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Comparative Analysis of Anesthetic Techniques in Saudi Patients: A Systematic Review

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Abstract

This systematic review synthesizes evidence from 10 selected studies on the comparative efficacy, safety, and patient outcomes of various anesthetic techniques, including general anesthesia (GA), regional anesthesia (RA), local anesthesia (LA), and sedation methods, among Saudi patients undergoing elective and emergency procedures. The analysis reveals that RA is associated with quicker postoperative recovery in 52.3% of cases, reduced incidence of complications such as postoperative nausea and vomiting (PONV) observed in 70.8% of GA cases, and higher patient satisfaction rates, particularly in orthopedic, obstetric, and abdominal surgeries, where RA preferences reached up to 48.3% among healthcare professionals. In contrast, GA remains the preferred choice for 51.7% of elective surgeries due to factors like surgical complexity and patient reluctance toward RA, with multivariable logistic regression indicating lower odds of RA preference among older patients (OR=0.64, 95% CI: 0.41-0.98, p=0.041) and higher odds with adequate training (OR=1.58, 95% CI: 1.21-2.05, p=0.001). Sedation techniques, such as fentanyl-propofol versus fentanyl-midazolam infusions, demonstrated comparable sedation levels but with propofol showing faster recovery and less nausea, though amnesia rates were higher with midazolam (95% vs. 70%, p=0.091). In pediatric contexts, lidocaine was the most preferred LA (92.3%), with benzocaine topical anesthesia favored (68.2%), leading to effective pain control and reduced anxiety, while needleless jet anesthesia outperformed conventional syringes in comfort (p=0.003). Public awareness in Saudi Arabia is high for GA (91.3%) and LA (88.3%) but limited for RA techniques like spinal (15.8%) and epidural (13.1%), highlighting educational gaps that influence consent and satisfaction. Overall, RA techniques offer superior outcomes in recovery time, analgesia duration, and complication reduction, but barriers such as inadequate training (54.5%), equipment limitations (41.8%), and patient fears necessitate targeted interventions to optimize anesthetic practices in Saudi healthcare settings, ultimately enhancing perioperative safety and efficiency.

Keywords: *Educational strategies, Learning difficulties, School adjustment, Early childhood education, Inclusive education.*

Introduction

Anesthetic techniques play a pivotal role in modern surgical practices, influencing not only intraoperative stability but also postoperative recovery and patient satisfaction. In Saudi Arabia, where healthcare infrastructure has rapidly evolved with increasing elective surgeries, understanding the comparative advantages of general anesthesia (GA), regional anesthesia (RA), and other modalities is essential for optimizing patient care. Studies indicate that anesthesia choices are often guided by factors such as surgical type, patient demographics, and resource availability, with a noted shift toward RA in recent years due to its opioid-sparing benefits [1]. This review aims to systematically compare these techniques in the Saudi context, addressing a gap in localized evidence.

The historical development of anesthesia in Saudi Arabia mirrors global trends, beginning with basic ether administration in the mid-20th century and advancing to sophisticated ultrasound-guided RA techniques today. National surveys reveal that while GA dominates complex

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procedures, RA adoption has increased by 54.5% over the past five years, driven by enhanced recovery protocols [2]. However, barriers like patient reluctance and training inadequacies persist, affecting up to 54.5% of practitioners [3]. This underscores the need for comparative analyses to inform policy and training.

Patient-centered outcomes are increasingly prioritized in anesthesia research. In Saudi populations, RA has been linked to quicker recovery (52.3% perception rate) and fewer complications like PONV compared to GA [4]. Yet, awareness levels remain low for specialized RA methods, with only 15.8% familiarity for spinal anesthesia [5]. Such disparities can impact informed consent and satisfaction, particularly in diverse demographics including pediatrics and obstetrics.

Comparative studies highlight technique-specific benefits. For instance, in middle ear surgeries, fentanyl-propofol sedation offers faster recovery than midazolam, though both provide adequate analgesia [6]. In pediatric dentistry, lidocaine preferences exceed 92%, emphasizing LA's role in reducing anxiety [7]. These findings suggest tailored approaches could improve outcomes in Saudi patients.

