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Original Research Article

Safety and adverse events of MRI sedation and anaesthesia: A four-year retrospective analysis of 2400 patients across age groups

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Abstract

Background and Aims: Sedation for magnetic resonance imaging (MRI) is frequently required across various age groups to ensure patient immobility and good imaging quality. However, The MRI suite presents special challenges due to limited access, long scan times, and patient-specific sedation requirements. This retrospective study aimed to assess the safety, efficacy, and incidence of adverse events associated with sedation or anaesthesia for MRI across a broad spectrum of patients in an Indian high-volume MRI centre over four years.

Materials and Methods: A retrospective cohort analysis was conducted on 2,400 patients from 3 months of age up to 100 years for elective MRI under sedation by anaesthesiologists. Data were retrieved from electronic medical records, including demographic details, ASA status, fasting status, drugs administered, adequacy of sedation, recovery profile, and adverse events. Sedation regimens were tailored to clinical context and age, ranging from oral medications in paediatric patients to total intravenous anaesthesia in high-risk adults.

Results: The overall procedural success rate was 98.7%, and the complication rate was 3.96%. There were no sentinel events (e.g., cardiac arrest, aspiration). Mean MRI scan time was 34 minutes, and recovery time 25 minutes. Paediatric patients receiving oral sedation had longer recovery times (180±25 min) compared to those on intravenous sedation (48±12 min; $p<0.001$). Adolescents had better outcomes with ketamine-midazolam compared to Dexmedetomidine, while adults receiving pentazocine-promethazine achieved optimal and faster recovery (23±5 min). Patients with ASA III status were associated with 3.1-fold increased odds of complications (OR=3.1, p=0.008). Elderly patients tolerated IV midazolam or oral alprazolam with excellent safety outcomes. Pre-emptive analgesia significantly enhanced procedural success in patients with preexisting pain, and airway-related events were successfully managed without escalation.

Conclusion: MRI sedation is safe and effective in all ages with age-related, standardized protocols under the supervision of skilled anaesthesiologists. The findings support continued refinement of sedation protocols with an emphasis on risk stratification, antiemetic optimization, and enhanced monitoring in children and high-risk patients.

Keywords: MRI, Sedation, Anaesthesia, Adverse events, IV sedation, Oral sedation, Patient safety.

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1. Introduction

Magnetic resonance imaging (MRI) requires immobilization of patients during scan for acquiring accurate images, and it becomes challenging in various subsets of patients. The slightest motion of the patient can produce an artifact, which not only hampers the quality of the image but can also lead to an abnormal or wrong diagnosis and higher chances of a repeat scan.[1] The number and duration of scan sequences are variable, with some complex studies lasting up to few hours. Moreover, the MRI suite is inherently noisy and claustrophobic with restricted access to the patient. Sedation or Anesthesia is usually given for MRI procedure for a variety of reasons. Patients profile varies between kids, the elderly, pregnant females, claustrophobic individuals, patients with abnormal behaviour, uncooperative patients with meningitis or encephalitis, patients having psychiatric illness and patients with a history of alcohol or drug abuse. The aim of sedation and anesthesia is, therefore, to provide

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immobilisation to obtain the best possible images, while maintaining patient safety and comfort throughout.[2]

In clinical practice, especially in the pediatric age group, the goals of sedation for diagnostic and therapeutic procedures are to guard the patient's safety and welfare, minimize physical discomfort and pain, control anxiety, maximize the potential for amnesia, and control behaviour and movement.[3-5] All patients requiring sedation or anesthesia must undergo a careful pre-sedation or anesthesia checkup, appropriate fasting and a focused airway examination, and intravenous cannulation. Owing to the noisy and claustrophobic environment of the MRI scanner with the need of minimizing any type of movement, deep sedation is usually needed during the scan. Safe delivery of sedation requires appropriate levels of physiological monitoring by MRI compatible equipments (electrocardiogram, non-invasive blood pressure, pulse oximeter, capnography), equipment for emergency airway management (MRI compatible laryngoscopes, supraglottic devices, etc.), appropriate venous access and lines and MRI compatible anesthesia machine or workstation.[6,7]

A variety of drugs are useful for sedation and a clear understanding of the pharmacokinetic and pharmacodynamics effects of the individual agent is vital when choosing the most appropriate drug for a particular patient. The choice of appropriate drug may vary as per the patient's age, disease status and duration of scan. This retrospective study was conducted to evaluate whether protocol-driven, age-specific sedation and anesthesia practices can ensure a high rate of procedural success with minimal adverse events during MRI across a broad patient population, ranging from infants to the elderly, in a high-volume clinical setting.

