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Review Article

Anaesthesia Section

Dexmedetomidine versus Remifentanil for Controlled Hypotension in surgery: A Narrative Review of Efficacy and Recovery Profiles

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ABSTRACT

Dexmedetomidine and remifentanil are essential pharmacologic drugs that are now integral to anaesthetic practice, particularly for inducing controlled hypotension and enhancing intraoperative conditions. Dexmedetomidine, a selective α2-adrenoceptor agonist, is well known for its sedative and sympatholytic properties, with profound haemodynamic stability and minimal respiratory depression. Hence it is best suited for Intensive Care Unit (ICU) sedation and for opioid sparing strategies. It is beneficial in scenarios where earlier emergence from anaesthesia and prolonged sedation are advantageous. Remifentanil, a synthetic ultra short-acting opioid, has a rapid onset and offset, enabling precise titration and swift recovery, and is therefore well suited for fast-track surgeries. Both drugs are effective in reducing intraoperative blood loss and in improving surgical field conditions through controlled hypotension. Nonetheless, remifentanil's faster onset may confer an advantage by achieving a clearer surgical field with less bleeding. While dexmedetomidine stands out for improving postoperative recovery with less pain and reduced opioid requirements, remifentanil stands out for more rapid recovery and shorter extubation times. The safety profiles of both drugs are favourable overall, with dexmedetomidine associated with bradycardia and remifentanil with nausea and shivering. This review discusses the pharmacological profiles, clinical use, safety issues and relative effectiveness of dexmedetomidine and remifentanil in controlled hypotension during surgery. It collects new information on their intraoperative haemodynamic impacts, recovery profiles, and patient-surgeon satisfaction measures in various surgical environments. One gap addressed is the absence of integrated clinical recommendations on choosing between the two agents, considering specific surgical and patient scenarios. By synthesising data from recent meta-analyses and randomised trials, the review highlights the clinical utility of drug selection as a function of surgery type, desired recovery profile and institutional practice patterns. Clinically significant guidance for anaesthesiologists and surgeons is provided by the results, with a view to maximising surgical field conditions while reducing undesirable outcomes, particularly in procedures where a bloodless field and haemodynamic stability are paramount.

Keywords: Adverse effects, Haemodynamic stability, Randomised controlled trials, Recovery profile, Surgical anaesthesia, Systematic review

INTRODUCTION

Controlled hypotension is a practical anaesthetic technique designed to reduce Mean Arterial Pressure (MAP) intraoperatively, thereby reducing intraoperative blood loss and enhancing the surgical field. It is especially helpful in precision bloodless field surgeries, for example orthopedic, neurosurgical, spinal, and plastic procedures. Reducing MAP to as low as 50-65 mmHg (hypotensive anaesthesia) can improve visualisation, shorten surgery time, and lower transfusion requirements. Safety and efficacy depend on the selection of the pharmacologic agent, the patient's condition, and continuous haemodynamic monitoring [1].

Several agents, including anaesthetic adjuncts, vasodilators, beta-blockers, and calcium channel blockers, have been used for controlled hypotension. Among the most effective are remifentanil, an ultra short-acting μ-opioid receptor agonist, and dexmedetomidine, a selective α2-adrenergic receptor agonist. They each possess distinctive pharmacodynamic profiles and clinical benefits, and a comparison between them is pertinent to optimising anaesthetic management [2].

Dexmedetomidine activates central nervous system presynaptic α2-adrenergic receptors, stimulating inhibitory neurons and reducing sympathetic outflow. This leads to decreased circulating catecholamines such as norepinephrine and epinephrine, and thus decreases heart rate, blood pressure, and cardiac output. A bolus administration of 1 μg/kg has been shown to lower serum catecholamine levels and provide more stable intraoperative haemodynamics. Its sympatholytic effect can improve the visibility of the surgical field without causing respiratory depression, an obvious advantage over opioid treatment. Dexmedetomidine also possesses approximately eightfold greater selectivity for α2-receptors than clonidine, with high affinity for the α2A subtype responsible for its anxiolytic, analgesic, and sedative effects [3].

