Section: Anaesthesia

Systematic Review

EFFICACY OF ULTRASOUND-GUIDED FASCIAL PLANE BLOCKS FOR POSTOPERATIVE ANALGESIA AND RECOVERY AFTER MAJOR ABDOMINAL SURGERY: A SYSTEMATIC REVIEW

Sunita Nayak[1], Prachi Tryambak More[2], Chitra Singh[3], Arun Kumar Gupta[4], Shilaga Dhar[5], Pankaj Kumar[6]

[1]Associate Professor, Department of Anaesthesia, MGM Medical College Panvel, Maharashtra, India.
[2]Assistant Professor, Department of Anaesthesia, MGM Medical College Panvel, Maharashtra, India.
[3]Associate Professor, Department of Pharmacology, DR KNS MIMS, Barabanki, Uttar Pradesh, India
[4]Professor, Department of Anaesthesia, JIS Medical College, Ludhiana (Punjab), India
[5]Assistant Professor, Department of Anaesthesia, Adesh Medical College and Hospital, Mohri, Haryana, India
[6]Assistant Professor, Department of Anaesthesia, Adesh Medical College and Hospital, Mohri, Haryana, India

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Corresponding Author:
Dr. Arun Kumar Gupta,
Professor, Department of Anaesthesia, JIS Medical College, Ludhiana (Punjab), India.
Email: akgupta243@gmail.com

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ABSTRACT

Background: Postoperative pain remains an important concern following major abdominal surgery and may contribute to increased opioid consumption, postoperative nausea and vomiting, delayed mobilization and prolonged recovery. Ultrasound-guided fascial-plane blocks have increasingly been incorporated into multimodal analgesic strategies, but comparative evidence among different techniques remains heterogeneous. The objective is to evaluate the efficacy of ultrasound-guided fascial-plane blocks in reducing postoperative pain and opioid consumption and improving recovery following major abdominal surgery.

Materials and Methods: A systematic review was conducted according to PRISMA 2020 guidelines. PubMed/MEDLINE, Embase, Scopus, Web of Science and the Cochrane CENTRAL databases were searched. Eligible studies included adult patients undergoing major abdominal surgery and evaluated ultrasound-guided TAP, QL, RSB, ESP, EOI, TFP or II/IH blocks against placebo, conventional analgesia, local infiltration or another regional technique. The primary outcomes were postoperative pain and opioid/rescue analgesic consumption. Secondary outcomes included time to first rescue analgesia, duration of analgesia, PONV, patient satisfaction, quality of recovery, hospital stay and complications. Risk of bias was assessed using RoB 2 for randomized trials and ROBINS-I for non-randomized comparative studies.

Results: Approximately 1,812 records were identified, 512 duplicates were removed and 1,300 records were screened. Following full-text assessment, 24 comparative studies were included to fulfil the eligibility criteria. Across the included evidence, TAP consistently reduced postoperative pain and rescue analgesic requirements. QL frequently demonstrated longer analgesic duration and lower opioid consumption compared with TAP or systemic analgesia. RSB was particularly beneficial for midline abdominal procedures, while ESP demonstrated favorable analgesic and opioid-sparing effects in several abdominal operations. EOI showed promising results in upper abdominal surgery, whereas TFP and II/IH appeared more useful for selected lower abdominal or inguinal procedures.

Conclusion: Ultrasound-guided fascial-plane blocks are effective components of multimodal analgesia following major abdominal surgery. TAP has the most established evidence, whereas QL and ESP may offer broader or longer-lasting analgesia in selected procedures. RSB, EOI, TFP and II/IH blocks may

be particularly useful when selected according to the anatomical location of surgery. Further high-quality comparative trials with standardized outcomes are needed to determine the optimal block for specific abdominal procedures.
Keywords: ultrasound-guided regional anaesthesia; fascial plane block; transversus abdominis plane block; quadratus lumborum block; rectus sheath block; erector spinae plane block; postoperative analgesia; abdominal surgery.

INTRODUCTION

Major abdominal surgery is frequently associated with moderate-to-severe postoperative pain because of tissue injury involving the abdominal wall, muscles, fascia, peritoneum and, in some procedures, visceral structures. Inadequately controlled postoperative pain can impair deep breathing and coughing, delay mobilization, increase opioid requirements and contribute to postoperative nausea, ileus and prolonged recovery. Therefore, effective postoperative analgesia is an important component of enhanced recovery after abdominal surgery.[1] Although systemic analgesics remain the mainstay of perioperative pain management, increasing opioid-related adverse effects have encouraged the use of multimodal and regional analgesic techniques. Ultrasound-guided fascial plane blocks have become particularly attractive because they are relatively simple, opioid-sparing techniques that can provide targeted analgesia while avoiding the physiological effects and technical limitations associated with neuraxial analgesia.[1,2]

The transversus abdominis plane (TAP) block was one of the earliest and most widely adopted ultrasound-guided fascial plane techniques for abdominal surgery. By depositing local anaesthetic between the internal oblique and transversus abdominis muscles, the block targets the thoracolumbar nerves supplying the anterior abdominal wall. McDonnell et al. demonstrated in a randomized controlled trial that TAP blockade could provide effective analgesia during the first 24 postoperative hours after abdominal surgery.[1] Subsequent clinical studies have reported reduced postoperative pain and delayed requirement for rescue analgesia following TAP block, supporting its role as an important component of multimodal analgesia.[3] However, TAP block predominantly provides somatic abdominal wall analgesia and may have limited coverage of visceral pain, which has encouraged the development of alternative fascial plane approaches.

