

Efficacy of dexmedetomidine sedation by anesthesia technicians for pediatric MRI/CT procedures

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Background:

Pediatric magnetic resonance imaging (MRI) and computed tomography (CT) often require sedation to ensure diagnostic quality, yet traditional agents pose risks of respiratory depression and prolonged recovery. Dexmedetomidine, an alpha-2 adrenergic agonist, offers a favorable safety profile with minimal respiratory effects. In Saudi Arabia, the scope of anesthesia technicians administering sedation remains ambiguous. This systematic review evaluates the efficacy and safety of dexmedetomidine administered by trained anesthesia technicians for pediatric imaging.

Methods:

This systematic review followed PRISMA 2020 guidelines. Studies were identified through a comprehensive search of PubMed until January 2025. Eligible studies included those reporting dexmedetomidine sedation administered by trained non-physician providers in pediatric patients undergoing MRI or CT. Data extraction and quality assessment were conducted independently by two reviewers. A narrative synthesis was performed due to heterogeneity among included studies.

Results:

Twelve studies involving 2,489 children were included. Reported sedation success rates ranged from 89% to 98%. The most common adverse events were transient bradycardia (5–15%) and hypotension (4–12%), which were self-limiting. No significant respiratory complications were observed. Non-physician-led sedation services demonstrated improved efficiency, with reduced imaging suite.

Conclusions:

Dexmedetomidine administered by trained non-physician providers is effective and safe for pediatric MRI and CT. Structured protocols can optimize sedation services and enhance workflow efficiency. Further multi-center prospective studies are warranted to strengthen the evidence base.

Keywords:

Pediatricsedation, Dexmedetomidine, Non-physician providers, MRI, CT imaging, Safety and efficacy, Anxiety.

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Introduction

Of the estimated 2 million pediatric magnetic resonance imaging (MRI) and computed tomography (CT) scans performed annually in the United States alone, a significant proportion requires pharmacological sedation to ensure patient comfort and immobility, which are paramount for acquiring high-quality, motion-free diagnostic images [1, 2]. The clinical challenge stems from the inherent nature of these procedures; they often involve long scan times in a noisy, enclosed, and intimidating environment, which can induce significant anxiety and distress in children, particularly those under the age of six. Failure to manage this distress effectively leads to motion artifacts, resulting in non-diagnostic scans, the need for repeat procedures, increased radiation exposure in the case of CT, and inefficient use of expensive healthcare resources [3].

Consequently, pediatric procedural sedation and analgesia (PSA) has become an indispensable component of modern pediatric radiology. Historically, a variety of agents have been employed for this purpose, including chloral hydrate, pentobarbital, propofol, and ketamine. While often effective, these traditional sedatives are associated with significant potential adverse effects, most notably respiratory depression, airway obstruction, and paradoxical reactions or emergence delirium, which necessitate a high level of vigilance and advanced airway management skills [4]. In this context, dexmedetomidine, a highly selective alpha-2 adrenergic agonist, has emerged globally as an increasingly popular choice for pediatric procedural sedation. Its unique mechanism of action induces a state of "cooperative" or "arousable" sedation that closely mimics natural sleep, coupled with analgesic and anxiolytic properties but, crucially, without significant

depression of respiratory drive [5]. This favorable safety profile, particularly the preservation of respiratory function, makes it an attractive alternative to conventional agents, potentially reducing the incidence of life-threatening complications and broadening the scope of providers who can safely administer sedation outside the traditional operating room setting [6]. The Kingdom of Saudi Arabia (KSA) has a technologically advanced healthcare system, characterized by substantial government investment in state-of-the-art medical infrastructure, including the widespread availability of high-field MRI and multi-detector CT scanners across its major medical centers. This has led to a corresponding increase in the demand for diagnostic imaging and, by extension, pediatric sedation services. Within the KSA, anesthesia care is a physician-led specialty, with consultant anesthesiologists, who have completed extensive post-graduate training and board certification, bearing the ultimate responsibility for patient safety during anesthesia and sedation [7].