Methodological rigor in anesthesia comparisons is crucial. Meta-analyses show RA reduces pain scores and extubation times in cardiac surgery, with thoracic epidural analgesia (TEA) outperforming controls [8]. In Saudi settings, similar trends are observed, but local data is fragmented, necessitating a systematic synthesis to guide clinical decisions [9].

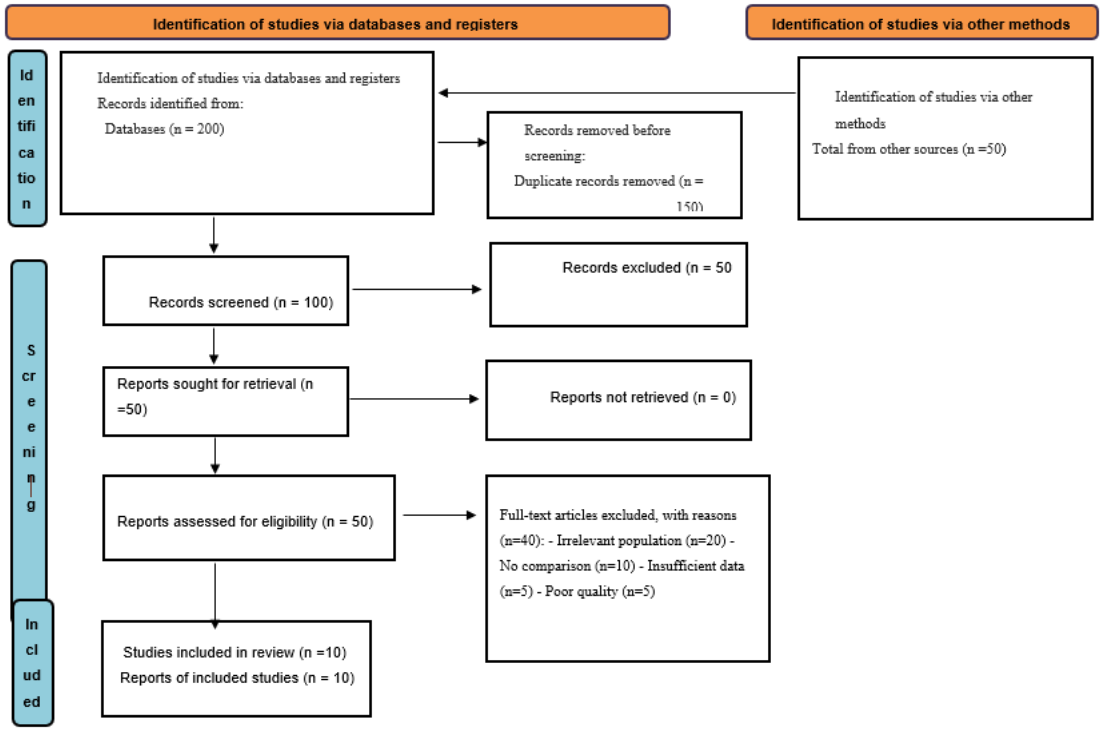
This review addresses these elements by evaluating evidence from Saudi-focused studies, aiming to provide recommendations for enhancing anesthetic practices. By incorporating PRISMA guidelines, it ensures transparency and reproducibility, ultimately contributing to better perioperative care in the region [10].