Remifentanil, on the other hand, provides immediate and adequate analgesia with predictable pharmacokinetics by being metabolised by nonspecific plasma and tissue esterases. Its titratability renders it suitable for precisely controlled hypotension in surgical interventions of varying duration and intensity. Nevertheless, administration of remifentanil can be followed by side effects such as bradycardia, hypotension, and postoperative hyperalgesia. It also does not have the sedative and anxiolytic effects of dexmedetomidine and is likely to require adjunctive agents to provide balance in anaesthesia [4].

Although both drugs may be effective in controlled hypotension, their different profiles in haemodynamic effect, sedation, recovery profile, respiratory safety, and postoperative pain management demand careful evaluation. Proper selection should be based on surgical need, patient co-morbidities and the intended anaesthetic plan. This review aims to provide a detailed comparison between dexmedetomidine and remifentanil for controlled hypotension in general anaesthesia, based on their modes of action, intraoperative effects, safety profiles, and recovery characteristics.

MATERIALS AND METHODS

The methodology of this review is consistent with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, with the aim of assessing and comparing the pharmacological profiles, clinical use, and efficacy of dexmedetomidine and remifentanil in inducing controlled hypotension during surgery. A comprehensive search was performed across databases such as PubMed, Scopus, and Web of Science up to May 2024. The search terms used included "dexmedetomidine," "remifentanil," "controlled hypotension," "surgical procedures," and "systematic review" or "meta-analysis." Boolean operators such as AND and OR were used to combine the terms (for example, "dexmedetomidine AND remifentanil AND controlled hypotension AND surgical procedures AND (systematic review OR meta-analysis)").

Inclusion and Exclusion criteria: Studies were eligible if they were Randomised Controlled Trials (RCTs), cohort studies, or systematic reviews comparing dexmedetomidine and remifentanil in controlled hypotension, with particular interest in efficacy, haemodynamic stability, recovery profiles, and side effects. Studies were excluded if they were non comparative or included fewer than twenty participants. Inclusion criteria included peer-reviewed papers detailing pertinent surgical procedures such as endoscopic sinus surgery, middle ear surgery, and shoulder arthroscopy. The studies were full text screened to determine methodological quality regarding randomisation, blinding, sample size, and statistical analysis. Overall, the studies met the inclusion criteria, and a narrative synthesis of the results was performed. The review followed standard procedures for systematic reviews, thus ensuring transparency and reproducibility in the evaluation and selection process.

Pharmacological Profile of Dexmedetomidine

Dexmedetomidine is the dextrorotatory enantiomer of medetomidine and is a highly selective α2-adrenoceptor agonist. It is highly bound to plasma proteins (about 94%), and its distribution is rapid, with the steady state volume of distribution ranging from 1.31 to 2.46 L/kg. It is extensively metabolised in the liver through glucuronidation and cytochrome P450-mediated hydroxylation, with inactive metabolites excreted primarily in the urine. The elimination half-life is 2.1-3.7 hours in ICU patients and healthy volunteers. Clearance is influenced by factors such as body weight, hypoalbuminaemia, and cardiac output, although hepatic extraction remains efficient. There is individual variability, but dose proportionality within the therapeutic window has been demonstrated. The sedative effect is dose-related, resembling normal sleep, and respiratory depression is minimal even at concentrations above the therapeutic range, rendering dexmedetomidine a promising agent for ICU and procedural sedation. The analgesic effect is minimal but can be used in opioid sparing regimens, and its safety profile is acceptable for prolonged critical care use [5,6].

The hypotensive effect of dexmedetomidine is central to its use in anaesthesia, where a bloodless field is desirable. It achieves controlled hypotension at clinically relevant doses through its sympatholytic action, substantially decreasing circulating catecholamines by 60-80%. Its haemodynamic profile is biphasic: extremely high initial plasma concentrations, particularly with acute bolus administration (usually a bolus of 1 μg/kg over ten minutes), can result in transient hypertension secondary to peripheral α2B-receptor-induced vasoconstriction, followed by prolonged hypotension as the plasma concentrations equilibrate. This latter phase, due to central activation of α2A receptors, results in reduced sympathetic outflow, heart rate, cardiac output, and systemic vascular resistance. These effects augment intraoperative clarity by restricting bleeding but must be titrated carefully, particularly in patients with compromised cardiac function. Despite the reduction in cardiac output, dexmedetomidine has not been shown to cause clinically significant adverse effects on myocardial contractility, and stroke volume is comparatively preserved until plasma levels are markedly raised. Therefore, when properly dosed, dexmedetomidine provides a reproducible and manageable means of inducing hypotension under general anaesthesia without substantial respiratory compromise [6,7].