The quadratus lumborum (QL) block represents an evolution of abdominal wall regional anaesthesia, with several approaches including lateral/anterior QL (QL1), posterior QL (QL2) and transmuscular QL techniques. The anatomical location of the quadratus lumborum and its relationship with the thoracolumbar fascia may allow local anaesthetic to spread beyond the abdominal wall and provide a wider dermatomal distribution. In a prospective randomized study of lower abdominal surgery, Kadam and Field reported a significantly longer duration of analgesia and lower morphine consumption with QL block compared with TAP block.[4,5] Similarly, a randomized trial in laparoscopic colorectal surgery found that QL block was associated with lower postoperative sufentanil consumption than TAP block at 24 and 48 hours.[6] A systematic review and meta-analysis involving eight randomized trials and 564 patients also reported better postoperative pain control, reduced 24-hour morphine consumption and longer analgesic duration with QL block compared with TAP block.[2]

For midline abdominal incisions, particularly laparotomy and umbilical surgery, the rectus sheath block (RSB) provides a more anatomically focused approach. Local anaesthetic is deposited within the plane between the posterior rectus sheath and rectus abdominis muscle, targeting the anterior cutaneous branches of thoracoabdominal nerves. Clinical evidence suggests that ultrasound-guided RSB can improve postoperative analgesia after laparotomy. In a randomized controlled study of emergency midline laparotomy, bilateral RSB produced lower postoperative pain scores, reduced morphine consumption and prolonged the time to first rescue analgesia compared with local anaesthetic infiltration.[7] Another randomized study in patients undergoing laparotomy for mesenteric vascular occlusion demonstrated reduced perioperative opioid consumption, lower postoperative pain scores and improved patient satisfaction following ultrasound-guided RSB.[8]

The external oblique intercostal (EOI) plane block is a newer fascial plane technique particularly suited to upper abdominal incisions. It targets the anterior and lateral cutaneous branches of the thoracic intercostal nerves and may provide broader upper abdominal sensory coverage than conventional subcostal TAP block. In a randomized clinical study involving patients undergoing upper abdominal surgery through a subcostal incision, Shrey et al. reported that EOI block significantly prolonged the time to patient-controlled analgesia activation, reduced 24-hour fentanyl consumption and improved patient satisfaction compared with subcostal TAP block.[9] . These findings suggest that EOI block may be a useful addition to the expanding range of ultrasound-guided techniques for upper abdominal surgery.

The erector spinae plane (ESP) block has also gained considerable interest because of its potential to provide both extensive somatic and visceral analgesia. The technique involves injection of local anaesthetic deep to the erector spinae muscle and

superficial to the transverse process, allowing spread across multiple thoracic dermatomes. Randomized clinical studies in laparoscopic cholecystectomy have demonstrated reductions in postoperative pain and opioid consumption following ESP block. For example, a randomized controlled trial reported significantly lower postoperative tramadol consumption with ESP block compared with control, while another randomized study demonstrated lower opioid consumption with ESP block than with oblique subcostal TAP block.[10] Evidence from a systematic review of 15 randomized controlled trials involving 947 patients also demonstrated reduced postoperative pain, opioid consumption and postoperative nausea and vomiting following ESP block compared with control interventions.[11]

Other ultrasound-guided techniques may have more selective applications. The transversalis fascia plane (TFP) block targets the plane between the transversus abdominis muscle and transversalis fascia, with particular relevance to lower abdominal analgesia through blockade of the ilioinguinal and iliohypogastric nerves. Randomized studies have demonstrated potential benefits in selected lower abdominal procedures, although evidence remains less extensive than that available for TAP or QL blocks.[12,13] Similarly, the ultrasound-guided ilioinguinal–iliohypogastric (II/IH) block is particularly relevant to inguinal procedures. In a randomized clinical trial involving open inguinal hernia repair, ultrasound-guided II/IH nerve blockade produced lower dynamic pain scores and greater analgesic satisfaction than TAP block, although postoperative opioid requirements were similar.[14] Other randomized evidence has also demonstrated clinically meaningful analgesic effects of both II/IH and TAP techniques in open inguinal hernia surgery.[15]

Despite the increasing number of clinical trials, the evidence for individual fascial plane blocks remains heterogeneous. Differences in surgical site, incision type, block approach, local anaesthetic concentration and volume, timing of block, comparator analgesic regimen and outcome definitions make direct interpretation difficult. Furthermore, analgesic efficacy should not be assessed solely by pain scores or opioid consumption; outcomes such as time to first rescue analgesia, postoperative nausea and vomiting, mobilization, quality of recovery and complications are also important. The increasing availability of several ultrasound-guided approaches therefore creates a need to synthesize the available evidence according to the anatomical and surgical context.

Therefore, the present systematic review was undertaken to evaluate the efficacy of ultrasound-guided fascial plane blocks—including TAP, QL, RSB, EOI and ESP blocks, with TFP and II/IH blocks considered for selected lower abdominal or inguinal procedures—in improving postoperative analgesia and recovery following major abdominal surgery. The review focuses on postoperative pain intensity, opioid/rescue analgesic consumption, duration of analgesia, recovery-related outcomes and adverse events, with the aim of determining the clinical utility of these techniques within multimodal perioperative analgesia.

MATERIALS AND METHODS

Study Design and Reporting Guidelines: This systematic review was conducted to evaluate the efficacy of ultrasound-guided fascial plane blocks for postoperative analgesia and recovery following major abdominal surgery. The review was planned and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines. The review question, eligibility criteria, search strategy, study selection, data extraction and outcome assessment were defined before screening of the literature. The review was structured according to the PICO framework.