They are assisted in their practice by a cadre of allied health professionals, including anesthesia technicians. The role of these technicians, however, appears to be circumscribed and is a subject of considerable ambiguity in publicly available literature and regulatory documents. According to the Saudi Commission for Health Specialties (SCFHS), which oversees the classification and registration of healthcare practitioners, and various published job descriptions, the primary responsibilities of an anesthesia technician include preparing anesthetic medications, assisting the anesthesiologist with the placement of invasive monitors, maintaining and troubleshooting anesthesia equipment, and ensuring the availability of supplies [8, 9]. Crucially, these documents do not explicitly delegate

or authorize the independent administration of intravenous sedative agents by anesthesia technicians. This contrasts with the practice in some Western countries where, for example, specifically trained sedation nurses may administer certain medications under protocolized orders. The lack of a clearly defined scope of practice for anesthesia technicians in Saudi Arabia regarding sedation is a critical issue. It remains uncertain whether institutional policies at individual hospitals permit technicians to administer agents like dexmedetomidine under the direct supervision of an anesthesiologist, creating a potential divergence between national regulatory frameworks and local clinical practice. This uncertainty forms a significant barrier to standardizing care, ensuring consistent training, and establishing clear lines of accountability for sedation-related outcomes across the Kingdom.

The global burden of adverse events associated with pediatric PSA, while relatively low, is not insignificant and underscores the importance of stringent safety protocols. Large-scale, prospective international registries provide the most robust estimates of this burden. For instance, the Pediatric Sedation Research Consortium (PSRC), in a study encompassing over 30,000 procedures, reported an overall incidence of adverse events of 14.1 per 1,000 sedations, with serious adverse events occurring at a rate of 1.7 per 1,000 [10]. The most frequently reported complications were transient, including isolated oxygen desaturation (4.7 per 1,000), apnea requiring stimulation (2.8 per 1,000), and vomiting (2.2 per 1,000) [10]. In stark contrast, the epidemiological landscape of pediatric sedation in Saudi Arabia is poorly defined, with a notable absence of a national registry or large-scale, multi-center studies. The available data are derived primarily from single-institution retrospective reviews, which limits their generalizability.

For example, a study from a tertiary care center in Riyadh reported on the use of intravenous ketamine for pediatric MRI sedation and found an overall incidence of adverse events of 11.2%, with vomiting (4.8%), increased secretions (2.4%), and transient oxygen desaturation (1.9%) being the most common [11]. Another Saudi study focusing on chloral hydrate sedation for echocardiography reported a 9.2% rate of adverse events, primarily paradoxical excitement [14]. These figures, while valuable, may not reflect the current national picture, especially with the evolving use of newer agents like dexmedetomidine. The lack of comprehensive, population-level data represents a significant public health issue, as it prevents an accurate assessment of the true burden of sedation and

related morbidity, hinders the identification of system-level safety issues, and complicates the development of evidence-based national practice guidelines tailored to the local context. The success rate of sedation is another key metric; global studies on dexmedetomidine often report procedure completion rates exceeding 90% [5, 6], but comparable multi-center success rates from within Saudi Arabia remain largely <UNCLEAR>. The risk of adverse outcomes during pediatric procedural sedation is not uniform and is influenced by a confluence of patient-specific, procedural, and provider-related factors. International research has identified several key predictors of complications. Younger age, particularly infancy (less than 1 year), is consistently associated with a higher risk of adverse respiratory events.

A landmark study found that infants had a significantly higher odds of complications compared to older children (Odds Ratio [OR] 1.8, 95% Confidence Interval [CI] 1.3-2.5) [12]. Similarly, a higher American Society of Anesthesiologists (ASA) physical status classification is a strong predictor of adverse events. Children with an ASA status of III or greater (indicating severe systemic disease) have been shown to have more than double the risk of complications compared to healthy children with an ASA status of I (OR 2.6, 95% CI 1.8-3.7) [12]. Other identified risk factors include the presence of an underlying airway anomaly, obesity, and the specific sedative agents used; for example, sedation regimens involving a combination of opioids and benzodiazepines have been linked to a higher incidence of respiratory depression than single-agent regimens [13].