Pharmacological Profile of Remifentanil

Remifentanil is an ultra-potent, ultra short-acting synthetic opioid of the 4-anilidopiperidine class, structurally related to fentanyl, alfentanil, and sufentanil. Remifentanil was designed with a methyl ester moiety within the N-acyl group and is thus highly prone to hydrolysis by nonspecific tissue and blood esterases. This characteristic leads to rapid inactivation after administration, producing an unusual pharmacokinetic pattern. Remifentanil is a single isomer with no chiral centres and is formulated as a lyophilised powder that contains its free base and glycine, pH-adjusted to 3.0. It is highly water soluble and typically reconstituted in water or 5% dextrose for injection. Following intravenous administration, remifentanil is extensively metabolised by extrahepatic hydrolysis to a carboxylic acid metabolite (GI-90291) via ester cleavage, with minimal contribution from hepatic biotransformation. Its clearance (2.9 L/min) is far greater than hepatic blood flow, a definitive indicator of extrahepatic elimination. Its mean residence time (11 minutes) and moderate steady-state volume of distribution (32 L) are highly favourable for rapid titration and recovery, which is desirable in anaesthetic use [4,8].

Remifentanil has dose-dependent cardiovascular and respiratory effects typical of potent opioids, but with a significantly shorter duration of action. Respiratory depression can occur rapidly, but the effect dissipates quickly because of its very short half-life. Its cardiovascular profile includes decreases in heart rate, MAP, and cardiac output, likely mediated by enhanced vagal tone rather than histamine release. Clinically, remifentanil has been shown to result in more constant intraoperative haemodynamics than other opioids such as fentanyl or alfentanil. Specifically, its stable and predictable hypotensive effect has led some anaesthesiologists to avoid using adjunct hypotensive drugs such as nitroprusside or esmolol during surgery. Remifentanil's duration of action and predictable recovery make it well suited for this use, where rapid recovery and accurate control of blood pressure are crucial [8,9].

Mechanism of Controlled Hypotension

Controlled hypotension, or intentional hypotension, is the deliberate reduction of systemic arterial pressure under anaesthesia to decrease surgical blood loss and enhance visibility in the operative field. Controlled hypotension typically lowers systolic blood pressure (SBP) to 80-90 mmHg or MAP to 50-65 mmHg in normotensive patients, or lowers MAP by approximately 30% in hypertensive patients. Defined initially by Cushing in 1917 and clinically developed during the 1940s, controlled hypotension has become routine in most types of surgery. It is especially ideal for surgeries with a short tolerance to blood loss, such as middle ear surgery, endoscopic sinus surgery, reconstructive and plastic microsurgery, ophthalmic and neurosurgical procedures, and high-risk procedures such as orthopaedic, cardiovascular, and hepatic surgery. The advantages include fewer transfusions needed, improved operating conditions, and possibly shorter operative times. Although useful, hypotension should be titrated according to the individual patient's baseline condition to prevent adverse effects on perfusion to end-organ tissues. Studies have indicated that organ perfusion is maintained with MAPs between 50 and 65 mmHg, particularly in ASA I and II patients, and mortality due to ischemia is low when the procedure is carefully performed and reversed before surgical closure to expose any hidden bleeding [10,11].

The physiological mechanism of controlled hypotension operates through haemodynamics- the interdependence of blood flow (D), pressure (P), and vascular resistance (R)- as explained by

the equation D=P/R. An arterial pressure reduction with either an increase in vascular resistance or its maintenance decreases blood flow in the operative field, thereby reducing bleeding. However, this action largely relies on local vascular tone, microcirculatory autoregulatory capacity, and the medications used. Anaesthetic drugs such as remifentanil are well suited for this function, since they can induce hypotension by causing vasodilation with high-flow maintenance that preserves oxygen delivery to peripheral compartments. In contrast to hypovolaemia-induced hypotension, which is vasoconstrictive and results from reduced cardiac output with an augmented risk of ischaemia, volume-supported vasodilator-induced hypotension is safer and better controlled. Remifentanil, a short-acting μ-opioid receptor agonist, is rapidly metabolised by nonspecific esterases to permit accurate titration and prevent carryover effects. The pharmacokinetics are ideal for the rapid onset and rapid offset of action required to induce and reverse controlled intraoperative hypotension. Controlled hypotension is effective and safe only when a target blood pressure is achieved with adequate organ perfusion, recognising the relation between systemic and regional circulatory control [1,3].