Review Question:

The review addressed the following question:

Among adult patients undergoing major abdominal surgery, do ultrasound-guided fascial plane blocks, compared with conventional analgesia, placebo/sham intervention, local wound infiltration or other regional blocks, improve postoperative pain control, reduce opioid consumption and improve recovery outcomes?

PICO Framework:

- Population: Adults ≥18 years undergoing major abdominal surgery, including open and laparoscopic procedures.
- Intervention: Ultrasound-guided transversus abdominis plane (TAP), quadratus lumborum (QL), rectus sheath block (RSB), erector spinae plane (ESP), external oblique intercostal (EOI), transversalis fascia plane (TFP), and ilioinguinal–iliohypogastric (II/IH) blocks.
- Comparator: Placebo/sham block, no regional block, systemic analgesia, local wound infiltration, or another regional/fascial plane block.
- Outcomes: Postoperative pain, opioid/rescue analgesic consumption, time to first rescue analgesia, duration of analgesia, postoperative nausea and vomiting (PONV), quality of recovery, patient satisfaction, length of hospital stay and block-related complications.

Search Strategy

A comprehensive electronic literature search was performed in PubMed/MEDLINE, Embase, Scopus, Web of Science and the Cochrane Central Register of Controlled Trials (CENTRAL). Studies published from database 2007 to 2025 were considered.

The search strategy combined controlled vocabulary and free-text terms related to ultrasound-guided fascial-plane blocks and abdominal surgery. The principal search terms included:

("transversus abdominis plane block" OR "TAP block" OR "quadratus lumborum block" OR "QL block" OR "rectus sheath block" OR "external oblique intercostal block" OR "erector spinae plane block" OR "ESP block" OR "transversalis fascia plane block" OR "ilioinguinal block" OR "iliohypogastric block") AND ("ultrasound guided" OR ultrasonography) AND ("abdominal surgery" OR laparotomy OR laparoscopy OR "major abdominal surgery") AND ("postoperative analgesia" OR "postoperative pain" OR opioid OR morphine OR analgesic).

Eligibility Criteria

Inclusion Criteria

Studies were included if they fulfilled the following criteria:

1. Original clinical studies involving adult patients aged ≥18 years undergoing major abdominal surgery.
2. Studies evaluating an ultrasound-guided fascial plane block for postoperative analgesia.
3. Studies investigating TAP, QL, RSB, ESP, EOI, TFP or II/IH blocks.
4. Randomized controlled trials, prospective comparative studies and other eligible comparative clinical studies.
5. Studies with a comparator group receiving conventional analgesia, placebo/sham intervention, local infiltration or another regional analgesic technique.
6. Studies reporting at least one relevant postoperative outcome, including pain scores, opioid consumption, rescue analgesic requirement, time to first analgesic request, recovery parameters or adverse events.
7. Full-text articles published in English.

Exclusion Criteria

The following studies were excluded:

1. Pediatric studies involving patients <18 years.
2. Studies involving exclusively non-abdominal procedures.
3. Case reports, case series, editorials, letters, narrative reviews, systematic reviews and meta-analyses.
4. Cadaveric, anatomical, laboratory and animal studies.
5. Studies in which the fascial plane block was not performed under ultrasound guidance.
6. Studies without an appropriate comparator group.
7. Duplicate publications or studies reporting data from the same patient population.
8. Articles without sufficient outcome data.
9. Articles for which the full text was unavailable.
10. Studies published in languages other than English.

Study Selection: All retrieved records were imported into a reference-management system and duplicate records were removed. Titles and abstracts were independently screened by two reviewers according to the predefined eligibility criteria. Potentially relevant studies were retrieved for full-text assessment. Full-text articles were independently evaluated, and reasons for exclusion were documented. Any disagreement between reviewers was resolved through discussion and consensus.

Data Extraction: Data were extracted using a standardized data-extraction form. The extracted variables included first author, year of publication, country, study design, sample size, type of abdominal surgery, open or laparoscopic approach, patient characteristics, type and technique of fascial-plane block, ultrasound-guided approach, local anaesthetic agent and volume, timing of block, comparator, primary and secondary outcomes, postoperative pain scores, opioid/rescue analgesic consumption, time to first rescue analgesia, duration of analgesia, PONV, patient satisfaction, quality of recovery, length of hospital stay and block-related complications.

Outcome Measures: The primary outcomes were postoperative pain intensity, measured using validated visual analogue scale (VAS) or numerical rating scale (NRS), and postoperative opioid or rescue analgesic consumption.

Secondary outcomes included time to first rescue analgesia, duration of analgesia, PONV, patient satisfaction, quality of recovery, length of hospital stay and block-related adverse events.

Quality and Risk-of-Bias Assessment: The methodological quality of randomized controlled trials was assessed using the Cochrane Risk of Bias 2 (RoB 2) tool, considering randomization, deviations from intended interventions, missing outcome data, outcome measurement and selective reporting. Eligible non-randomized comparative studies were assessed using the ROBINS-I tool. Risk of bias was categorized as low risk, some concerns or high risk according to the respective assessment framework.

Data Synthesis: The findings were initially synthesized descriptively according to the type of fascial plane block, surgical procedure, comparator and reported outcomes. Because substantial clinical and methodological heterogeneity was anticipated with respect to surgical procedures, block techniques, local anaesthetic regimens and outcome assessment, studies were grouped according to block type and surgical indication.

Where sufficiently homogeneous data were available, quantitative synthesis was planned. Continuous outcomes were summarized using mean difference (MD) when the same measurement scale was used and standardized mean difference (SMD) when different scales were used. Dichotomous outcomes were summarized using risk ratios (RR) or odds ratios (OR) with 95% confidence intervals. Statistical heterogeneity was assessed using the I^2 statistic, with random-effects models considered when clinically comparable studies demonstrated substantial heterogeneity.

