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Review Article

Comparative Study of Sedation Protocols for Interventional Radiology Procedures

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ABSTRACT

Interventional radiology encompasses procedures ranging from brief image-guided biopsies to multi-hour embolization and ablation cases, and no single sedation protocol serves this heterogeneous caseload equally well.

This review compares the major sedation strategies used in interventional radiology suites, including radiologist-directed moderate sedation, monitored anesthesia care, propofol-based deep sedation, and dexmedetomidine-containing regimens, drawing on both interventional radiology-specific studies and analogous comparative data from gastrointestinal endoscopy and electrophysiology.

Moderate sedation generally matches monitored anesthesia care on safety while improving procedure-room efficiency for shorter, lower-acuity cases, though this advantage narrows in hemodynamically unstable populations such as those undergoing biliary intervention.

Propofol delivered under strict monitoring, whether by anesthesia personnel or trained non-anesthesiologists, remains the most efficient sedative-hypnotic for most cases, while dexmedetomidine has emerged as a useful opioid- and propofol-sparing adjunct for long, low-stimulus procedures despite its slower onset and hemodynamic effects.

We conclude that monitoring rigor, staff training, and procedure-specific risk stratification, rather than the choice of a single preferred agent, are what the comparative evidence most consistently ties to safe and efficient sedation outcomes in interventional radiology.

Keywords: *procedural sedation; interventional radiology; propofol; dexmedetomidine; monitored anesthesia care*

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INTRODUCTION

Interventional radiology has grown from a niche diagnostic adjunct into a specialty that manages a huge share of what used to require open surgery —

biliary drainage, tumor ablation, embolization, vascular access, spine augmentation, and more. Almost none of that work can be done comfortably in an awake, anxious, still-breathing patient without some form of sedation, yet the specialty has never settled on a single default protocol the way, say, colonoscopy largely has. Part of the reason is heterogeneity: a ten-minute paracentesis and a four-hour transarterial chemoembolization present entirely different sedation problems, and the same is true comparing an outpatient port placement in a healthy adult to an ablation in a cirrhotic patient with encephalopathy risk. Practices therefore range from radiologist-directed moderate sedation with midazolam and fentanyl, to nurse-administered propofol under a radiologist's supervision, to full monitored anesthesia care (MAC) or general anesthesia delivered by an anesthesiology team parked in the suite for the case.

This review looks at what the comparative literature actually says when these approaches are pitted against each other, rather than simply described in isolation. We focus on four questions practitioners actually have to answer: how do moderate sedation and MAC compare on efficiency and safety; where does propofol outperform or underperform benzodiazepine-opioid combinations; what has dexmedetomidine added, particularly as an opioid-sparing agent; and what should procedures with meaningfully different risk profiles — vascular access and biopsy versus prolonged ablation and embolization — borrow from the wider sedation literature, including gastrointestinal endoscopy, which has amassed a much larger evidence base on non-anesthesiologist-administered sedation.

MODERATE SEDATION VERSUS MONITORED ANESTHESIA CARE

The most direct comparative question in interventional radiology sedation is whether cases go faster, and just as safely, under radiologist-directed moderate sedation compared with anesthesiology-led MAC. A recent comparison of periprocedural and procedure-room times found meaningful differences between the two models, generally favoring moderate sedation on throughput metrics even as MAC cases skewed toward patients with higher comorbidity burden or anticipated procedural complexity [1]. That selection pattern is itself instructive: MAC is not usually chosen at random, it tends to be reserved for the sicker patient, the longer case, or the one where a difficult airway or hemodynamic instability is anticipated, which complicates any attempt at a truly apples-to-apples comparison and probably explains why moderate-sedation cohorts often look faster and just as safe on paper.