Application of Dexmedetomidine and Remifentanil for Controlled Hypotension

Dexmedetomidine and remifentanil have extensive applications across various types of surgery for inducing controlled hypotension, enhancing the visibility of the surgical field, and optimising perioperative management. Both drugs have been effective in controlling intraoperative bleeding and providing a clear field of operation in endoscopic sinus surgery. Remifentanil, with its rapid onset and short half-life, is particularly valued in cases where rapid recovery and precise control of anaesthetic depth are required. Dexmedetomidine offers better haemodynamic stability and analgesia and is employed in cases where smoother emergence and reduced opioid requirements are desirable [12].

During monitored anaesthesia care procedures such as otologic surgery, dexmedetomidine has been shown to enhance patient comfort and surgeon satisfaction because of its analgesic and sedative effects. Clinical trials by Richa F et al., Ozcan AA et al., Lee J et al., Kaya A et al., Menshawi MA et al., Zamani F et al., Huh H et al., Xu N et al., Janipour M et al., and Breazu CM et al., reveal that remifentanil permits faster extubation and rapid recovery (most studies used neostigmine for reversal) compared with dexmedetomidine. Dexmedetomidine is advantageous because it reduces postoperative pain, lowers the incidence of nausea and shivering, and enhances patient satisfaction [12-21]. These drugs are therefore selectively employed depending on the surgical case, patient population, and the requirement for rapid recovery versus smooth recovery. The list of comparative studies and meta-analyses used for review is summarised in [Table/Fig-1].

Study name and place	Study design/ Population	Drug regimen
Richa F et al., 2008 Lebanon [13]	Prospective, double-blind RCT (n=24)	Dexmedetomidine: 1 μg/kg over 10 min, then 0.4-0.8 μg/kg/h
		Remifentanil: 1 μg/kg over 1 min, then 0.2-0.4 μg/kg/min
Ozcan AA et al., 2012, Turkey [14]	RCT (n=50) undergoing Functional Endoscopic Sinus Surgery (FESS)	Remifentanil: 0.25 μg/kg/h infusion
		Dexmedetomidine: 0.2-0.7 μg/kg/min infusion
Lee J et al., 2013, Korea [15]	Prospective, double-blind RCT (n=66) undergoing endoscopic sinus surgery	Dexmedetomidine: 1 μg/kg over 10 min, then 0.4-0.8 μg/kg/h
		Remifentanil: 1 μg/kg over 1 min, then 0.2-0.4 μg/kg/min
Kaya A et al., 2011, Turkey [12]	RCT (n=50)	Dexmedetomidine: 0.5 μg/kg over 10 min, then 0.5-1 μg/kg/h
		Remifentanil: 0.5 μg/kg over 1 min, then 0.2-0.5 μg/kg/h
Menshawi MA et al., 2020, Egypt [16]	RCT (n=40)	Dexmedetomidine: 1 μg/kg over 10 min, then 0.3-0.6 μg/kg/h
		Remifentanil: 1 μg/kg bolus, then 0.25-0.50 μg/kg/min
Zamani F et al., 2020, Iran [17]	RCT (n=60)	Dexmedetomidine: 0.5 μg/kg/h
		Remifentanil: 50-100 μg/kg/h
Huh H et al., 2020, Korea [18]	RCT	Dexmedetomidine vs. remifentanil during endoscopic sinus surgery
Xu N et al., 2023, China [20]	Meta-analysis of 9 RCTs (n=543)	Dexmedetomidine vs. remifentanil for controlled hypotension during general anaesthesia
Janipour M et al., 2024, Iran [21]	Systematic review and meta-analysis (n=302)	Dexmedetomidine vs remifentanil across five RCTs
Breazu CM et al., 2025, Romania [19]	RCT (n=73) Otosclerosis surgery under monitored anaesthesia care	Dexmedetomidine: 1 μg/kg loading over 15 min, then 0.5 μg/kg/h + fentanyl 1 μg/kg
		Remifentanil: Target-controlled infusion 1-3 ng/mL + midazolam and dexamethasone

[Table/Fig-1]: List of studies included [12-21].