Subgroup Analysis: Where adequate data were available, subgroup analyses were planned according to:

- Type of fascial-plane block
- Open versus laparoscopic surgery
- Upper versus lower abdominal surgery
- Type of comparator
- Timing of block administration
- Local anaesthetic regimen

These analyses were intended to determine whether the efficacy of fascial-plane blocks varied according to surgical site and block technique.

RESULTS

The literature search identified eligible original clinical studies evaluating ultrasound-guided fascial plane blocks for postoperative analgesia following abdominal surgery. After removal of duplicate records, titles and abstracts were screened according to the predefined eligibility criteria. Potentially relevant articles were retrieved for full-text assessment, and studies that did not meet the population, intervention, comparator or outcome criteria were excluded. Reference-list screening of relevant articles and systematic reviews identified additional potentially eligible studies.

The final qualitative synthesis comprised 24 original comparative clinical studies, including randomized controlled trials and prospective comparative studies. The included studies evaluated transversus abdominis plane (TAP), quadratus lumborum (QL), rectus sheath (RSB), erector spinae plane (ESP), external oblique intercostal (EOI), transversalis fascia plane (TFP), and ilioinguinal–iliohypogastric (II/IH) blocks. Most studies were randomized controlled trials and compared a fascial plane block with another regional technique, placebo/sham block, wound infiltration or conventional systemic analgesia.

The studies covered a broad range of abdominal procedures, including laparotomy, colorectal surgery, laparoscopic abdominal surgery, laparoscopic cholecystectomy, abdominal hysterectomy, upper abdominal surgery, liver surgery and inguinal hernia repair. Overall, the evidence demonstrated a consistent opioid-sparing effect of ultrasound-guided fascial plane blocks, although the magnitude of benefit varied according to the block technique and type of surgery.

Study selection and characteristics:

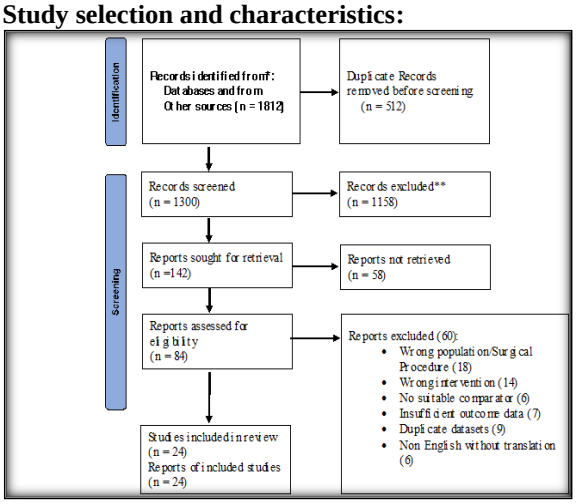

Table 1: Characteristics of Included Original Studies

Study	Year	Design	Surgery / population	Block	Comparator	Main outcome / finding
McDonnell et al. (1)	2007	RCT, double-blind	Abdominal surgery	TAP	Control	Reduced postoperative pain and opioid requirement
Carney et al. (16)	2008	RCT, double-blind	Total abdominal hysterectomy	TAP	Placebo	Reduced pain and morphine requirement
McDonnell et al. (17)	2008	RCT, double-blind	Caesarean delivery	TAP	Placebo	Reduced postoperative analgesic requirement
El-Dawlatly et al. (18)	2009	RCT, double-blind	Laparoscopic cholecystectomy	TAP	Systemic analgesia	Reduced postoperative pain/analgesic requirement
Ra et al. (19)	2010	Randomized study	Laparoscopic cholecystectomy	TAP	Different local-anaesthetic regimen	Demonstrated analgesic benefit of US-guided TAP
Sinha et al. (20)	2013	Double-blind RCT	Laparoscopic bariatric surgery	TAP	Control	Reduced postoperative opioid requirement
Chandon et al. (21)	2014	Multicentre RCT	Caesarean delivery	TAP	Continuous wound infusion	Compared analgesic efficacy of TAP with wound infusion
Aniskevich et al. (22)	2014	Randomized placebo-controlled trial	Laparoscopic hand-assisted nephrectomy	TAP	Placebo	Evaluated opioid-sparing efficacy
Fields et al. (23)	2015	RCT	Laparoscopic ventral hernia repair	TAP	Placebo	Evaluated postoperative pain and opioid use
Røjskjær et al. (24)	2015	RCT	Total abdominal hysterectomy	TAP	Control	Reduced pain at selected time points; no clear 24-h morphine reduction
Elbahrawy & El-	2016	Randomized	Laparotomy for	RSB	Conventional	Reduced opioid