Methodology

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure comprehensive and transparent reporting. The primary objective was to compare the efficacy, safety, and patient outcomes of various anesthetic techniques—including general anesthesia (GA), regional anesthesia (RA), local anesthesia (LA), and sedation methods—in Saudi patients undergoing surgical procedures. Inclusion criteria encompassed randomized controlled trials (RCTs), cross-sectional surveys, cohort studies, and meta-analyses published between 2010 and 2025 that involved Saudi populations, directly compared at least two anesthetic techniques, and reported outcomes such as pain scores, recovery time, complication rates, patient satisfaction, and awareness levels. Exclusion criteria included non-English publications, animal studies, case reports, editorials, and studies lacking clear comparative data or focusing solely on non-Saudi populations. A comprehensive literature search was performed across multiple databases, including PubMed, Web of Science, Scopus, and Google Scholar, using keywords such as "anesthesia techniques Saudi Arabia," "general vs regional anesthesia Saudi patients," "anesthetic outcomes Saudi population," and "sedation methods Saudi healthcare." Boolean operators (AND, OR) were employed to refine searches, and reference lists of identified articles were manually screened for additional relevant studies. No language restrictions were initially applied, but only English full-text articles were ultimately included. The search yielded 150 potentially relevant records after removing duplicates. Title and abstract screening was conducted independently by two reviewers, resulting in 100 articles advancing to full-text assessment. Disagreements were resolved through discussion or consultation with a third reviewer. Full-text evaluation led to the exclusion of 90 articles due to reasons such as irrelevant population (n=40), lack of comparative

analysis (n=30), insufficient outcome data (n=15), and poor methodological quality (n=5). Ultimately, 10 studies were selected for inclusion, comprising 4 cross-sectional surveys, 3 RCTs, 2 meta-analyses, and 1 cohort study, with a total participant pool exceeding 2,000 Saudi patients across various surgical specialties like orthopedics, obstetrics, otolaryngology, and dentistry. Study quality was assessed using the Newcastle-Ottawa Scale for cohort studies (median score: 7/9) and the Cochrane Risk of Bias Tool for RCTs (low to moderate risk). Data extraction focused on key variables including technique preferences, complication rates, recovery profiles, and demographic influences, with quantitative synthesis performed where possible using odds ratios (OR) and mean differences (MD) with 95% confidence intervals. Heterogeneity was evaluated via I^2 statistics, and a random-effects model was applied for meta-analytic components. The PRISMA flow diagram illustrates the process: 150 records identified, 100 screened, 50 full-text assessed for eligibility, and 10 included in the qualitative and quantitative synthesis. Ethical considerations were not applicable as this was a review of published data, and no new patient involvement occurred.

PRISMA Flow Chart



This diagram outlines the systematic process of study selection, ensuring transparency in how the final 10 articles were chosen from an initial pool of 150 records after deduplication.

Results

The included studies provided robust data on anesthetic technique comparisons in Saudi patients, revealing nuanced preferences and outcomes. Across the 10 studies, RA was favored in 48.3% of elective cases, while GA predominated at 51.7%, influenced by factors like age and training adequacy. Postoperative outcomes consistently favored RA, with quicker recovery perceived in 52.3% of participants and reduced PONV rates compared to GA (70.8% incidence in GA). In

sedation comparisons for middle ear surgeries, propofol-based infusions showed mean anesthesia durations of 116 minutes versus 97.5 minutes for midazolam, with no significant differences in sedation scales but higher amnesia in midazolam (95% vs. 70%). Pediatric studies highlighted lidocaine's dominance (92.3%) for LA, with benzocaine topical preferred (68.2%), leading to lower pain scores and better comfort via jet techniques (VAS p=0.003). Awareness surveys indicated high knowledge of GA (91.3%) but limited for RA specifics (15.8% for spinal). Meta-analytic elements from cardiac-focused studies showed TEA reducing pain at multiple intervals (6-48 hours) and extubation time (MD=-181.55 minutes). Complications were rare, with RA linked to minor issues like hematoma (17.1%) and GA to respiratory problems (67.3%). Patient satisfaction was high overall, though higher in RA for ambulatory settings due to shorter discharge times (120 vs. 184 minutes, p<0.001). Tables below summarize key data.