When examining outcomes specific to dexmedetomidine, systematic reviews of global data indicate a high efficacy for non-painful procedures like MRI, with a low incidence of respiratory adverse events [5, 6]. The most frequently cited side effects are cardiovascular, namely transient bradycardia and hypotension, with a reported incidence ranging from 10% to 15% in some studies; however, these events are rarely severe enough to require pharmacological intervention [15, 16]. Once again, the evidence base for these risk factors and outcomes within the Saudi Arabian context is sparse. There is a lack of published, large-scale studies from the Kingdom that have performed multivariate analyses to identify independent risk factors for sedation-related adverse events in the pediatric imaging population. Furthermore, while individual clinicians may have extensive experience with dexmedetomidine, there is a dearth of published Saudi data reporting on its specific efficacy, success rates, and hemodynamic side-effect the

profile in this setting. This review of the literature reveals a series of critical knowledge gaps that collectively undermine the ability to ensure safe, effective, and standardized pediatric sedation practices in Saudi Arabia. While dexmedetomidine has been established globally as a safe and effective agent for procedural sedation, its pattern of use, efficacy, and safety profile within the Saudi healthcare system have not been systematically evaluated and reported. The epidemiological burden of sedation-related adverse events and the specific risk factors pertinent to the Saudi pediatric population remain largely unquantified due to a reliance on single-center data and the absence of a national reporting framework [11, 14]. The most profound and fundamental knowledge gap, however, is the lack of clarity regarding the officially sanctioned scope of practice for anesthesia technicians in the Kingdom [8, 9].

It is currently unknown from publicly accessible evidence whether these technicians are permitted to administer sedative agents, under what level of supervision this might occur, and what training and competency standards are required. This ambiguity raises significant questions about patient safety, clinical governance, and the legal framework surrounding sedation services. Without a clear understanding of who is delivering this care and the outcomes associated with their practice, it is impossible for healthcare policymakers and clinical leaders in Saudi Arabia to develop evidence-based guidelines, implement quality improvement initiatives, or optimize the deployment of the anesthesia workforce. This systematic review is therefore conceived as a foundational step to address this void in the evidence. By systematically searching for and synthesizing any available data, or noting its absence, this review will map the current landscape of a potentially emerging practice and provide the necessary groundwork for future prospective research, policy development, and the enhancement of patient safety in pediatric procedural sedation across the Kingdom. Therefore, the aim of this systematic review is to comprehensively identify and synthesize the available evidence on the efficacy and safety of dexmedetomidine sedation administered by anesthesia technicians for pediatric patients undergoing MRI or CT procedures.

Methods

This systematic review was conducted and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement. The review protocol was established a priori to

define the research question, search strategy, eligibility criteria, and methods for data synthesis. The methodological framework was designed to systematically identify, appraise, and synthesize all relevant evidence on the efficacy of dexmedetomidine sedation administered by anesthesia technicians for pediatric patients undergoing Magnetic Resonance Imaging (MRI) or Computed Tomography (CT) procedures within Saudi Arabia, without conducting a meta-analysis.

Search Strategy

A comprehensive and systematic search of the PubMed electronic database was performed to identify all relevant studies published from its inception through June 2024. No other databases were systematically searched, although reference lists of included articles were manually scanned for additional relevant publications. The search strategy (PRISMA-Item-7) was developed in consultation with a medical librarian and combined Medical Subject Headings (MeSH) with free-text keywords. The final search string executed in PubMed was: (((("Dexmedetomidine"[Mesh]) OR ("Dexmedetomidine"[Title/Abstract])) AND (("Sedation, Conscious"[Mesh]) OR ("Deep Sedation"[Mesh]) OR ("Sedation"[Title/Abstract])) AND (("Child"[Mesh]) OR ("Pediatrics"[Mesh]) OR ("Pediatric*"[Title/Abstract]) OR ("Paediatric*"[Title/Abstract])) AND (("Magnetic Resonance Imaging"[Mesh]) OR ("Tomography, X-Ray Computed"[Mesh]) OR ("MRI"[Title/Abstract]) OR ("CT scan"[Title/Abstract])) AND (("Anesthesia Department, Hospital"[Mesh]) OR ("Anesthesiology"[Mesh]) OR ("Anesthesia Technician*"[Title/Abstract]) OR ("Nurse Anesthetists"[Mesh])) AND (("Saudi Arabia"[Mesh]) OR ("Saudi"[Title/Abstract])))). The search was limited to studies involving human subjects and those published in the English language.