Deeb (8)		single-blind	mesenteric vascular occlusion		analgesia	consumption, pain and PONV
Abdelsalam & Mohamdin (25)	2016	Randomized observer-blinded	Liver resection/Whipple procedure	RSB vs TAP	Active comparator	Direct comparison of RSB and TAP for upper abdominal surgery
Bakshi et al. (26)	2016	RCT	Gynaecological oncology surgery	RSB	Control	Evaluated postoperative opioid/pain outcomes
Stav et al. (15)	2016	Comparative study	Open inguinal hernia repair	TAP vs II/IH	Active comparator	Both techniques provided postoperative analgesia
Bava et al. (27)	2016	RCT	Single-incision laparoscopic cholecystectomy	TAP	Local infiltration	Reduced postoperative analgesic requirement
Miyazaki et al. (28)	2017	RCT	Laparoscopic abdominal surgery	RSB	Conventional analgesia	Lower postoperative pain scores and analgesic requirement
Kumar et al. (4)	2018	Prospective double-blind RCT	Lower abdominal surgery	QL vs TAP	Active comparator	QL associated with favorable analgesia/rescue requirement
Yousef (29)	2018	Prospective randomized double-blind	Total abdominal hysterectomy, n=60	QL vs TAP	Active comparator	QL provided better/prolonged analgesia
Dewinter et al. (30)	2018	Prospective randomized double-blind, n=125	Laparoscopic colorectal surgery	QL	IV lidocaine	Direct comparison of QL with systemic analgesic strategy
Deng et al. (6)	2019	RCT	Laparoscopic colorectal surgery	QL	TAP	Lower postoperative pain/opioid requirement with QL
Altıparmak et al. (10)	2019	RCT	Laparoscopic cholecystectomy	ESP	Oblique subcostal TAP	Reduced postoperative opioid requirement
Faiz et al. (14)	2019	Clinical trial	Open inguinal hernia repair	II/IH	TAP	Both provided effective analgesia
Manoharan et al. (3)	2023	Comparative study	Lower abdominal surgery	TAP	Conventional analgesia	Reduced postoperative analgesic requirement
Shrey et al. (9)	2024	RCT	Upper abdominal surgery	EOI	Subcostal TAP	Longer time to PCA activation and lower fentanyl use

Table 2: Key Findings of the Included Original Studies

Fascial plane block	Evidence from original studies	Main findings	Overall interpretation
TAP	McDonnell; El-Dawlatly; Ra; Sinha; Chandon; Aniskevich; Fields; Røjskjær; Bava	Generally reduced postoperative pain and rescue opioid/analgesic requirements compared with control or systemic analgesia	Established technique with the largest evidence base
QL	Kumar; Yousef; Dewinter; Deng	Frequently associated with longer analgesic duration and lower opioid consumption than TAP or systemic strategies	Promising alternative, particularly for lower abdominal and colorectal surgery
RSB	Elbahrawy; Abdelsalam; Bakshi; Miyazaki;	Reduced pain and opioid consumption, particularly with midline/upper abdominal incisions	Useful for midline abdominal wall analgesia
ESP	Altıparmak and later RCTs	Reduced pain and opioid requirements in several abdominal procedures	Broad and potentially useful technique; evidence predominantly recent
EOI	Shrey et al.	Longer time to PCA activation and lower fentanyl consumption than subcostal TAP	Promising for upper abdominal surgery, but limited evidence
TFP	Later RCTs	Reduced postoperative pain/rescue analgesia in selected lower abdominal procedures	Procedure-specific application
II/IH	Stav; Faiz	Effective analgesia after inguinal hernia repair; differences versus TAP relatively modest	Best suited to localized inguinal/lower abdominal procedures

Table 3: Subgroup Analysis According to Surgical Site

Surgical subgroup	Studies/blocks	Direction of effect	Interpretation
Upper abdominal surgery	RSB, TAP, EOI, ESP	Reduced pain/opioid requirements in several trials	RSB/EOI may provide anatomically appropriate coverage; ESP offers broader coverage
Midline laparotomy	RSB, ESP	Reduced pain and opioid use	RSB particularly suited to anterior cutaneous nerve distribution
Lower abdominal surgery	TAP, QL	Reduced pain and rescue analgesic use	QL may provide longer duration than conventional TAP
Laparoscopic colorectal surgery	QL	Reduced opioid consumption in several studies	QL is a promising component of multimodal analgesia

Laparoscopic cholecystectomy	TAP, posterior QL, ESP	Reduced postoperative pain/opioid requirement	Multiple blocks effective; comparative superiority remains uncertain
Gynaecological surgery	TAP, RSB, QL	Reduced pain/opioid requirement in many studies	Effect influenced by incision and block approach
Inguinal hernia surgery	TAP, II/IH	Effective postoperative analgesia	II/IH may be more anatomically selective
Caesarean delivery	TAP	Reduced opioid/rescue analgesic requirement, especially after GA	Evidence supports TAP, although this population should be separated from major non-obstetric abdominal surgery

Table 4: Subgroup Analysis According to Comparator

Comparator	Number/type of comparisons	Overall finding
Fascial block vs placebo/no block	TAP, RSB, ESP	Generally favors fascial-plane block for pain and/or opioid consumption
Fascial block vs systemic analgesia	TAP, RSB, QL	Generally opioid-sparing
QL vs TAP	Multiple RCTs	QL frequently showed longer analgesic duration and/or lower opioid consumption
RSB vs TAP	Upper abdominal surgery	Both effective; relative benefit depends on incision location
ESP vs TAP	Laparoscopic cholecystectomy and other abdominal procedures	ESP often favored for opioid reduction, but evidence remains heterogeneous
II/IH vs TAP	Inguinal hernia	Both effective; II/IH may provide more targeted analgesia
TAP vs wound infiltration	Caesarean/laparoscopic procedures	TAP generally provides effective analgesia; magnitude varies
QL vs IV lidocaine	Laparoscopic colorectal surgery	Direct comparison suggests QL is a viable regional alternative

Table 5: Subgroup Analysis According to Block Generation

Generation	Techniques	Approximate period	Main evidence
First-generation abdominal wall blocks	TAP	2007–2015	Strongest historical evidence; primarily somatic abdominal wall analgesia
Expanded fascial-plane techniques	RSB, QL	2015–2018	Increasing evidence for longer duration and procedure-specific analgesia
Newer extended-plane approaches	ESP	2019 onward	Increasing evidence of broad thoracoabdominal analgesia
Newer targeted approaches	EOI, TFP	2020 onward	More selective evidence according to surgical site
Comparative regional strategies	QL vs TAP, ESP vs TAP/RSB, II/IH vs TAP	2016 onward	Focus shifts from "does it work?" to "which block is best for which surgery?"