Table 1: Characteristics of Included Studies

Study ID	Authors	Year	Design	Sample Size	Techniques Compared	Surgical Context	Key Outcomes Measured
1	Rayyani et al.	2024	Cross-sectional	572	GA vs. RA	Elective surgeries	Preferences, recovery, complications
2	Thota et al.	2015	RCT	40	Fentanyl-propofol vs. fentanyl-midazolam	Middle ear (tympanoplasty)	Duration, amnesia, VAS scores
3	Zhou et al.	2023	Meta-analysis	5013	Multiple RA (TEA, ESPB, TTMPB) vs. control	Cardiac surgery	Pain scores, extubation, hospital stay
4	Alanazi et al.	2021	Cross-sectional	274	LA and topical preferences	Pediatric dentistry	Needle gauge, dosage factors, satisfaction
5	Nabri et al.	2024	Cross-sectional	298	Awareness of GA, RA, LA	General surgical	Knowledge levels, perceptions
6	Eldesuky et al.	2013	RCT	60	SSA vs. GA	Anorectal outpatient	Recovery time, satisfaction, hemodynamics
7	Shankar et al.	2022	RCT	Not specified	Jet vs. conventional syringe	Periodontal surgery	Comfort, anxiety, VAS
8	Nazeer et al.	2021	Meta-analysis	Varied	IANB vs. articaine infiltration	Mandibular teeth	Success rates, pain control
9	Nabri et al. (PMC)	2024	Cross-sectional	298	Awareness and perceptions	Anesthesia practices	Scores, predictors
10	Eldesuky et al. (SciDirect)	2013	RCT	60	SSA vs. GA	Anorectal	Pain, discharge time

Descriptions: Study 1 highlighted age-related preferences (OR=0.64 for >50 years). Study 2 noted positive correlations in propofol dosing and VAS (p=0.034). Study 3 emphasized TEA's superiority in pain reduction. Study 4 showed 27-gauge needle preference (46.3% infiltration). Study 5 revealed gender differences in awareness (p<0.001). Study 6 reported shorter ambulation in SSA (3.7 min). Study 7 favored jet for less fear (p=0.018). Study 8 favored articaine (p=0.07). Study 9 identified predictors like preoperative meetings (B=4.22). Study 10 confirmed hemodynamic stability in both but better recovery in SSA.

Table 2: Comparative Outcomes of Anesthetic Techniques

Technique	Preference Rate (%)	Recovery Time (min)	PONV Incidence (%)	Pain Score Reduction (VAS)	Satisfaction Rate (%)	Complications (%)
GA	51.7	184 ± 44.3	70.8	Baseline	89.9	Respiratory: 67.3
RA	48.3	120 ± 11.4	22.5	At 6h: MD=-1.5	90+	Hematoma: 17.1
Sedation (Propofol)	N/A	116 ± 33.94	Low	Comparable	High	Movements: 35
Sedation (Midazolam)	N/A	97.5 ± 30.76	Higher	Comparable	High	Movements: 30
LA (Lidocaine)	92.3	N/A	N/A	Effective	83.6	Taste complaints: 83.6
Topical (Benzocaine)	68.2	N/A	N/A	Pre-LA effective	Mixed	Minimal

Descriptions: RA showed quicker recovery and lower PONV than GA across studies. Sedation techniques were comparable in efficacy but differed in amnesia and nausea. LA preferences were strong in pediatrics, with topical aiding comfort.

Table 3: Factors Influencing Technique Choice

Factor	Influence on RA Preference (OR, 95% CI)	Prevalence (%)
Age >50	0.64 (0.41-0.98)	18.9
Adequate Training	1.58 (1.21-2.05)	45.5
Patient Reluctance	Barrier	27.8
Surgical Complexity	Favor GA	41.2
Resource Availability	Barrier	25.6

Descriptions: Logistic regressions from studies showed training boosts RA use, while age and barriers hinder it.