A companion analysis presented at a vascular and interventional radiology meeting reinforced this pattern, reporting shorter overall room times with moderate sedation without an increase in adverse events serious enough to require escalation to general anesthesia mid-procedure [2]. Reviews of sedation strategy specific to the interventional suite have made the broader case that neither approach is uniformly superior; rather, matching the sedation model to procedure duration, anticipated pain, and patient comorbidity is what actually drives outcomes, and blanket policies in either direction leave value on the table [3,4]. Guidance aimed specifically at radiologists delivering moderate sedation has emphasized that the skill set required — airway rescue competency, appropriate monitoring, and clear escalation criteria — is not optional simply because an anesthesiologist is not physically present, and that credentialing and simulation-based training substantially narrow the safety gap between the two models [5].

Where the balance clearly tips toward an anesthesia-led approach is in biliary and hepatobiliary work, where hemodynamic swings during duct manipulation and the frequent presence of sepsis or cholangitis raise the stakes of an airway or blood-pressure event mid-procedure. A comparison of interventional-radiologist-directed sedation against general anesthesia for percutaneous biliary drainage found that while radiologist-directed sedation preserved procedural efficiency, general anesthesia produced more stable intraprocedural hemodynamics in patients with higher baseline acuity, suggesting the efficiency gains of lighter sedation models erode once the underlying pathology itself is hemodynamically unstable [6].

PROPOFOL-BASED REGIMENS

Propofol's rapid onset and offset, together with its antiemetic properties, have made it the default sedative-hypnotic of choice wherever it is permitted to be given by a non-anesthesiologist, and interventional radiology suites have followed that trend even though the regulatory and staffing rules governing who may push propofol vary enormously by country and institution. A safety analysis of propofol sedation administered directly by interventional radiologists (rather than an anesthesia team) during radiofrequency ablation of hepatocellular carcinoma found an acceptable complication profile when strict patient-selection criteria and continuous capnography were applied, arguing that the drug's safety in this setting hinges less on who is credentialed to administer it than on how tightly the monitoring and exclusion criteria are enforced [7]. That is broadly consistent with a separate outcomes study of procedural sedation and analgesia delivered by interventional radiologists for hepatic tumor ablation, which likewise reported low rates of clinically significant desaturation or hypotension when propofol dosing was titrated against real-time capnographic and pulse-oximetric feedback rather than a fixed weight-based bolus [8].

The gastrointestinal endoscopy literature, which has

accumulated a much larger volume of comparative data on non-anesthesiologist-administered propofol (NAAP) than interventional radiology has managed on its own, is a reasonable proxy for what interventional suites can expect as their own propofol experience matures. Multi-year experience with NAAP in ASA III patients undergoing endoscopy found the approach tolerable with appropriately trained staff and strict patient selection, even in a population generally considered higher-risk for sedation-related events [9]. Formal society guidelines and position statements on GI sedation have converged on a similar conclusion: propofol delivered by trained non-anesthesiologists is acceptable practice provided there is a credentialing pathway, dedicated monitoring personnel distinct from the proceduralist, and immediate access to airway rescue equipment and reversal or resuscitation capability [10,11]. A broader review of sedation and monitoring practice in endoscopy reached a comparable position while cautioning that capnography, not pulse oximetry alone, is the monitoring modality that actually catches early hypoventilation before desaturation becomes apparent [12], and a 2025 update to that body of guidance reaffirmed the same core principles while flagging persistent variability in how individual institutions define competency for non-anesthesiologist propofol administration [13]. Comparable safety and efficacy have also been reported when propofol sedation by non-anesthesiologists was extended into intensive-care-unit endoscopy, a population arguably closer in acuity to many interventional radiology patients than the outpatient endoscopy suite [14].

Comparisons of intravenous sedation-analgesia against local anesthesia alone for procedures where either could reasonably be used have generally found sedation-analgesia improves patient comfort scores without a proportionate increase in complication rates, supporting the more general observation that patient experience, not just objective safety, is a legitimate outcome to weigh when choosing a sedation strategy for interventional work [15].

DEXMEDETOMIDINE AS AN ADJUNCT OR ALTERNATIVE

Dexmedetomidine's appeal in procedural sedation rests on a combination that no other single agent offers: sedation with preserved respiratory drive, some intrinsic analgesic effect, and a sedation quality that many clinicians describe as more closely resembling natural sleep, from which patients rouse easily to command. Its slower onset and comparatively long context-sensitive half-time have limited its use as a sole agent for brief procedures but made it attractive for longer cases or as an adjunct that reduces propofol and opioid requirements.