Comparison of Parameters

Controlled hypotensive medications are now an essential aspect of standard use in surgery when haemodynamic stability and bloodless operative fields are of utmost importance. Both medications have proved effective but differ in their pharmacodynamic profiles, side-effect profiles, and postoperative outcomes.

Haemodynamic Control

Dexmedetomidine and remifentanil adequately maintained intraoperative MAP and HR within the desired range of hypotension. However, dexmedetomidine caused a greater net decrease in HR and SBP during and after extubation. This could be due to its sympatholytic and central α2-agonist effects. Studies by Richa F et al., Ozcan AA et al., Lee J et al., Kaya A et al., Menshawi MA et al., Zamani F et al., Huh H et al., Xu N et al., Janipour M et al., and Breazu CM et al., showed lower HRs in the dexmedetomidine groups, especially in the early post extubation period, which may be more stable during the extubation-to-wakefulness transition [12-21]. Remifentanil demonstrated faster haemodynamic recovery in certain situations, indicating that its short half-life enables tighter intraoperative control with rapid offset postoperatively [12-21]. The findings of the various studies are depicted in [Table/Fig-2].

Study name	Haemodynamic parameters
Richa F et al., 2008 [13]	MAP and HR were significantly lower in the remifentanil group at all times
Ozcan AA et al., 2012 [14]	HR was lower in the dexmedetomidine group at extubation and at 5, 10, 15, 20, and 30 min post extubation ($p<0.05$)
Lee J et al., 2013 [15]	No differences in haemodynamics
Kaya A et al., 2011 [12]	Both achieved target MAP (60-70 mmHg); HR and MAP were significantly lower in the dexmedetomidine group after drug induction and extubation.
Menshawi MA et al., 2020 [16]	Comparable intraoperative MAP and HR. HR was significantly lower post extubation in the dexmedetomidine group
Zamani F et al., 2020 [17]	MAP was significantly lower in the remifentanil group; bradycardia incidence varied
Huh H et al., 2020 (18)	There was no significant difference overall; the remifentanil group had significantly lower BP/HR during intubation.
Xu N et al., 2023 [20]	No difference in surgical field score, blood loss, minimum MAP, or HR; no difference in bradycardia incidence
Janipour M et al., 2024 [21]	Similar intraoperative MAP and HR; slightly lower HR in remifentanil group at 15 min
Breazu CM et al., 2025 [19]	The dexmedetomidine group had lower minimum intraoperative BP and HR with greater overall drops vs remifentanil; no severe complications.

[Table/Fig-2]: Haemodynamic parameters comparison across various studies [12-21].

Quality of Surgical Field

Operative visibility, classically scored by surgeons using Visual Analogue Scales (VAS), was excellent with both drugs. There was a minor advantage noted in a few reports with remifentanil in maintaining a drier surgical field, perhaps because of greater vasodilatory effects and quicker onset. Studies by Richa F et al., Ozcan AA et al., Lee J et al., Kaya A et al., Menshawi MA et al., Zamani F et al., Huh H et al., Xu N et al., Janipour M et al., and Breazu CM et al., reported no statistically significant difference in surgical field scores between the two drugs [12-21]. This suggests that both drugs offer similar operating conditions when dosed and titrated appropriately. Minor variations observed might be more attributable to the patient's physiology or the surgeon's method or preference rather than to the drug per se. The findings are shown in [Table/Fig-3] [12-21].

Study name	Surgical field
Richa F et al., 2008 [13]	Better with remifentanil; higher surgeon satisfaction with remifentanil
Ozcan AA et al., 2012 [14]	Similar dryness and surgical area visualisation
Lee J et al., 2013 [15]	No difference in the surgical field or blood loss
Kaya A et al., 2011 [12]	Ideal for both groups
Menshawi MA et al., 2020 [16]	Satisfactory in both groups
Zamani F et al., 2020 [17]	Both are effective; remifentanil is better.
Huh H et al., 2020 [18]	Not specifically detailed
Xu N et al., 2023 [20]	Both are effective in surgical conditions.
Janipour M et al., 2024 [21]	Comparable across studies
Breazu CM et al., 2025 [19]	Surgeons' satisfaction is similar between groups.

[Table/Fig-3]: Surgical field quality according to various studies [12-21].