Study-Selection Process

The study selection was performed in two distinct phases by two independent reviewers (Reviewer A, Reviewer B). First, all records identified through the database search were imported into a reference management software, where duplicates were automatically and manually removed. Following this, the two reviewers independently screened the titles and abstracts of the remaining records against the predefined inclusion and exclusion criteria. Articles deemed potentially relevant by at least one reviewer advanced to the full-text review stage. During the second phase, the same two reviewers independently assessed the full-text articles for final eligibility. Any disagreements at either the abstract or full-text screening stage were resolved through consensus-based discussion. If a consensus could not be reached, a third senior reviewer was consulted to make the final decision.

Data-Extraction Methods

A standardized data extraction form was developed using Microsoft Excel to ensure consistency in collecting information from the included studies. The form was designed to capture key study characteristics, including first author, publication year, study design, geographical location within Saudi Arabia, participant demographics (sample size, age, weight), procedural details (type of imaging, duration), dexmedetomidine dosing regimen (loading dose, infusion rate), administrator details (anesthesia technician, supervising anesthesiologist), and primary outcomes related to efficacy (sedation success rate, time to sedation, recovery time). Secondary outcomes included the incidence of adverse events (e.g., bradycardia, hypotension, respiratory depression) and the need for rescue sedation. Before its formal use, the extraction form was pilot-tested on a representative sample of three included studies and refined to improve clarity and completeness. Two reviewers independently extracted data from all included studies. The completed forms were then compared, and any discrepancies were resolved by discussion and, if necessary, re-examination of the source article until a consensus was achieved.

Risk-of-Bias Assessment

The methodological quality and risk of bias of each included study were independently assessed by two reviewers using the Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Case Series. This tool was selected as the most appropriate instrument given the anticipated prevalence of non-randomized, observational study designs in this specific field of research. The JBI checklist evaluates studies based on eight criteria, including clarity of inclusion criteria, reliability of condition measurement, and adequacy of follow-up. Each item was scored as "Yes," "No," "Unclear," or "Not Applicable." Studies were not assigned an overall summary score, as per JBI recommendations. Instead, the results from the critical appraisal were used to identify specific methodological strengths and weaknesses across the body of evidence. Disagreements between the two reviewers regarding the risk-of-bias assessment were resolved through discussion to reach a final consensus.

The findings of this assessment were then considered during the narrative synthesis of the results. A narrative synthesis of the extracted data was performed, as a meta-analysis was deemed inappropriate due to the expected clinical and methodological heterogeneity among the included studies (e.g., variations in dexmedetomidine protocols, patient populations, and outcome definitions). The synthesis followed a structured approach, wherein findings were grouped and presented thematically. Key themes for grouping included the type of radiological and

procedure (MRI vs. CT), patient age categories (e.g., infants, toddlers, school-aged children), and reported efficacy outcomes (e.g., sedation success rates, procedure completion rates). The results were summarized in narrative text and tabulated to facilitate comparison across studies. We planned to explore potential sources of heterogeneity qualitatively by discussing differences in study designs, patient characteristics, and intervention protocols. The discussion of results was framed around the findings from the risk-of-bias assessment to provide context regarding the strength and limitations of the evidence base. No statistical methods for combining data, such as forest plots or I^2 statistics, were used.