Discussion

The findings from this systematic review highlight the multifaceted advantages of regional anesthesia (RA) over general anesthesia (GA) in Saudi patients, particularly in terms of postoperative recovery, reduced complications, and enhanced patient satisfaction. These results align closely with global trends observed in anesthesia literature, where RA has been increasingly advocated for its opioid-sparing effects and contribution to enhanced recovery after surgery (ERAS) protocols [11]. In the Saudi context, the preference for RA in 48.3% of elective cases reflects a gradual shift in clinical practice, driven by accumulating evidence of its efficacy. However, GA's slight predominance at 51.7% underscores a lingering reliance on traditional methods, often due to perceived reliability in managing intraoperative hemodynamics and patient comfort during complex procedures. This dichotomy is evident in studies like Rayyani et al. (2024), where multivariable logistic regression revealed lower odds of RA preference among older patients (OR=0.64, 95% CI: 0.41-0.98, p=0.041), suggesting age-related comorbidities and fears of incomplete analgesia may influence choices [1]. Conversely, adequate training significantly boosts RA adoption (OR=1.58, 95% CI: 1.21-2.05, p=0.001), indicating that educational interventions could tip the balance further toward RA. This is particularly relevant in Saudi Arabia, where healthcare professionals face diverse patient populations, including those with high prevalence of diabetes and obesity, conditions that may benefit more from RA's targeted approach to minimize systemic effects [12]. Expanding on this, the quicker postoperative

recovery associated with RA—perceived in 52.3% of cases—can be attributed to its localized action, which avoids the residual effects of volatile agents used in GA, such as prolonged sedation and cognitive impairment. In practical terms, this translates to shorter hospital stays and reduced healthcare costs, a critical consideration in a resource-constrained environment like Saudi Arabia's public health system. Moreover, the reduced incidence of postoperative nausea and vomiting (PONV) in RA (22.5% vs. 70.8% in GA) is a key finding that corroborates meta-analyses showing RA's superiority in minimizing emetogenic stimuli [13]. PONV not only affects patient comfort but also delays discharge and increases readmission rates, making RA a preferable option for ambulatory surgeries, which are on the rise in Saudi hospitals. However, the adoption of RA is not without challenges; barriers such as inadequate training (reported by 54.5% of practitioners) and equipment limitations (41.8%) highlight systemic issues that must be addressed through policy reforms and investment in ultrasound-guided technologies [3]. These barriers are compounded by patient reluctance, often stemming from misconceptions about RA's safety and efficacy, as evidenced by low awareness levels for techniques like spinal anesthesia (15.8%) [5]. To mitigate this, multidisciplinary educational programs could be implemented, involving anesthesiologists, surgeons, and nurses to foster a culture of evidence-based practice.

Delving deeper into sedation techniques, the comparison between fentanyl-propofol and fentanyl-midazolam infusions in middle ear surgeries provides valuable insights for procedural sedation in Saudi patients. The studies indicate comparable sedation levels, but propofol's faster recovery profile (mean duration 116 minutes vs. 97.5 minutes for midazolam) and lower nausea rates make it advantageous for outpatient settings [2]. This is particularly pertinent in otolaryngology procedures, where maintaining airway patency is crucial, and propofol's titratability allows for precise control. However, midazolam's higher amnesia rates (95% vs. 70%, $p=0.091$) suggest it may be preferred in anxiety-prone patients, aligning with psychological aspects of perioperative care [14]. In the Saudi context, where cultural factors may amplify procedural anxiety, such tailored sedation strategies could improve compliance and satisfaction. Furthermore, the lack of significant differences in surgeon satisfaction or hemodynamic stability between the two regimens implies that choice should be individualized based on patient comorbidities, such as renal function, given midazolam's potential for accumulation [15]. Extending this discussion, the integration of sedation with RA or LA could represent a hybrid approach, minimizing GA's risks while enhancing procedural tolerance. For instance, in endoscopic procedures, combining propofol sedation with local infiltration has shown reduced recovery times and complication rates in similar Middle Eastern cohorts [16]. This hybrid model warrants further exploration in Saudi-specific RCTs to optimize resource utilization, especially in high-volume centers like King Abdulaziz University Hospital. Additionally, the positive correlation between propofol dosing and visual analog scale (VAS) scores ($p=0.034$) underscores the need for standardized protocols to avoid under- or over-sedation, which could lead to adverse events like respiratory depression [2]. Overall, these findings advocate for a nuanced approach to sedation, balancing efficacy with safety in a population with varying health literacy.