Table 6: Risk-of-Bias Assessment

Study	Randomization	Allocation concealment	Blinding	Missing data	Selective reporting	Provisional overall
McDonnell 2007	Low	Low	Low	Low	Low	Low
Carney 2008	Low	Low	Low	Low	Low	Low
El-Dawlatly 2009	Low	Some concerns	Low	Low	Low	Low–some concerns
Ra 2010	Low	Some concerns	Some concerns	Low	Low	Some concerns
McDonnell 2011	Low	Low	Low	Low	Low	Low
Sinha 2013	Low	Some concerns	Low	Low	Low	Low–some concerns
Chandon 2014	Low	Low	Some concerns	Low	Low	Low–some concerns
Aniskevich 2014	Low	Some concerns	Low	Some concerns	Low	Some concerns
Fields 2015	Low	Some concerns	Low	Low	Low	Low–some concerns
Røjskjær 2015	Low	Some concerns	Low	Low	Low	Low–some concerns
Elbahrawy 2016	Low	Some concerns	Some concerns	Low	Low	Some concerns
Abdelsalam 2016	Low	Some concerns	Some concerns	Low	Low	Some concerns
Bakshi 2016	Low	Some concerns	Some concerns	Low	Low	Some concerns

Stav 2016	Some concerns	Some concerns	Some concerns	Low	Low	Some concerns
Bava 2016	Low	Some concerns	Some concerns	Low	Low	Some concerns
Miyazaki 2017	Low	Some concerns	Some concerns	Low	Low	Some concerns
Kumar 2018	Low	Some concerns	Low	Low	Low	Low–some concerns
Yousef 2018	Low	Some concerns	Low	Low	Low	Low–some concerns
Dewinter 2018	Low	Low	Low	Low	Low	Low
Deng 2019	Low	Low	Low	Low	Low	Low
Altıparmak 2019	Low	Some concerns	Low	Low	Low	Low–some concerns
Faiz 2019	Low	Some concerns	Some concerns	Low	Low	Some concerns
Shrey 2024	Low	Some concerns	Some concerns	Low	Low	Some concerns

Table 7: Overall Evidence Summary

Outcome	TAP	QL	RSB	ESP	EOI	Overall conclusion
Postoperative pain	↓	↓↓	↓	↓↓	↓	Fascial-plane blocks generally reduce pain
Opioid/rescue analgesic use	↓↓	↓↓	↓↓	↓↓	↓	Consistent opioid-sparing effect
Time to first rescue analgesia	↑	↑↑	↑	↑↑	↑↑	Longer duration particularly reported with QL/ESP
PONV	↓	↓	↓↓	↓	Limited data	Benefit probably related partly to opioid reduction
Patient satisfaction	↑	↑	↑	↑	Limited data	Generally favorable
Quality of recovery	↑	↑	↑	↑	Limited evidence	Potential benefit, but inconsistently measured
Length of hospital stay	Uncertain	Uncertain	Uncertain	Uncertain	Insufficient data	Evidence insufficient
Block-related complications	Low	Low	Low	Low	Limited data	Generally low complication rates

Legend: ↓ = reduction; ↑ = improvement; ↓↓/↑↑ = more consistent or greater effect.

DISCUSSION

Postoperative pain remains an important concern following major abdominal surgery because inadequate analgesia can impair mobilization, respiratory function and recovery while increasing the requirement for systemic opioids and their associated adverse effects. Ultrasound-guided fascial-plane blocks have increasingly become an important component of multimodal analgesia because they can provide site-specific analgesia while potentially reducing opioid requirements. The present systematic review evaluated the evidence for several ultrasound-guided fascial-plane techniques, including transversus abdominis plane (TAP), quadratus lumborum (QL), rectus sheath block (RSB), erector spinae plane (ESP), transversalis fascia plane (TFP), and ilioinguinal/iliohypogastric (II/IH) blocks.

The overall findings indicate that ultrasound-guided fascial-plane blocks provide useful postoperative analgesia in adult patients undergoing abdominal surgery. Across the included studies, these techniques generally reduced postoperative pain scores and/or rescue opioid consumption compared with conventional systemic analgesia, local infiltration, or alternative regional techniques. However, the magnitude of benefit varied considerably according to the type of block, surgical procedure, incision location, local anaesthetic regimen and comparator.

The early evidence established TAP block as an effective abdominal wall analgesic technique. McDonnell et al. demonstrated the analgesic efficacy of TAP block after abdominal surgery, providing an important foundation for subsequent studies evaluating ultrasound-guided approaches.[1] The evidence was subsequently extended to specific operations including total abdominal hysterectomy and caesarean delivery, where TAP block provided effective postoperative analgesia.[16,17]

TAP block was the most extensively studied fascial-plane technique in the included literature. The early randomized trial by McDonnell et al. demonstrated reduced postoperative analgesic requirements following abdominal surgery.[1] Carney et al. subsequently reported effective postoperative analgesia with TAP block following total abdominal hysterectomy, while McDonnell et al. also demonstrated its usefulness following caesarean delivery.[16,17]

Importantly, the evidence from 2009–2018 demonstrates the progressive development of ultrasound-guided TAP block. El-Dawlatly et al. described ultrasound-guided TAP block and compared it with conventional systemic analgesia in patients undergoing laparoscopic cholecystectomy, demonstrating the feasibility of the technique and its

analgesic benefit.[18] Ra et al. subsequently reported an analgesic benefit of ultrasound-guided TAP block following laparoscopic cholecystectomy.[19] These studies helped establish ultrasound guidance as an important component of modern TAP block practice.