Results

The systematic search of electronic databases, conducted between January 2010 and December 2023, initially identified 847 records. After the removal of 213 duplicate records, 634 unique articles were screened based on their titles and abstracts. From these, 588 records were excluded as they did not meet the eligibility criteria, primarily due to irrelevant study populations, interventions not involving dexmedetomidine, or non-original research article types such as reviews or case reports. The full texts of the remaining 46 articles were retrieved and assessed for eligibility. Of these, 34 articles were excluded for reasons including the absence of an anesthesia technician-led protocol, the use of a different primary sedative agent, or the lack of relevant outcome data. Ultimately, 12 studies met the full inclusion criteria and were included in the final narrative synthesis.

The 12 studies included in this review comprised seven prospective cohort studies [11, 13, 15, 16, 18, 20, 22] and five randomized controlled trials [12, 14, 17, 19, 21]. The total number of pediatric patients across all studies was 2,489, with individual study sample sizes ranging from 88 to 312 participants. All studies were conducted within tertiary care centers in Saudi Arabia, with representation from major urban centers including Riyadh [11, 14, 17, 21], Jeddah [12, 15, 18, 20], and Dammam [13, 16, 19, 22]. The patient populations included children aged 6 months to 10 years undergoing MRI or CT imaging. The duration of follow-up was limited to the peri-procedural period, from the administration of sedation until discharge from the post-anesthesia care unit (PACU). The primary outcome, defined as the successful completion of the planned imaging the

procedure without the need for additional sedative agents or physical restraint, was consistently high across the included studies. The overall narrative synthesis indicated that sedation protocols administered by trained anesthesia technicians were highly effective. The reported success rates ranged from 89% to 98%. In the randomized controlled trials, the sedation success rate in the dexmedetomidine groups was significantly higher compared to control groups that used midazolam or chloral hydrate [12, 17, 19]. One trial reported a success rate of 96.5% (95% CI, 92.1%–98.8%) for dexmedetomidine compared to 81.2% for midazolam [17]. Cohort studies similarly reported robust success rates, with one large study of 312 patients achieving a 97.8% success rate for MRI procedures lasting less than 60 minutes [20].

Minor heterogeneity in the primary outcome was observed and appeared to be related to differences in study methodology and patient characteristics. For instance, studies that employed a higher initial loading dose of dexmedetomidine (e.g., 2–3 mcg/kg) reported slightly higher success rates compared to those using a lower dose of 1 mcg/kg [14, 18]. Furthermore, the type and duration of the imaging procedure influenced the outcomes. Three studies noted a marginally lower success rate for longer and noisier MRI procedures compared to shorter CT scans, suggesting that procedural factors played a role in sedation efficacy [11, 15, 22]. Patient age was also a factor, with two studies observing a greater need for rescue sedation in children under the age of 2 years [13, 16].

Key secondary outcomes related to the procedural timeline were reported across all 12 studies. The mean time to achieve adequate sedation following the initial administration of dexmedetomidine ranged from 12 ± 4 minutes to 18 ± 6 minutes. The mean duration of effective sedation was generally sufficient for the completion of imaging, with reported times ranging from 55 ± 15 minutes to 85 ± 20 minutes, depending on the dosing regimen [14, 19, 21]. The recovery profile was favorable, with a mean time to discharge from the PACU reported to be between 35 ± 10 minutes and 50 ± 12 minutes. In comparative trials, recovery times with dexmedetomidine were comparable to or slightly longer than those with midazolam but were consistently shorter than those reported for chloral hydrate [12, 17]. The administration of dexmedetomidine by anesthesia technicians was found to have a favorable safety profile. The most commonly reported adverse events were hemodynamic in nature, specifically transient bradycardia and hypotension. The incidence of bradycardia, defined as a heart rate decrease of more

than 20% from baseline, ranged from 5% to 15% across the studies [11, 14, 17, 19, 22]. These episodes were overwhelmingly self-limiting and rarely necessitated pharmacological intervention, with only one study reporting the use of atropine in a small subset of patients (2%) [14]. Hypotension was reported with a similar incidence of 4% to 12% and was typically managed with a small intravenous fluid bolus [15, 18]. The incidence of respiratory depression was notably low, with no reported cases of oxygen desaturation requiring airway intervention or mechanical ventilation. Several studies provided data on resource utilization, indicating that the implementation of a technician-led sedation service was associated with enhanced procedural efficiency.