2. Materials and Methods

2.1. Study design and setting

This was a retrospective cohort analysis conducted at a dedicated MRI centre in India after ethical clearance (IEC-HOD/01-06/18A). The study aimed to assess the safety profile and incidence of adverse events associated with procedural sedation across all age groups during MRI scans. Data was extracted from electronic medical records and sedation charts covering a consecutive cohort of 2400 patients who underwent elective MRI under sedation between June 2012 and June 2016. The MRI suite was equipped with MRI-compatible standard resuscitative equipments, including oxygen cylinders, masks, laryngoscopes, endotracheal tubes, and supraglottic airway devices.

2.2. Participants

All patients (neonates, paediatric, adolescents, adults, and elderly) scheduled for elective MRI under sedation during the study period were included. The cohort inherently excluded emergency MRIs and patients with contraindications to sedation (e.g., hemodynamic instability, allergy to sedative agents), as these were not managed under the centre's elective sedation protocol during the study period. No additional exclusions were applied during data extraction. All patients were managed according to institutional protocols, adhering to the American Society of Anaesthesiologists (ASA) fasting guidelines pre-procedure. Pre-medication was administered as clinically indicated.

2.3. Sedation protocols and procedures

Sedation plans were chosen based on the patient's age and condition as per standard centre practice during the study period. Sedation was administered and monitored by an experienced attending anaesthesiologist. Continuous monitoring throughout the procedure included pulse oximetry (SpO_2), clinical assessment of sedation depth, respiratory rate, and heart rate.

1. Paediatric patients (≤12 years): Protocols varied and included oral Pedicloryl (Triclofos; 50-100 mg/kg), oral Phenergan (Promethazine; 0.5-1 mg/kg), oral midazolam (0.5-0.75 mg/kg), oral ketamine (3-6 mg/kg), intramuscular ketamine (3-5 mg/kg), intravenous ketamine (1-2 mg/kg) ± midazolam (0.05-0.1 mg/kg), intravenous propofol (bolus 1-2 mg/kg, infusion 50-200 µg/kg/min), or intravenous dexmedetomidine (loading 0.5-1 µg/kg over 10 min, infusion 0.2-0.7 µg/kg/hr). Choice of protocol depended on age, scan duration, and anticipated cooperation.
2. Adolescent patients (12-18 years): Primary protocols involved intravenous ketamine (0.5-1 mg/kg) ± midazolam (0.03-0.05 mg/kg) or intravenous dexmedetomidine (loading 0.5-1 µg/kg over 10 min, infusion 0.2-0.7 µg/kg/hr). For prolonged scans (>1 hour), total intravenous anaesthesia (TIVA) with propofol infusion (100-200 µg/kg/min) was preferably employed.
3. Adult patients (18-60 years): Sedation regimens included intravenous midazolam (0.02–0.05 mg/kg) ± ketamine (0.2–0.5 mg/kg), intravenous dexmedetomidine (loading dose 0.5–1 µg/kg over 10 minutes, infusion 0.2–0.7 µg/kg/hr), and propofol TIVA (bolus 0.5–1.5 mg/kg, infusion 50–200 µg/kg/min). Additionally, a combination of intravenous pentazocine (Fortwin; 0.3–0.6 mg/kg) and promethazine (Phenergan; 0.5–1 mg/kg) was commonly used, especially for adult patients undergoing shorter scans, offering rapid recovery. For claustrophobic patients refusing IV access, oral alprazolam (0.25–0.5 mg) or zolpidem (5–10 mg) was administered.
4. Elderly patients (>60 years): Due to heightened sensitivity, sedation was primarily restricted to

intravenous midazolam (0.01-0.03 mg/kg, max 1-2 mg) or oral alprazolam (0.125-0.25 mg)..

