.6)
Range	60–180	80–220		
Number of pinpricks				
Mean ± SD	1.22 ± 0.45	1.30 ± 0.52	0.184	-0.08 (-0.20 to 0.04)
Range	1–3	1–4		
Depth of TAP space (cm)				
Mean ± SD	2.05 ± 0.35	2.55 ± 0.42	<0.001	-0.50 (-0.59 to -0.41)
Range	1.5–2.8	1.8–3.5		
Independent Samples t-test, p>0.05 is not significant, p<0.001 is highly significant				

depth prior to the surgical procedure. Although there was an indication that slightly fewer needle insertions were required before surgery, this variation did not achieve statistical significance. These results suggest that administering the block before surgery provides clear technical benefits regarding efficiency and ease of accessing anatomy **(Tab. 4.)**.

DISCUSSION

The non-significant results indicate strong baseline equivalence between the Preoperative and Postoperative TAP block groups. With no significant differences in age, BMI, parity, surgical indications, or gestational age, the groups are comparable. Therefore, any differences in pain scores or analgesic consumption can be confidently attributed to the timing of the TAP block rather than pre-existing disparities.

The results showed a trend of lower pain scores in the Preoperative TAP group at all time points, both at rest and during movement; however, these differences were not statistically significant. This suggests that administering the block before surgery did not significantly improve postoperative pain control compared to doing it afterward. Although preemptive analgesia appeared to have some benefits, the effects were too weak to be considered statistically significant within this sample.

As regards the analgesic requirements, there was no statistically significant difference between groups in the proportion of patients requiring rescue meperidine, the time to first analgesic request, or the total opioid dose consumed. This aligns with the pain score data, indicating that the observed trend towards improved analgesia in the preoperative group did not translate into a significant reduction in analgesic demand. The need for and consumption of rescue opioids were effectively equivalent regardless of whether the TAP block was performed before or after the surgical procedure.

The results indicate a mixed significance profile. Two key technical metrics showed a high level of significance: the preoperative block was completed significantly faster, and the target fascial plane was found at a considerably shallower depth. This suggests that the pre-surgical anatomy is more intact and accessible, free from tissue edema and disruption caused by surgery. On the other hand, the number of needle insertion attempts (pinpricks) was not significant, indicating that while the plane was easier to reach, the precision needed to access it remained similar across different time points, which can be explained by the meticulous and skillful technique performed by the anesthetist. This highlights the distinct and measurable benefits in procedural efficiency and ease offered by the preoperative setting.

Comparison of our results to similar studies

The existing research primarily highlights the role of the postoperative Transversus Abdominis Plane (TAP) block as a crucial element of multimodal analgesia following cesarean delivery. In contrast, the application of the block prior to surgical incision remains a pilot study that has not been explored. This research aims to add to the emerging body of evidence by directly comparing these two approaches, assessing whether the anticipated benefits of preemptive analgesia result in measurable differences in clinical outcomes within the context of this common surgical procedure.

Our study's results contextualize the established findings of Mishriky BM, et al. [8], whose meta-analysis confirmed the postoperative TAP block as a highly effective intervention, significantly reducing 24-hour morphine consumption by approximately 20 mg and pain scores for up to 12 hours. In direct comparison, our preoperative TAP block yielded statistically similar outcomes in both opioid requirements and pain control. This demonstrates that the preoperative approach achieves an analgesic efficacy non-inferior to the postoperative standard set by Mishriky, et al., providing a viable and equally effective alternative in timing for this analgesic technique.

Our results support Wang P, et al.'s [9] meta-analysis on the efficacy of TAP blocks *vs.* no blockade, while providing new insights on timing. Wang, et al. demonstrated that ultrasound-guided TAP blocks significantly reduce 24-hour opioid consumption by around 13 mg, extend time to first analgesic request by over 3.5 hours, and decrease the need for rescue medication. Our study shows that preoperative TAP blocks achieve analgesic outcomes—opioid consumption, pain scores, and time to first rescue dose—that are statistically comparable to postoperative blocks. This suggests that the benefits of TAP blocks, as highlighted by Wang, et al., can be realized whether the block is administered before or after the surgical incision, enhancing flexibility in practice. Additionally, our findings indicate that TAP blocks may not provide added benefit over intrathecal morphine, as similar outcomes were observed with both timing strategies, indicating robust and effective analgesia regardless of timing.