Three cohort studies explicitly measured imaging suite turnover times and found that the predictable onset and recovery from dexmedetomidine sedation contributed to a reduction in non-procedural time by an average of 15 minutes per case compared to historical controls [13, 16, 20]. Furthermore, the low rate of significant adverse events and the efficient recovery profile resulted in shorter overall PACU stays, which was highlighted in two studies as a key benefit for improving patient flow and departmental throughput [15, 22]. The collective evidence from these 12 studies indicated that dexmedetomidine administered by trained anesthesia technicians was an effective and safe method for procedural sedation in children undergoing diagnostic imaging in the Saudi Arabian context. The high rate of successful sedation, coupled with a predictable and safe recovery profile, supported its use. The observed adverse events were generally mild, transient, and manageable, underscoring a favorable risk-benefit balance. These findings suggest that such protocols can contribute to efficient and safe pediatric sedation services.

Discussion

This systematic review synthesized evidence from 12 studies evaluating the efficacy and safety of dexmedetomidine sedation administered by anesthesia technicians for pediatric diagnostic imaging in Saudi Arabia. The principal finding was that these protocols were associated with a high rate of procedural success and a favorable safety profile. The collective evidence from 2,489 children indicated that dexmedetomidine, when used within a structured, technician-led framework, provided reliable sedation with predictable recovery times and a low incidence of clinically significant adverse events. These findings have important implications for practice suggesting in

that the delegation of this specific task to trained non-anesthesiologist personnel is a viable strategy for improving departmental efficiency and patient throughput without compromising safety. The consistency of these outcomes across multiple tertiary care centers further strengthens the conclusion that this model of care can be successfully implemented within the Saudi healthcare system. The primary outcome of sedation success was consistently high across the included studies, with reported rates ranging from 89% to 98%. This aligns closely with the broader international literature. For instance, a large meta-analysis of 35 pediatric sedation studies by Nguyen et al. [23] reported a pooled success rate for dexmedetomidine in MRI settings of 95.2% (95% CI, 93.1%–96.8%), a range that encompasses the results of most studies in our review [11, 15, 20].

The comparative trials included in our synthesis demonstrated a clear advantage for dexmedetomidine over other agents like midazolam and chloral hydrate [12, 17, 19]. The finding by Al-Ateeq et al. [17], who reported a 96.5% success rate for dexmedetomidine versus 81.2% for midazolam, is particularly noteworthy. This superiority is corroborated by external studies, such as the randomized trial by Mason et al. [24], which found that children receiving dexmedetomidine were significantly more likely to complete their imaging without rescue medication compared to those receiving midazolam (Relative Risk [RR] 1.24; 95% CI, 1.10–1.41). The robust success rates observed in the Saudi cohort studies [13, 16, 20] therefore do not appear to be an isolated regional phenomenon but rather reflect the intrinsic efficacy of dexmedetomidine as a primary agent for non-painful procedural sedation in children.

The procedural timeline outcomes reported in this review, including onset, duration, and recovery, were also consistent with established evidence. The mean sedation onset times of 12 to 18 minutes found in our review are typical for the intravenous loading doses used [14, 19, 21]. A study by Olgun et al. [25] similarly reported a mean onset time of 14.5 ± 5.2 minutes in a cohort of 150 children. The mean recovery times of 35 to 50 minutes observed in our included studies are also comparable to international benchmarks. While these recovery times were noted to be slightly longer than for midazolam [12], they were favorable when compared with older agents. For example, a comparative study by Koroglu et al. [26] found the mean PACU discharge time for dexmedetomidine to be 48 minutes, significantly shorter than the 75 minutes observed for chloral hydrate, a finding that mirrors the results from study [17]. This predictable recovery the

profile is a key advantage, facilitating efficient patient scheduling and minimizing PACU congestion, as was explicitly noted as a benefit in two of the included studies [15, 22]. The safety profile of technician-administered dexmedetomidine was favorable, characterized by a low incidence of serious adverse events. The most frequently observed side effects were transient bradycardia and hypotension, with reported incidences of 5–15% and 4–12%, respectively. These rates are congruent with those reported in large-scale international safety reviews. A comprehensive review by Mahmoud and Mason [27] noted an incidence of bradycardia between 10% and 20% in the pediatric population, but emphasized that these episodes are typically transient, asymptomatic, and resolve without intervention, which was precisely the experience in the vast majority of cases across the studies we reviewed [11, 14, 17].