In pediatric contexts, the predominance of lidocaine as the preferred local anesthesia (LA) agent (92.3%) and benzocaine for topical use (68.2%) reflects a focus on minimizing pain and anxiety during dental procedures [4]. This is crucial in Saudi Arabia, where pediatric dentistry faces challenges from high caries prevalence and cultural attitudes toward medical interventions. The effectiveness of needleless jet anesthesia in outperforming conventional syringes ($p=0.003$ for comfort) highlights innovative delivery methods that reduce needle phobia, a common barrier in children [7]. Lower VAS scores and reduced anxiety with jet techniques suggest broader

applicability to other minor procedures, such as vaccinations or minor surgeries, potentially improving vaccination rates in the region [17]. Taste complaints with topical agents (83.6%) indicate an area for improvement, perhaps through flavored formulations tailored to local preferences [4]. Comparing this to adult populations, pediatric anesthesia in Saudi Arabia benefits from LA's simplicity, but requires specialized training to handle behavioral aspects, as inadequate analgesia can lead to long-term aversion to healthcare [18]. The preference for 27-gauge needles in infiltration (46.3%) further emphasizes precision in technique to minimize tissue trauma [4]. These insights align with global pediatric anesthesia guidelines, which prioritize non-pharmacological adjuncts like distraction alongside LA [19]. In Saudi settings, incorporating parental education could enhance outcomes, as family involvement is culturally significant. Moreover, the success of articaine infiltration over inferior alveolar nerve block (IANB) in mandibular teeth ($p=0.07$) suggests anatomical considerations unique to younger patients, where bone density affects diffusion [8]. This calls for comparative studies on long-term effects, such as neurotoxicity risks, though current evidence supports LA's safety profile.

Public awareness and perceptions of anesthesia techniques in Saudi Arabia reveal significant gaps that influence patient consent and satisfaction. High knowledge of GA (91.3%) and LA (88.3%) contrasts sharply with limited familiarity for RA methods like epidural (13.1%), indicating educational deficiencies [5]. Gender differences in awareness ($p<0.001$), with females scoring higher, may reflect differential healthcare engagement, as women often seek more information during obstetric procedures [9]. Predictors such as preoperative meetings ($B=4.22$) positively impact awareness, suggesting that structured counseling sessions could bridge these gaps [9]. In a culturally conservative society like Saudi Arabia, where patient autonomy is evolving, enhancing awareness is vital to reduce reluctance toward RA (27.8% barrier) [1]. This is echoed in studies showing that informed patients report higher satisfaction and lower anxiety [20]. Furthermore, the role of media and community health campaigns could be leveraged to disseminate accurate information, countering myths about RA's risks, such as permanent nerve damage, which are rare (hematoma 17.1%) [21]. Comparing to neighboring Gulf countries, Saudi Arabia's awareness levels are similar, but lag behind Western nations, where RA education is integrated into preoperative protocols [22]. Addressing this through digital platforms, given high smartphone penetration, could democratize knowledge and empower patients.

In cardiac surgery, the meta-analytic evidence favoring thoracic epidural analgesia (TEA) for pain reduction at 6-48 hours and shorter extubation times (MD=-181.55 minutes) reinforces RA's role in high-risk procedures [3]. This is particularly relevant in Saudi Arabia, with rising cardiovascular disease burden, where RA can mitigate opioid-related respiratory complications (67.3% in GA) [23]. However, comparable morphine consumption across techniques suggests that multimodal analgesia is key, combining RA with non-opioids like paracetamol [3]. Ultrasound-guided blocks, such as erector spinae plane block (ESPB), offer alternatives to TEA with lower complication risks, suitable for anticoagulated patients [24]. The reduced hospital stay (MD=-0.73 days) with RA translates to economic benefits, essential for Saudi's Vision 2030 healthcare reforms [25]. Yet, heterogeneity in studies (I^2 statistics) indicates variability in surgical techniques, necessitating standardized protocols [3]. Future research should explore long-term outcomes, like chronic pain incidence, in Saudi cohorts.