5. Pain management: Patients identified with pre-procedural pain (Visual Analog Scale, VAS ≤5) during pre-anaesthetic assessment received intramuscular diclofenac (1.5 mg/kg, max 75 mg) 30-45 minutes prior to sedation. Patients with significant pain (VAS ≥5) received intravenous tramadol (1-2 mg/kg, max 100 mg) and intravenous ondansetron (0.1 mg/kg, max 4 mg) approximately 30 minutes before the procedure.

2.4. Data collection and outcome measures

Data were retrospectively collected from electronic medical records of patients who underwent MRI under sedation. Information included demographic details such as age, gender, and weight; ASA physical status classification; relevant medical history; procedure duration; and sedation or analgesic medications administered along with their doses. Additional parameters such as the time taken to reach the target sedation level, total sedation time, recovery time, and any documented adverse events were also recorded.

The principal endpoint assessed was the successful completion of the MRI scan. This was defined as the procedure being initiated according to schedule and fully concluded without premature termination attributable to inadequate sedation or the occurrence of significant adverse events preventing scan finalization.

Secondary outcomes evaluated safety and efficacy by tracking predefined adverse events during MRI sedation. These included failed sedation (inadequate depth leading to movement or scan abandonment), nausea or vomiting, allergic reactions, oxygen desaturation (SpO_2 <90% for more than 30 seconds), apnea (breathing pause >20 seconds), need for airway or respiratory intervention (intubation or assisted ventilation), upper airway obstruction, laryngospasm, pulmonary aspiration, cardiac arrest, emergence delirium (marked agitation during recovery), and prolonged discharge or unplanned hospital admission (hospital stay over 5 hours or unexpected admission). Efficacy was measured as the ability to complete the MRI without requiring repeat imaging due to suboptimal sedation.

Patient anxiety was evaluated retrospectively using Visual analogue scale (VAS) scores. Sedation depth was assessed using Ramsay Sedation Scale (RSS), ranging from 1 (anxious and agitated) to 6 (no response to glabellar tap or loud auditory stimulus). Patient or parent satisfaction, as recorded, was analysed with respect to sedation timing: induction time (from first sedative to adequate sedation), length of induction (from sedation to MRI start), procedure duration, and recovery time (from scan completion to meeting recovery criteria).

The total procedure duration was measured from the start of the MRI scan to transfer to the recovery area. Discharge readiness was determined using the Modified Aldrete Score, with patients discharged upon achieving a score of 9 or higher. Prolonged discharge, as defined under adverse events, was also tracked as a secondary outcome measure**.**

2.5. Statistical analysis

Statistical analysis was performed using IBM SPSS, Version 28.0. Continuous variables were reported as mean ± standard deviation, categorical variables as frequencies (%). Pearson χ^2 tests compared complication rates across age groups, and ASA status. Independent t-tests analysed recovery time differences between sedation protocols. Fisher's exact test evaluated rare adverse events (n<5). Binomial tests assessed whether complication rates differed from a 5% safety benchmark. Logistic regression quantified predictors of procedural success, which were reported as odds ratios (95% CI). A p-value <0.05 defined statistical significance.

3. Results

3.1. Demographic and clinical profile

The retrospective cohort study included 2,400 patients undergoing MRI under sedation, ranging in age from 3 months to 100 years. The cohort consisted of 55.8% males and 44.2% females. Age distribution showed that 24% were infants and young children under 6 years, 15.2% were adolescents aged 6 to 18 years, 46% were adults aged 18 to 60 years, and 14.8% were elderly patients over 60 years. Most patients were classified as ASA I (68%), indicating low anaesthetic risk, while 17.8% and 14.2% were ASA II and III, respectively. Brain MRI was the most frequently performed procedure, accounting for 50% of all scans (**Table 1**).