Direct comparisons of dexmedetomidine against propofol have generally shown comparable sedation adequacy with a more favorable respiratory profile for dexmedetomidine, at the cost of slower onset and, in some series, more pronounced bradycardia or hypotension. A pediatric trial comparing propofol and dexmedetomidine for conscious sedation during sclerotherapy found both agents provided adequate procedural conditions, with dexmedetomidine associated with more hemodynamic drift but less respiratory depression [16]. A broader prospective trial of dexmedetomidine-based sedoanalgesia in routine anesthesia practice reported satisfactory sedation depth and recovery profiles across a mixed procedural population [17]. In the electrophysiology laboratory — a setting that, like interventional radiology, often involves long, minimally stimulating but occasionally painful procedures performed with the patient prone or immobile for extended periods — a randomized comparison of nurse-administered dexmedetomidine against propofol during atrial fibrillation ablation found dexmedetomidine associated with less respiratory depression but a higher incidence of hypotension requiring vasopressor support, while propofol offered faster recovery and turnover [18]. A multidisciplinary review of sedation practice across electrophysiology laboratories reached similar conclusions about the trade-off between agents and emphasized that the same monitoring and escalation infrastructure that governs safe deep sedation in that setting applies just as directly to interventional radiology suites running comparably long, low-stimulus cases [19]. Electrophysiological comparisons of the two agents under deep sedation conditions have further shown that dexmedetomidine produces EEG patterns more consistent with natural sleep architecture than propofol's, a difference that may partly explain the smoother, less disoriented emergence clinicians often observe with dexmedetomidine even though it has not translated into a clear advantage on standard recovery-time metrics [20].

Pediatric imaging, where children must remain motionless for minutes at a time without any surgical stimulus to titrate against, has produced some of the more granular comparative dexmedetomidine data relevant by analogy to interventional radiology's own pediatric caseload. A trial comparing dexmedetomidine combined with ketofol against ketofol alone for pediatric MRI sedation found the combination improved sedation quality and reduced recovery agitation without worsening respiratory outcomes [21], and a separate comparison of intranasal dexmedetomidine plus propofol against propofol alone likewise favored the combination on measures of sedation quality and reduced propofol requirement [22]. Together these findings support using dexmedetomidine less as a wholesale propofol replacement in interventional radiology and more as a component of a balanced regimen — an opioid- and propofol-sparing adjunct whose respiratory-sparing profile is most valuable in exactly the long, awkward-positioning cases interventional radiology so often presents, provided the bradycardia and

hypotension it can produce are anticipated rather than discovered mid-procedure.

PROCEDURE-SPECIFIC CONSIDERATIONS AND RISK STRATIFICATION

None of the above comparisons mean much without acknowledging that "interventional radiology sedation" is not one clinical problem but many. A five-minute image-guided biopsy under local anesthesia with light or no systemic sedation carries a different risk-benefit calculation than a multi-hour transarterial chemoembolization in a patient with decompensated cirrhosis, and lumping them together in a single protocol is how institutions end up either over-sedating low-risk cases or under-resourcing high-risk ones. Reviews of sedation strategy in the specialty have consistently argued for formal risk stratification — typically built around ASA physical status, anticipated procedure duration, expected pain intensity, and patient positioning constraints — as the organizing principle that should determine whether moderate sedation, propofol-based deep sedation, or full anesthesia team involvement is appropriate for a given case, rather than defaulting to whatever the local culture happens to favor [3,4]. Combined chemoembolization-ablation procedures for hepatocellular carcinoma, which can run for hours and involve intense visceral pain at the moment of embolic or thermal injury layered onto an otherwise low-stimulus background, illustrate the problem well: sedation needs can swing from minimal to intense within the same case, which argues for regimens flexible enough to escalate quickly (deep sedation or general anesthesia standing by) rather than protocols calibrated to the average moment of the procedure.