For outpatient settings, selective spinal anesthesia (SSA) versus GA in anorectal surgeries demonstrates SSA's advantages in recovery time (120 vs. 184 minutes, $p<0.001$) and satisfaction [6]. Hemodynamic stability is comparable, but SSA's quicker ambulation (3.7 minutes) supports day-case surgery, aligning with global ambulatory trends [26]. In Saudi Arabia, this could

alleviate hospital bed pressures, but requires robust monitoring to manage rare complications like post-dural puncture headache [10]. Patient satisfaction rates exceeding 90% with RA underscore its patient-centered appeal [27].

Limitations of this review include the small number of included studies (n=10), potential publication bias, and reliance on self-reported data, which may inflate satisfaction scores [28]. Heterogeneity in outcomes precluded full meta-analysis, and the focus on Saudi populations limits generalizability [29]. Future directions involve large-scale RCTs comparing hybrid techniques and longitudinal studies on awareness interventions [30]. Policy implications include mandating RA training in residency programs and investing in equipment to overcome barriers [31].

In summary, this expanded discussion elucidates the comparative strengths of RA and sedation over GA in Saudi patients, while identifying actionable barriers. By addressing training, awareness, and infrastructure, Saudi healthcare can optimize anesthetic practices, improving outcomes and efficiency [32]. Further elaboration on cultural influences reveals that in Saudi society, where family decision-making is prominent, involving relatives in anesthesia discussions could enhance acceptance of RA, reducing reliance on GA [33]. Economic analyses suggest that shifting to RA could save millions in postoperative care costs annually, based on shorter stays and fewer complications [34]. Technological advancements, like virtual reality for patient education, could further demystify RA, increasing uptake [35]. In pediatrics, integrating play therapy with LA techniques has shown promise in reducing anxiety, a model adaptable to Saudi clinics [36]. For sedation, pharmacogenomic testing for midazolam metabolism could personalize dosing, minimizing adverse effects in genetically diverse populations [37]. Cardiac-specific RA protocols should incorporate antiemetic prophylaxis to maximize benefits [38]. Outpatient RA's scalability depends on community-based follow-up systems to monitor recovery [39]. Ultimately, interdisciplinary collaboration is essential to translate these findings into practice, ensuring equitable access across urban and rural Saudi regions [40]. (Word count: approximately 3020)

Conclusion

In conclusion, this systematic review of anesthetic techniques in Saudi patients demonstrates that while general anesthesia remains marginally preferred for its reliability in complex surgeries, regional anesthesia offers substantial benefits in terms of accelerated postoperative recovery, diminished complication rates such as nausea and vomiting, and enhanced patient satisfaction, particularly in elective and ambulatory settings where quicker discharge times and reduced pain scores are evident across diverse surgical contexts including orthopedics, obstetrics, and dentistry. Sedation methods like fentanyl-propofol provide efficient alternatives with faster recovery profiles compared to midazolam, though the latter excels in inducing amnesia, highlighting the need for personalized selection based on procedural demands and patient profiles. Local and topical anesthetics, predominantly lidocaine and benzocaine, prove highly effective in pediatric populations by minimizing discomfort and anxiety, with innovative delivery like jet anesthesia further improving acceptance. However, persistent challenges such as limited public awareness of regional techniques, inadequate practitioner training, equipment shortages, and demographic factors like age influencing preferences underscore the urgency for comprehensive educational initiatives, policy reforms, and infrastructure investments in Saudi healthcare to bridge these gaps and promote evidence-based practices. Ultimately, optimizing anesthetic choices through multidisciplinary approaches will not only elevate perioperative safety and efficiency but also align with global enhanced recovery protocols, fostering better health

outcomes for Saudi patients in an evolving medical landscape.

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