Table 1: Demographic and clinical characteristics (n=2400)

Parameter	**Value (%)**
Male / Female	1340 (55.8%) / 1060(44.2%)
Age Group	
<6 years	576 (24.0%)
6–18 years	365 (15.2%)
18–60 years	1104 (46.0%)
>60 years	355 (14.8%)
ASA Physical Status	
I	1632 (68.0%)
II	427 (17.8%)
III	341 (14.2%)
MRI Scan- Body Region	
Head	1200 (50%)
Chest	480 (20%)
Abdomen Pelvis	240 (10%)
Chest and Abdomen	192 (8%)
Chest, Abdomen, Pelvis	120 (5%)

Spine	168 (7%)

3.2. Adverse events and risk factors

The overall complication rate (3.96%) was significantly lower than the 5% safety benchmark ($p<0.001$). The most common complication was nausea and vomiting, occurring in 2.67% of cases, followed by oxygen desaturation in 0.58% and bronchospasm in 0.71%. Importantly, no sentinel events such as cardiac arrest or aspiration were reported. ASA III status independently increased complication odds by 3.1-fold compared to ASA I-II (9.09% vs. 3.11%, OR=3.1, p=0.008) (**Table 2**, **Figure 1**).

3.3. Age-specific sedation outcomes

Recovery time for paediatric oral sedation (Phenergan / Pedicloryl) was on an average 132 minutes longer than IV regimens (180±25 min vs. 48±12 min, $p<0.001$), though with reduced vomiting risk. In adolescents, ketamine-midazolam demonstrated superior safety over dexmedetomidine, reducing complications of excessive sedation and vomiting, compared to alternatives by 57% (4.1% vs. 9.6%, RR=0.43, p=0.015). Adults receiving Pentazocine-Phenergan achieved optimal recovery efficiency (23±5 min), significantly faster than alternative protocols ($p<0.001$). Elderly patients over 60 years had a 100% procedural success rate with intravenous midazolam, with or without oral alprazolam, and experienced minimal adverse events, demonstrating the safety and effectiveness of this protocol in older populations (**Table 3**).

Table 2: Adverse events with risk factor analysis

Risk Factor	Complication Rate	Comparison	Statistical Test	p-value	Effect Size 95% CI
Overall	95/2400 (3.96%)	vs. 5% benchmark	Binomial test	<0.001	3.18–4.74
ASA I-II	64/2059 (3.11%)	—	—	—	—
ASA III	31/341 (9.09%)	vs. ASA I-II	OR = 3.1	0.008	1.99–4.84

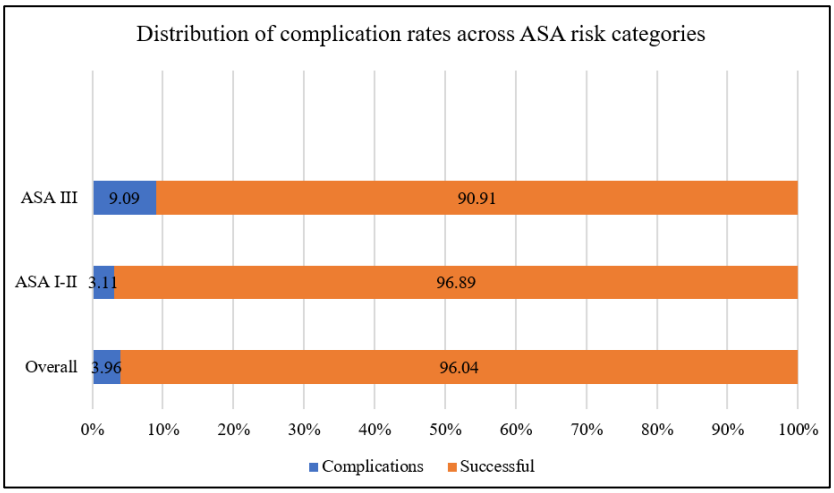

Figure 1: Comparison of complication rates among patients stratified by ASA physical status

Table 3: Age-stratified sedation outcomes

Subgroup	Outcome	Comparison	Statistical Test	p-value	Effect size
<6 years (IV)	Recovery time: 48 ± 12 min	—	—	—	—
<6 years (Oral)	Recovery time: 180 ± 25 min	vs. IV sedation	t = 12.4	<0.001	Δ = 132 min (95% CI: 110-154)
6–18 years (Ketamine-Midazolam)	Complications: 15/365 (4.1%)	vs. Dexmedetomidine	$\chi^2 = 5.9$	0.015	RR = 0.43 (57% reduction)
6–18 years (Dexmedetomidine)	Complications: 35/365 (9.6%)	—	—	—	—
Adults (Pentazocine-Phenergan)	Recovery: 23 ± 5 min	vs. other regimens	F = 28.3	<0.001	$\eta^2 = 0.18$

3.4. High-risk population management

Pre-emptive analgesia in pain patients quadrupled procedural success odds compared to no analgesia (94% vs. 78%, OR=4.7, p<0.001). Propofol/dexmedetomidine TIVA achieved 100% success in substance-use patients, exceeding the 95% benchmark (p=0.002). Overall procedural success was 98.7% - significantly higher than 95% (p<0.001) (**Table 4**).