Our results provide a nuanced contrast to Sultan P, et al.'s network meta-analysis [10], which found both TAP blocks and Wound Catheter (WC) infusions superior to inactive controls for reducing 24-hour opioid consumption but

no significant differences between the techniques. We introduce timing as a critical variable and demonstrate that the efficacy of the TAP block, whether preoperative or postoperative, is statistically equivalent. This refines Sultan, et al.'s findings, suggesting that the choice between a TAP block and a wound catheter may be more impactful than the timing of the TAP block. Our work complements theirs, indicating that the TAP block maintains a consistent analgesic profile regardless of perioperative timing, reinforcing its status as a leading option for post-cesarean analgesia.

Our findings for cesarean delivery present a stark contrast to the results reported by Rahimzadeh P, et al. [11] in their study on laparoscopic cholecystectomy. This discrepancy is likely rooted in the profound physiological impact of the gravid uterus. The massive, progressive stretching of the abdominal wall musculature during pregnancy causes a mechanical thinning and widening of the tissue planes. This creates a more expansive and potentially more accessible pathway for local anesthetic spread within the transversus abdominis plane. Consequently, a preemptive block before surgical incision may achieve a comprehensive sensory blockade that is not easily compromised by the subsequent surgery. In contrast, the confined space and inflammatory processes of a post-cholecystectomy abdomen may favor a postoperative block to manage established surgical trauma. Therefore, the optimal timing for a TAP block is highly procedure-specific, and the unique anatomical conditions of a term pregnancy appear to render both preemptive and postoperative blocks equally effective for cesarean delivery.

Clinical implications of our study

The primary clinical implication of our study is that the timing of TAP block administration—whether performed preemptively before surgical incision or postoperatively—does not significantly impact its analgesic efficacy for cesarean delivery. This provides clinicians with greater flexibility, allowing the block to be performed at the most convenient and efficient time within the surgical workflow without compromising pain relief outcomes. The choice can be based on operating room scheduling, provider preference, or patient positioning, simplifying logistical planning while ensuring consistent, high-quality postoperative analgesia.

The strengths and the limitations of the study

A key strength of this pilot study is its novel, direct comparative design, which provides foundational data on two distinct clinical timings for the same intervention. The use of a standardized protocol enhances the internal validity of these initial findings. Furthermore, the comprehensive evaluation of procedural metrics, pain scores, and analgesic consumption offers a holistic view crucial for informing the design of a larger, definitive trial.

As a pilot investigation, the primary limitation is that the study design was non-randomized, which introduces potential selection and allocation bias and limits our ability to infer causality. The single-center design further restricts generalizability, and the inability to blind the interventionist introduces potential performance bias. These limitations are inherent to a pilot study and highlight the need for a larger, multi-center randomized controlled trial to confirm these preliminary findings.

Recommendation for future studies

Based on these pilot findings, a large-scale, multi-center randomized controlled trial is recommended to definitively compare preoperative and postoperative TAP block timing. Such a study, powered to detect smaller clinical differences and assess patient-centered outcomes like recovery quality and long-term satisfaction, would provide more conclusive evidence to guide optimal clinical practice.

CONCLUSION

This study demonstrates that preoperative and postoperative TAP blocks provide equivalent analgesic efficacy after cesarean delivery. The significant procedural advantages of the preoperative approach—faster performance and shallower needle depth—support its feasibility as a practical alternative. These findings offer clinicians flexibility in timing based on operating room workflow and patient positioning, without compromising pain management outcomes.

AUTHORSHIP CONTRIBUTIONS

Khaled M. Alanwer: Conceptualization of the study, methodology design, acquisition of ethical approval, supervision of the clinical trial and data collection, project administration, and critical revision of the manuscript.

Ahmed Alaa eldin Wali: Provision of patients and surgical performance (cesarean deliveries), clinical oversight of parturients, review and editing of the manuscript from a surgical perspective.

Mohamed Abdo: Administration of spinal anesthesia, performance of TAP blocks, data collection and curation, review of the manuscript.

Ezz F. Ismail: Administration of spinal anesthesia, performance of TAP blocks, data collection and curation, review of the manuscript.

Bahaa Gamal Saad Mohamed: Formal statistical analysis, interpretation of results, writing—original draft preparation, and final review and editing of the manuscript.

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DISCLOSURE OF INTEREST

The authors declare no conflict of interest.

Ethics approval: Following local regulations, the protocol gained ethical and research approval from the institutional review board of Saudi German Hospital (ECC2021-06).

Informed consent: After explaining the procedure, all participants gave informed consent. We confirm that all methods were performed according to the relevant guidelines and regulations, per the Declaration of Helsinki.

DATA SHARING

The datasets used and analyzed during the current study are available from the corresponding author upon reasonable request.

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Not applicable.

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