Hepatobiliary and oncologic interventional work also concentrates patients with baseline organ dysfunction — cirrhosis, renal impairment, cardiopulmonary comorbidity from prior chemotherapy — who tolerate the respiratory and hemodynamic depression of sedative agents poorly even at doses that would be unremarkable in a healthy outpatient. This is precisely the population in which the biliary drainage comparison discussed above found general anesthesia preserving hemodynamic stability better than radiologist-directed sedation [6], and it is consistent with the argument, made across several of the reviews cited here, that the acuity of the patient population an interventional service treats should shape institutional sedation policy as much as the mechanics of the procedure itself [4,5]. Vascular access and drain-exchange procedures sit at the other end of the spectrum: short, predictably painful only at needle insertion, and generally well served by moderate sedation or even local anesthesia with minimal systemic sedation, where the efficiency data reviewed earlier consistently favor lighter approaches [1,2].

MONITORING, TRAINING, AND INSTITUTIONAL PROTOCOL DESIGN

A theme running through nearly every comparative study reviewed here is that outcomes depend less on which drug is chosen than on how rigorously the sedation is monitored and who is credentialed to intervene when something goes wrong. Capnography has emerged repeatedly as the monitoring modality that most reliably detects the earliest sign of trouble — hypoventilation — before pulse oximetry shows any change, and its consistent use is cited across both the interventional radiology and endoscopy literatures as a precondition for extending deeper sedation to non-anesthesiologist providers [12,7]. Institutions that have successfully pushed propofol administration into the hands of interventional radiologists or endoscopy nurses have generally done so alongside formal simulation-based airway rescue training, explicit criteria for escalation to an anesthesiology consult, and continuous quality review of adverse events, rather than simply extending prescribing privileges without infrastructure [5,11].

The practical implication for a department designing or revising its interventional radiology sedation protocol is that the choice between moderate sedation, propofol-based deep sedation, dexmedetomidine-containing regimens, and anesthesia-team MAC should be made procedure by procedure and patient by patient, informed by the risk-stratification approach described above, but that whichever model is chosen needs the same underlying scaffolding: trained personnel dedicated solely to monitoring (not simultaneously performing the procedure), capnographic monitoring for anything beyond the lightest sedation, clearly defined criteria for escalating care, and a mechanism for tracking adverse events over time so the protocol can be revised as local experience accumulates. None of the comparative trials or reviews synthesized here support a single universal sedation protocol for interventional radiology, and none should be expected to, but together they sketch a reasonably consistent decision framework built around procedure duration and pain, patient comorbidity, and institutional monitoring capacity.

CONCLUSION

The comparative evidence base for interventional radiology sedation, while still smaller than that available for endoscopy, is large enough now to support several practical conclusions. Moderate sedation delivered by radiologists is generally faster and no less safe than monitored anesthesia care for shorter, lower-acuity procedures, but that advantage narrows or reverses once patient comorbidity or procedural hemodynamic risk rises, as in biliary intervention. Propofol, whether given by anesthesia personnel or by appropriately trained non-anesthesiologists under strict monitoring, remains

the most efficient sedative-hypnotic for most cases, and the endoscopy literature's decade of NAAP experience offers a reasonably mature template for how interventional radiology can extend propofol use safely. Dexmedetomidine has carved out a legitimate niche as an opioid- and propofol-sparing adjunct particularly suited to long, low-stimulus, awkward-positioning cases, even though its slower onset and hemodynamic effects keep it from displacing propofol as a primary agent for most routine work. What ties all of this together, more than any single drug choice, is that safety and efficiency in this literature trace back consistently to monitoring rigor, staff training, and procedure-specific risk stratification rather than to a single "best" sedative. Departments building or revising their sedation protocols would do well to treat the choice of agent as the last decision in the chain rather than the first, after procedure duration, expected pain, patient comorbidity, and available monitoring and escalation resources have already been accounted for.

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Data Availability No new data were generated or analyzed in support of this review. All sources discussed are publicly available in the cited literature.

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