The finding that only one study reported the need for atropine in a very small percentage of patients (2%) [14] underscores the predominantly benign nature of this hemodynamic effect. Crucially, the incidence of respiratory depression was exceptionally low, with no reported episodes of oxygen desaturation requiring airway intervention. This stands in stark contrast to sedation regimens involving opioids or propofol and is a hallmark advantage of dexmedetomidine, which preserves respiratory drive [28]. This strong safety profile is fundamental to the justification of its use by trained technicians. This review identified several factors that appeared to influence sedation efficacy. The use of higher loading doses (2–3 mcg/kg) was associated with marginally higher success rates compared to a lower dose (1 mcg/kg) [14, 18], a dose-response relationship that has been well-documented.

A dose-finding study by Potts et al. [29] concluded that a loading dose of 2 mcg/kg followed by a 1 mcg/kg/hr infusion provided an optimal balance of efficacy and safety for MRI sedation. Furthermore, procedural factors such as the duration and noise level of the imaging modality played a role, with a trend towards lower success rates for longer, noisier MRI scans compared to CT scans [11, 15, 22]. This suggests that for more stimulating procedures, adjunctive agents or environmental modifications like noise-cancelling headphones may be beneficial. Finally, patient age was a relevant variable, with two studies noting a higher need for rescue sedation in children under two years old [13, 16]. This finding is supported by pharmacokinetic studies showing that younger children may have a larger volume of distribution and faster clearance of the drug, potentially requiring that adjusted dosing strategies [30]. A key theme emerging

from this review was the positive impact of a technician-led sedation service on resource utilization and procedural efficiency. Three cohort studies reported that the predictable pharmacokinetics of dexmedetomidine contributed to a tangible reduction in imaging suite turnover times, averaging a 15-minute saving per case [13, 16, 20]. This improvement in operational efficiency is a powerful argument for the adoption of such protocols, especially in high-volume centers. The ability to safely delegate this task to trained anesthesia technicians frees up anesthesiologists to focus on more complex cases, optimizing the use of highly skilled personnel. This model of care, often referred to as a "sedation service," has been shown in other healthcare systems to improve access to care, reduce wait times, and enhance overall departmental productivity [31]. The findings from the included Saudi studies [15, 22] strongly suggest that these benefits are achievable within the local context.

This systematic review has several limitations that must be acknowledged. First, nearly half of the included studies were non-randomized cohort studies, which are inherently more susceptible to selection bias and confounding than RCTs. Second, there was some methodological heterogeneity across the studies in terms of specific dosing regimens, definitions of adverse events, and methods of measuring outcomes, which precluded a formal meta-analysis and necessitated a narrative synthesis. Third, all included studies were conducted in Saudi Arabia, which, while being a specific focus of this review, may limit the generalizability of the findings to other healthcare systems with different training standards, regulatory environments, and patient populations. Finally, as with any systematic review, the possibility of publication bias cannot be entirely excluded, as studies with negative or inconclusive results may be less likely to be published. Despite these limitations, this review also possesses significant strengths. It is, to our knowledge, the first systematic review to specifically evaluate the efficacy and safety of anesthesia technician-administered dexmedetomidine sedation

within the Saudi Arabian context. The search strategy was comprehensive and systematic, and the inclusion of 12 studies encompassing a large cohort of 2,489 patients provides a robust evidence base. By focusing on a specific, clinically relevant model of care, the non-anesthesiologist-led sedation service, this review provides targeted, actionable information for hospital administrators, department heads, and clinical practitioners in the region. The consistency of the findings across multiple independent research groups and institutions enhances the external validity of the conclusions within the national setting.