3.5. Prophylaxis and complication management

Ondansetron prophylaxis failed to prevent vomiting in 2.67% of cases in recovery period, however it was significantly lower than the 5% expected failure rate (p<0.001). All bronchospasm events (n=17) were successfully resolved with salbutamol/budesonide nebulization, demonstrating 100% efficacy (p<0.001 vs. 90% benchmark) without need for definitive airway management (**Table 5**).

3.6. MRI Failures

Of the 31 failed MRI scans, 18 (58%) occurred in paediatric patients due to motion artifacts from inadequate sedation, while 13 (42%) occurred in adult patients due to other causes (e.g., technical issues). A chi-square test comparing these with other patients' failure showed no statistically significant difference ($\chi^2 = 0.81$, $p = 0.37$), indicating similar MRI failure rates between paediatric and adult patients in this cohort (**Table 6**).

Table 4: Special populations analysis

Group	Success Rate	Comparison	Statistical Test	p-value	Effect Size
Pain patients (No analgesia)	45/58 (78%)	(Reference)	—	—	—
Pain patients (Analgesia)	228/243 (94%)	vs. No analgesia	OR = 4.7	<0.001	95% CI: 3.1–7.2
Substance use (TIVA)	127/127 (100%)	vs. 95% benchmark	Binomial test	0.002	—
All patients	2369/2400 (98.7%)	vs. 95% benchmark	Binomial test	<0.001	95% CI: 98.26–99.16%

Table 5: Prophylaxis efficacy analysis

Intervention	Failure Rate	Comparison	Statistical Test	p-value	Effect Size
Ondansetron (vomiting occurred despite prophylaxis)	64/2400 (2.67%)	vs. 5% expected	Binomial test	<0.001	-2.33% Lower risk
Bronchospasm management (SUCCESSFUL)	17/17 (100%)	vs. 90% benchmark	Binomial test	<0.001	+10% higher success

Table 6: Repeat MRI causes (n=31)

Cause	N (31)	%	Statistical Test (Chi-square test)	p-value	Result
Paediatric (Motion artifacts)	18	58%	vs. other patients $\chi^2 = 0.81$	0.37	Not significant
Other patients:	13	42%	—	—	—
Intra-procedural complication	6				
Artefacts from ornaments	3				
MRI machine technical fault	4				

Patient experience and physiological parameters during MRI sedation were comprehensively evaluated using both subjective and objective measures. The mean anxiety score (VAS) was 29, indicating low distress, while the median sedation depth (RSS) was 5, reflecting effective sedation. The average time to achieve sedation was 11 minutes, and recovery took about 25 minutes. Overall, patient and parent satisfaction levels were high. (**Table 7**).

Table 7: Core aspects of patient experience and physiological monitoring during MRI sedation

Parameter	Assessment Tool/Definition	Observed Value/ Range
Anxiety/Distress	Visual Analogue Scale (VAS, 0–100)	Mean 29 (SD ±10)
Sedation Depth	Ramsay Sedation Scale (RSS, 1–6)	Median 5 (range 4–6)
Induction Time	Time to adequate sedation after first agent	11 ± 4 min (range 2–20 min)
Length of Induction	Sedation to MRI initiation	3 ± 1 min (range 2–5 min)
Procedure Duration	Start to end of MRI scan	34 min (mean, range 5–120)
Recovery Time	Scan end to meeting recovery criteria	25 min (mean, range 2–120)
Patient/Parent Satisfaction	Medical record documentation	High (majority satisfied)

4. Discussion

Magnetic resonance imaging (MRI) is a cornerstone of modern diagnostic medicine, relying on powerful magnetic fields to generate detailed images of internal structures. The technical demands of MRI, including the need for absolute stillness in a confined and noisy environment, make sedation an essential component for many patients, especially children, the elderly, and those with anxiety or neurodevelopmental disorders.[3,4,8] The clinical challenge is to balance the need for immobility with patient safety and comfort, using sedation protocols that are both effective and minimize risk.