Postoperative Extubation and Recovery

Results of Ozcan AA et al., Lee J et al., Menshawi MA et al., Zamani F et al., Huh H et al., Xu N et al., and Janipour M et al., showed faster extubation times and better emergence profiles with remifentanil [14-18,20,21]. Its ultra-short context sensitive half-life facilitates rapid weaning and recovery after discontinuation of the infusion, making it the drug of choice for fast track or outpatient surgery. The longer-lasting sedative effects of dexmedetomidine prolong extubation and recovery times. Although this can be a disadvantage in high-turnover surgical environments, the more prolonged sedation can be advantageous in preventing early postoperative restlessness and facilitating smoother emergence in at-risk patient populations. For postoperative analgesia, dexmedetomidine performed better. Numerous studies and meta-analyses report significantly lower Post-Anaesthesia Care Unit (PACU) pain scores in patients who received dexmedetomidine, with decreased needs for rescue analgesia. Such opioid sparing action is welcome, particularly in reducing narcotic side effects and facilitating enhanced recovery after surgery protocols. Additionally, dexmedetomidine also had decreased sedation scores, which at first glance might appear counterintuitive in light of its longer recovery time. Still, this would most likely reflect a quieter and less agitated state rather than increased sedation. The findings are depicted in [Table/Fig-4] [14-18,20,21].

Study name	Postoperative parameters
Ozcan AA et al., 2012 [14]	Longer recovery time in the dexmedetomidine group, faster extubation with remifentanil.
	No liver or kidney function differences
Lee J et al., 2013 [15]	Sedation scores were significantly lower in the dexmedetomidine group at PACU ($p<0.001$); there was no difference in pain, and faster extubation with remifentanil.
Menshawi MA et al., 2020 [16]	Longer recovery and analgesia in the dexmedetomidine group; higher sedation.
Zamani F et al., 2020 [17]	Longer recovery in the dexmedetomidine group, faster extubation with remifentanil.
Huh H et al., 2020 [18]	The dexmedetomidine group had better sedation on PACU arrival and lower pain scores at 30 and 60 min.
Xu N et al., 2023 [20]	Dexmedetomidine had lower pain scores, less shivering, nausea, and vomiting; remifentanil had a shorter extubation time.
Janipour M et al., 2024 [21]	No significant differences in recovery time, pain, analgesic use, satisfaction, or agitation scores

[Table/Fig-4]: Postoperative outcomes across various studies [14-18,20,21].

Adverse Events and Safety Profile

Both drugs were generally well tolerated regarding perioperative complications, and no severe adverse events within the included studies were documented. However, dexmedetomidine was associated with a higher incidence of bradycardia due to its central sympatholytic action, though this rarely necessitated intervention (Ozcan AA et al., Lee J et al., Xu N et al., and Janipour M et al., [14-15,20-21]). Remifentanil, by contrast, was associated with a greater incidence of postoperative nausea, vomiting, and shivering. This highlights the advantage of dexmedetomidine in enhancing overall patient comfort in the early postoperative period. Liver and renal function tests showed no significant differences between the two groups in the few studies that reported them, suggesting that both drugs are safe for patients without existing liver or kidney dysfunction [14-15,20-21].

Patient and Surgeon Satisfaction

When measured using a validated instrument such as the Iowa Satisfaction with Anaesthesia Scale, patient satisfaction was similar between the two drugs. Surgeon satisfaction, defined by operative field conditions and ease of surgery, was also similar between groups. There was a high correlation between patient and surgeon satisfaction with the operative field, emphasising that a bloodless, stable operative field is crucial for optimal results, as described by Kaya A et al., and Menshawi MA et al., [12,16,18,19].

CONCLUSION(S)

Both remifentanil and dexmedetomidine are excellent drugs for inducing controlled hypotension and creating ideal surgical conditions in general. Remifentanil offers rapid emergence and shorter extubation times, making it suitable for surgeries requiring rapid recovery. Dexmedetomidine provides greater postoperative analgesia, greater haemodynamic stability on extubation, and fewer opioid-related side effects. Therefore, both medications should be chosen on an individual basis according to the surgical situation, the patient's co-morbidities and the requirements for postoperative recovery. Future well-designed trials can more clearly define the subtle distinctions between these drugs and guide more individualised anaesthetic regimens.

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