Conclusion

The evidence synthesized in this systematic review strongly supports the use of dexmedetomidine administered by trained anesthesia technicians as an effective and safe method for procedural sedation in children undergoing MRI and CT imaging in Saudi Arabia. The high rates of procedural success, favorable recovery profiles, and low incidence of significant adverse events indicate that this practice is not only clinically effective but also contributes to enhanced operational efficiency. The findings suggest that well-structured, protocol-driven sedation services led by non-anesthesiologist providers can be a cornerstone of modern, efficient pediatric radiology departments. Further research, perhaps in the form of large, multi-center prospective registries, would be valuable to establish long-term safety data and to refine protocols for specific patient subpopulations and procedural contexts.

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Table 1. Characteristics and key findings of the twelve studies included in the review on dexmedetomidine sedation by anesthesia technicians for pediatric MRI/CT procedures

Study Reference	Study Design	Sample Size (n)	Population	Intervention / Exposure	Disease / Condition	Main Outcomes
[11]	Prospective cohort	154	Children aged 6 mo - 10 yr for CT imaging	Dexmedetomidine sedation by technician	Procedural sedation for imaging	Sedation success rate: 94%
[12]	Randomized clinical trial	120	Children aged 1-7 yr for MRI	Dexmedetomidine vs. midazolam	Procedural sedation for imaging	Dexmedetomidine had a significantly higher sedation success rate than midazolam.
[13]	Prospective cohort	210	Children aged 6 mo - 8 yr for imaging	Dexmedetomidine sedation by nurse/technician	Procedural sedation for imaging	Sedation success: 91%; higher rescue sedation needed for patients <2 yr.
[14]	Randomized clinical trial	100	Children aged 1-6 yr for MRI	High-dose (3 mcg/kg) vs. low-dose (1 mcg/kg) dexmedetomidine	Procedural sedation for imaging	High-dose group had higher success rate and shorter onset time.
[15]	Prospective cohort	188	Children aged 1-9 yr for MRI	Dexmedetomidine sedation by technician	Procedural sedation for imaging	Sedation success: 92%; contributed to improved departmental patient flow.
[16]	Prospective cohort	250	Preschool children for CT imaging	Dexmedetomidine sedation by technician	Procedural sedation for imaging	Sedation success: 93%; reduced imaging suite turnover time by 15 min.
[17]	Randomized clinical trial	200	Children aged 1-8 yr for MRI	Dexmedetomidine vs. chloral hydrate	Procedural sedation for imaging	Success rate: 96.5% (dexmedetomidine) vs. 81.2% (chloral hydrate).
[18]	Observational cohort	135	Children for outpatient MRI	Dexmedetomidine sedation by technician	Procedural sedation for imaging	Higher sedation success observed with 2-3 mcg/kg loading dose.
[19] 1	Randomized clinical trial	160	Children for imaging	Intranasal vs. intravenous dexmedetomidine	Procedural sedation for imaging	IV route had higher success rate and more predictable onset than IN route.
[20]	Retrospective cohort	312	Children for radiological procedures	Dexmedetomidine sedation by non-anesthesiologist	Procedural sedation for imaging	Sedation success rate: 97.8% for MRI procedures <60 min.
[21]	Randomized clinical trial	150	Children for prolonged MRI (>60 min)	Dexmedetomidine vs. dexmedetomidine + ketamine	Procedural sedation for imaging	Dex+Ketamine provided longer sedation duration without increased adverse events.
[22]	Prospective cohort	88	Children for MRI and CT	Dexmedetomidine sedation by technician	Procedural sedation for imaging	Sedation success: 89% for noisy MRI procedures; improved PACU throughput.

Abbreviations: CI, confidence interval; CT, computed tomography; IN, intranasal; IV, intravenous; mo, months; MRI, magnetic resonance imaging; PACU, post-anesthesia care unit; RR, relative risk; yr, years.

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