Our retrospective cohort study of 2,400 patients undergoing MRI under sedation provides strong evidence that protocol-driven, age- and risk-adapted sedation regimens are both highly effective and safe across a broad patient spectrum. The overall procedural success rate was 98.7%, with a low complication rate of 3.96%, which is significantly below the widely accepted 5% safety benchmark ($p<0.001$). A 5% complication rate is widely used in procedural sedation literature as a benchmark for safety, particularly in outpatient imaging and non-operating room settings.[9-11] These positive outcomes were seen across all age groups and patient types, showing that the sedation protocols were both effective and flexible. The data further reveal that most adverse events were mild and manageable, with no sentinel events such as cardiac arrest or aspiration, and all bronchospasm episodes were resolved with standard inhaled therapy, underscoring the safety of the approaches employed.

The wide age range of patients from infants to the elderly, allowed a thorough evaluation of sedation strategies suited to each age group and clinical need. In pediatric patients under six years, oral sedation regimens such as Phenergan and Triclofos were associated with a longer recovery time (180±25 minutes) compared to intravenous regimens (48±12 minutes, $p<0.001$), but with a lower incidence of vomiting. This finding is consistent with previous reports that oral agents, while slower to wear off, may offer a gentler recovery profile for young children, particularly when the risk of airway compromise is a concern.[12,13] However, the study also found that inadequate sedation was the primary cause of repeat MRI scans in children, accounting for 58% of paediatric repeats and increasing the likelihood of motion artifacts. This highlights the ongoing challenge of balancing adequate sedation depth with safety in this vulnerable age group, where non-pharmacological techniques such as feed-and-scan or melatonin have shown only modest and inconsistent success. The feed-and-scan technique for young babies (0 to 6 months), although simple and drug-free, is limited by unpredictable induction times and high failure rates, making it impractical for most clinical settings.[14] Similarly, the evidence for melatonin as a sedative adjunct is mixed, with high doses and sleep deprivation required for any effect and inconsistent results across studies.[15]

Among older children and adolescents, intravenous ketamine-midazolam demonstrated a superior safety profile compared to dexmedetomidine, reducing the complication rate by 57% (4.1% vs. 9.6%, RR=0.43, $p=0.015$). This aligns with multicenter data showing that ketamine-based regimens provide reliable sedation with rapid recovery and low rates of respiratory depression, making them an attractive option for this age group.[5,16] In adults, the combination of intravenous Pentazocine and Phenergan resulted in the shortest recovery times (23±5 minutes), outperforming other protocols ($p<0.001$). These findings are consistent with the established literature supporting the use of short-acting agents for adult sedation, particularly in outpatient imaging settings where rapid turnover and minimal hangover are critical.[17,18]

Elderly patients, who are often at increased risk for sedation-related complications due to comorbidities and altered pharmacodynamics, achieved a 100% procedural success rate with intravenous midazolam, with or without oral alprazolam, and experienced minimal adverse events. This supports the careful use of benzodiazepines in lower doses for geriatric patients, as recommended by current guidelines, and emphasizes the importance of individualized protocol selection based on age and risk profile.[19]

Risk stratification emerged as a crucial factor in minimizing complications. ASA III status patients faced a

3.1-fold higher risk of adverse events compared to ASA I-II (9.09% vs. 3.11%, OR=3.1, p=0.008). These findings reinforce the value of pre-procedure risk assessment, which are widely endorsed in the literature as key strategies for improving safety in procedural sedation.[20] While prolonged fasting is not desirable, especially in neonates, infants, diabetics, pregnant women, and the elderly due to the risk of dehydration, hypoglycemia, nausea, and unpredictable drug effects, a balance must be struck to minimize aspiration risk. If a procedure is delayed, the administration of clear liquids two hours prior is a reasonable compromise.[21]