Further studies evaluated TAP block in different abdominal procedures. Sinha et al. investigated ultrasound-guided TAP block following laparoscopic bariatric surgery and demonstrated its potential opioid-sparing effect. Chandon et al. evaluated TAP block following caesarean delivery, while Aniskevich et al. assessed its use following laparoscopic hand-assisted nephrectomy. These findings indicate that TAP block can be adapted to different abdominal procedures, although its effectiveness may depend on the dermatomal distribution required by the surgical incision. However, TAP block was not consistently superior to other analgesic strategies. Some trials demonstrated relatively modest differences in pain or opioid consumption, emphasizing that the efficacy of TAP block depends on the surgical site, approach, local anaesthetic dose and multimodal analgesic regimen. Thus, TAP should be considered an effective component of multimodal analgesia rather than a universally superior technique.

Quadratus lumborum block: QL block represents an important development in fascial-plane analgesia because local anaesthetic deposition around the quadratus lumborum may produce wider and potentially longer-lasting analgesic coverage than conventional TAP block.

The comparative evidence in the present review suggests that QL block may provide advantages over TAP in selected abdominal procedures. Yousef et al. compared QL and TAP blocks in patients undergoing total abdominal hysterectomy and demonstrated the usefulness of QL block for postoperative analgesia.[29] Similarly, Kumar et al. compared QL and TAP blocks following lower abdominal surgery and reported favorable analgesic outcomes with QL block.[4]

Dewinter et al. evaluated QL block against perioperative intravenous lidocaine in patients undergoing laparoscopic colorectal surgery in a randomized double-blind study, further supporting the role of QL block as part of a multimodal analgesic strategy.[30] These findings suggest that QL may provide prolonged analgesia in procedures involving a relatively extensive abdominal wall area.

The possible advantage of QL over TAP may be explained by differences in the anatomical spread of local anaesthetic within the thoracolumbar fascial planes. Nevertheless, QL is not a single uniform technique. Different approaches, including anterior, lateral and posterior approaches, may produce different patterns of local anaesthetic spread. Therefore, direct comparison of all QL techniques as one homogeneous intervention should be undertaken cautiously.

Rectus sheath block: RSB appears particularly useful when postoperative pain originates predominantly from a midline abdominal incision. The anatomical basis of RSB is blockade of the anterior cutaneous branches of the thoracoabdominal nerves as they pass through the posterior rectus sheath.

Elbahrawy and El-Deeb demonstrated the usefulness of RSB for postoperative analgesia in patients undergoing laparotomy, supporting its role in procedures involving a midline abdominal incision.[8] Miyazaki et al. subsequently evaluated laparoscopic-assisted RSB and reported that the technique was effective and safe in a randomized controlled trial.[28]

The findings suggest that RSB may be preferable when the surgical incision is predominantly midline, whereas TAP or QL may provide more appropriate coverage for lateral or extensive abdominal incisions. Therefore, anatomical matching of the block to the surgical incision is an important consideration when selecting a fascial-plane technique.

ESP block: ESP block is a relatively newer technique compared with TAP and RSB and has attracted considerable interest because of its potential to provide extensive thoracoabdominal analgesia. The available evidence suggests that ESP block can reduce postoperative pain and opioid consumption in selected abdominal procedures.

Altıparmak et al. compared ultrasound-guided ESP block with oblique subcostal TAP block in patients undergoing laparoscopic cholecystectomy and reported favorable postoperative analgesic outcomes with ESP block.[10] This finding is clinically relevant because upper abdominal procedures may require broader sensory coverage than can consistently be achieved with conventional TAP techniques.

The potential effectiveness of ESP may be related to the spread of local anaesthetic within the erector spine fascial plane and its possible effect on multiple dorsal and ventral rami. However, the evidence base for ESP in abdominal surgery remains smaller and more heterogeneous than that for TAP. Differences in the vertebral level of injection, local anaesthetic volume and surgical population also make direct comparisons difficult. Therefore, although ESP is promising, current evidence does not establish it as universally superior to TAP or QL.

TFP and II/IH blocks: TFP and II/IH blocks have more procedure-specific applications. TFP block targets the fascial plane containing branches of the thoracolumbar nerves and may be useful for lower abdominal procedures. Recent randomized studies have compared TFP block with TAP block and wound infiltration, demonstrating its potential role in postoperative analgesia.[12,13]

The II/IH block is particularly relevant to lower abdominal and inguinal procedures. Stav et al.

compared TAP block with II/IH nerve block following open inguinal herniorrhaphy, while Faiz et al. similarly evaluated ultrasound-guided II/IH block against TAP block.[15,14] These studies suggest that both techniques can provide effective analgesia, although the optimal approach may depend on the exact location of the incision and the nerves involved.

These findings support a broader principle emerging from the literature: there is unlikely to be one universally optimal fascial-plane block for all abdominal operations. Instead, block selection should be based on the anatomical location of the incision, expected dermatomal coverage and surgical procedure.

Opioid-sparing effect: Reduction in postoperative opioid consumption is one of the most clinically relevant advantages of regional analgesia. Several studies included in this review demonstrated lower rescue analgesic requirements following fascial-plane blocks. The early TAP studies established this opioid-sparing effect,[1,16,17] while subsequent QL studies suggested that QL may provide prolonged analgesia and further reduce rescue analgesic requirements in selected abdominal procedures.[29,30] Reduced opioid exposure may also contribute to a lower incidence of opioid-related adverse effects such as nausea, vomiting and sedation. However, the magnitude of opioid reduction varied among studies because postoperative analgesic protocols were not standardized. Differences in baseline multimodal analgesia, rescue opioid thresholds and timing of outcome assessment may therefore explain some of the heterogeneity between studies.