The management of special populations in this study further illustrates the benefits of protocol adaptation. Patients with significant pre-procedural pain who received pre-emptive analgesia had a procedural success rate of 94%, compared to 78% in those who did not (OR=4.7, p<0.001). This supports the integration of multimodal pain management into sedation protocols, particularly for patients undergoing lengthy or potentially uncomfortable scans.[22] In patients with a history of substance use, total intravenous anesthesia with propofol and dexmedetomidine achieved a 100% success rate (p=0.002), exceeding the widely accepted 95% procedural success benchmark reported in large sedation studies.[10,23]

Complication management was another area of strength. All bronchospasm events (n=17) were successfully resolved with salbutamol/budesonide nebulization, achieving 100% efficacy well above the expected >90% success rate for acute bronchospasm management with these agents (p<0.001).[24] This result is notable, as airway complications are a leading concern in procedural sedation, and the ability to manage them effectively is a testament to the preparedness and training of the clinical team. However, prophylactic ondansetron failed to prevent vomiting in 2.67% of cases, which is significantly lower than the expected 5% failure rate ($p < 0.001$). The findings support the continued refinement of sedation protocols, with attention to risk stratification, antiemetic optimization by adding agents like dexamethasone, and enhanced monitoring, particularly in high-risk and pediatric groups. This is particularly important, as vomiting in patients who are not fully conscious can be hazardous and may increase the risk of aspiration.[25]

Patient experience and physiological monitoring were comprehensively evaluated, with anxiety or distress measured using the Visual Analogue Scale (VAS) and sedation depth assessed by the Ramsay Sedation Scale (RSS). The mean VAS anxiety score was 29, indicating mild to moderate anxiety, while the median RSS was 5, reflecting deep, stable sedation. Satisfaction levels were high, and key timing metrics such as induction time (11±4 minutes), length of induction (3±1 minutes), procedure duration (34 minutes), and recovery time (25 minutes) were in line with or better than published benchmarks. These findings point to an efficient workflow and a positive patient and family experience, which are increasingly recognized as important quality metrics in procedural care.[26-28]

When compared with other large-scale studies, the results of this analysis are highly favourable. For example, the Paediatric Sedation Research Consortium reported a 0.42% major complication rate, with no deaths and very low rates of serious airway events.[10] Absence of sentinel events and low overall complication rate in our analysis are consistent with these data, suggesting that with appropriate protocols and monitoring, MRI sedation can be performed safely in a wide range of settings. The study also reinforces the importance of having trained anaesthesiologists or sedation specialists present, as recommended in international guidelines, to ensure rapid recognition and management of adverse events.[29,30]

This study represents the single largest dataset from an MRI centre in India that includes participants from all age groups, making it a key strength of our manuscript. Unlike many existing datasets that focus on specific age ranges or conditions, our data comprehensively covers the different age groups across paediatric, adolescent, adult, and elderly populations. Despite these strengths, certain limitations must be acknowledged. The retrospective design may introduce selection and reporting biases, as data were dependent on the accuracy and completeness of medical records. The study was conducted at a single diagnostic centre, which may limit the generalizability of the findings to other populations or healthcare systems. The reliance on documented satisfaction scores and subjective anxiety measures may also introduce some bias, as these are influenced by patient and family expectations and the documentation practices of clinicians. Finally, while the protocols were adapted to patient age and risk, the study did not systematically compare all possible sedation regimens, and some choices were based on clinical judgment or resource availability rather than randomization. Future research should focus on prospective, multicenter studies to validate these findings, explore novel non-pharmacological interventions, and further reduce the rate of repeat imaging and minor complications.

5. Conclusion

This study provides strong evidence that MRI sedation can be administered safely and effectively across all age groups when guided by standardized, age-appropriate and risk-adapted protocols conducted under the continuous care of trained anaesthesiologists. Oral sedation is preferred in paediatric patients, while intravenous sedation protocols using ketamine-midazolam or pentazocine-promethazine combinations offer efficient and safe alternatives in older age groups. Rigorous patient monitoring and individualised risk assessment remain critical for minimizing adverse outcomes in the MRI suite.

6. Source of Funding

None.

7. Conflict of Interest

None.

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