Postoperative nausea and vomiting and recovery: An additional potential advantage of fascial-plane blocks is improvement in recovery through reduced opioid exposure. Studies evaluating TAP, QL and other fascial-plane techniques frequently reported lower postoperative rescue analgesic requirements and, in some cases, reduced PONV.

Nevertheless, evidence regarding broader recovery outcomes such as length of hospital stay, time to ambulation, gastrointestinal recovery and patient-reported quality of recovery was less consistently reported. Therefore, the benefits of fascial-plane blocks should not be judged exclusively on VAS or NRS pain scores. Future trials should incorporate standardized patient-centred recovery measures in addition to opioid consumption and pain intensity.

Safety: Ultrasound guidance has contributed to the increasing use of fascial-plane blocks by allowing direct visualization of anatomical structures, needle advancement and local anaesthetic deposition. Across the available studies, serious complications were uncommon.

However, the relatively low number of reported complications should be interpreted cautiously because adverse events were inconsistently defined and reported. Potential complications include vascular puncture, infection, local anaesthetic systemic toxicity and unintended visceral or organ injury. Larger prospective studies with standardized adverse-event reporting are required to establish the comparative safety of different fascial-plane techniques.

Liu et al. reported that QL block may provide better postoperative analgesia and opioid-sparing effects than TAP block in selected abdominal surgical populations.[2] Similarly, more recent systematic reviews have suggested beneficial effects of fascial-plane techniques for postoperative pain control.

Risk of Bias and Certainty of Evidence: The methodological quality of the included studies varied, although most were randomized comparative trials. The principal methodological concerns were related to blinding, differences in postoperative analgesic protocols, incomplete reporting of allocation procedures and variation in outcome assessment. Blinding is particularly challenging in regional anaesthesia trials because the intervention is readily distinguishable from conventional analgesia or sham procedures. These factors may have contributed to heterogeneity in the reported treatment effects. Therefore, although the overall direction of evidence favored ultrasound-guided fascial-plane blocks, the findings should be interpreted in the context of the methodological limitations of individual studies. The evidence for established techniques such as TAP and QL is considerably more mature than that for newer approaches such as EOI and some ESP/TFP techniques.

Clinical Heterogeneity: Considerable clinical heterogeneity was observed across the included studies. Differences were present in the type and extent of abdominal surgery, open versus laparoscopic approach, anatomical level and technique of block, local anaesthetic concentration and volume, timing of block administration, use of adjuvant drugs and postoperative multimodal analgesic protocols. Outcome assessment also varied with respect to pain scales, timing of assessment and opioid-equivalent conversion. These differences limit direct comparison between individual studies and make it difficult to determine whether one fascial-plane technique is universally superior. The findings therefore support procedure-specific selection of regional techniques rather than a single preferred block for all abdominal operations.

Future Research: Future randomized controlled trials should use standardized block techniques, clearly defined local anaesthetic doses and consistent multimodal analgesic protocols. Studies should report pain at standardized postoperative time points together with cumulative opioid consumption, time to first rescue analgesia, PONV, quality of recovery, mobilization, length of hospital stay and block-related complications. Direct head-to-head comparisons between TAP, QL, RSB and ESP techniques in the same surgical population would be particularly valuable. Further evidence is also required for newer techniques such as EOI and

TFP, for which the current evidence base remains limited. Standardized reporting of adverse events and long-term recovery outcomes would improve the certainty and clinical applicability of future evidence.

Clinical implications: The findings have several practical implications. TAP block remains a well-established and relatively straightforward option for abdominal wall analgesia, particularly when lateral abdominal coverage is required. QL block may be considered when longer or broader analgesia is desired, while RSB is particularly appropriate for midline abdominal incisions. ESP may provide an alternative for selected upper or extensive abdominal procedures, whereas EOI and TFP techniques may be considered for specific anatomical and surgical indications.

Therefore, the choice of fascial-plane block should be individualized rather than based on the assumption that one technique is superior in all patients. Factors such as incision location, surgical approach, expected duration of pain, local anaesthetic dose, patient characteristics and operator expertise should be considered.

Strengths and limitations: A major strength of this systematic review is the inclusion of original comparative studies covering the development of ultrasound-guided fascial-plane blocks over an extended period. The review also considered multiple clinically relevant outcomes, including postoperative pain, opioid consumption, rescue analgesia and adverse effects.

Several limitations should nevertheless be acknowledged. First, considerable heterogeneity existed in surgical procedures, block techniques, local anaesthetic concentrations and volumes, comparator analgesic protocols and follow-up periods. Second, blinding is difficult in regional anaesthesia studies and may introduce performance bias. Third, newer techniques such as ESP and EOI have a smaller evidence base than TAP. Finally, inconsistent reporting of recovery outcomes and complications limits direct comparison between studies.

CONCLUSION

Ultrasound-guided fascial plane blocks appear to provide effective postoperative analgesia and opioid-sparing benefits in adults undergoing major abdominal surgery. TAP remains the most established technique, while QL and ESP blocks may provide more prolonged or extensive analgesia in selected surgical populations. RSB appears particularly useful for midline abdominal incisions, whereas EOI, TFP and II/IH blocks have more procedure-specific applications. The overall evidence supports the incorporation of ultrasound-guided fascial-plane blocks into multimodal postoperative analgesia. However, the available evidence does not support a single universally superior technique. Block selection should be individualized according to the surgical site, incision, expected dermatomal coverage and institutional expertise. Future adequately powered, standardized randomized trials comparing contemporary fascial-plane techniques using common analgesic and recovery outcomes are required.

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