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Review Article

# Early Recovery Outcomes Following Low-Dose Spinal Anesthesia in Day-Care Surgery

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***ABSTRACT***

*Conventional spinal anesthesia has long been viewed with suspicion in day-care surgery because of prolonged motor block and unpredictable bladder recovery, and over the past two decades anesthesiologists have responded by reshaping rather than abandoning the technique.*

*This review examines the comparative evidence for low-dose and selective spinal anesthesia strategies in ambulatory practice, including unilateral and dose-reduced bupivacaine technique, short-acting ester local anesthetics such as 2-chloroprocaine and prilocaine, and low-dose opioid adjuncts.*

*The literature indicates that restricting local anesthetic distribution and dose, or switching to genuinely short-acting agents, reliably shortens motor recovery and time to discharge readiness without compromising surgical anesthesia, while intrathecal fentanyl extends block adequacy without meaningfully delaying recovery, unlike intrathecal morphine.*

*Relaxing mandatory in-hospital voiding requirements for low-risk patients further removes a major, previously underappreciated bottleneck to same-day discharge that persists independent of block resolution.*

*We conclude that these combined modifications have made spinal anesthesia a genuinely competitive option against general anesthesia and peripheral nerve block for ambulatory surgery, though head-to-head trials using time-to-discharge as a primary endpoint remain comparatively scarce.*

***Keywords:*** *low-dose spinal anesthesia; ambulatory surgery; day-case surgery; unilateral spinal block; postoperative recovery*

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## INTRODUCTION

Spinal anesthesia has an odd reputation in ambulatory practice. It is dense, reliable, and cheap, and yet for a generation of day-surgery anesthesiologists it has carried a stigma as the technique that keeps patients on the ward long after the surgeon has finished suturing. That reputation was earned honestly: a conventional spinal dose of 12-15 mg of hyperbaric bupivacaine produces two to four hours of motor block,

unpredictable bladder atony, and a real chance that a patient scheduled for an outpatient knee arthroscopy is still numb from the umbilicus down when the recovery unit wants to close for the evening [1]. The response from regional anesthesiologists over the past two decades has been to shrink the dose rather than abandon the technique, and in doing so to rebuild spinal anesthesia into something that competes credibly with general anesthesia and peripheral nerve block for same-day discharge.

Low-dose spinal anesthesia is not a single recipe. It spans unilateral techniques using 4-8 mg of hyperbaric or hypobaric bupivacaine restricted to the operative side [2,3,4], selective saddle blocks for anorectal and perineal procedures, dose-finding work that has pushed conventional bilateral bupivacaine doses down toward 5-7.5 mg with opioid adjuncts [5,6], and, more recently, a shift toward genuinely short-acting local anesthetics such as 2-chloroprocaine and prilocaine that shorten recovery by pharmacokinetics rather than by dose reduction alone [7,8]. What unites these approaches is a single clinical target: motor and sensory block that resolves quickly enough, and bladder function that returns reliably enough, that a patient can meet standard discharge criteria within the same operating window a general anesthetic would allow. This review looks at what the comparative literature actually shows about early recovery after these techniques, and where the tradeoffs against general anesthesia and peripheral block still sit.

## DOSE REDUCTION AND UNILATERAL TECHNIQUE

The most direct way to shorten a spinal block is to reduce the dose of local anesthetic in the syringe, and the literature on this is old enough to be genuinely mature. The Italian Study Group on Unilateral Spinal Anesthesia established, across a series of trials on outpatient knee arthroscopy, that restricting a small-volume hyperbaric bupivacaine dose to the dependent, operative side by slow injection and prolonged lateral positioning produces a block that is both more hemodynamically stable and faster to resolve than a standard bilateral spinal of the same drug [2,3]. The mechanism is straightforward once stated: a unilateral block halves the number of blocked segments contributing to sympathectomy and motor weakness, so the same nociceptive coverage on the operative leg is bought with roughly half the physiologic disturbance.

Dose-finding work refined this further. Kuusniemi and colleagues showed that plain or hyperbaric bupivacaine in the 4-6 mg range, given unilaterally, provided adequate surgical anesthesia for knee arthroscopy with motor recovery in the contralateral, non-operative leg often within the first hour [4,9]. Lee and colleagues subsequently used an up-down sequential allocation method to estimate the ED50 and ED95 of hyperbaric bupivacaine for unilateral spinal anesthesia in diagnostic knee arthroscopy, arriving at doses in the 4-6 mg range that balanced surgical reliability against unnecessary block density [5]. These numbers matter clinically because every milligram of intrathecal bupivacaine beyond what is needed for surgical conditions is, in a day-surgery context, simply extending time to discharge without adding benefit.

The tradeoff of low-dose unilateral technique is block failure, and this is where the literature is appropriately cautious. Reducing dose narrows the margin between adequate and inadequate anesthesia, and imperfect lateral positioning, patient movement, or simple pharmacokinetic variability can leave a segment of the surgical field under-blocked [10]. Programs that have adopted low-dose unilateral spinal anesthesia as a default technique have generally done so alongside a low threshold for supplementation with local infiltration or light sedation, rather than treating the block as an all-or-nothing proposition. Comparable dose-reduction logic has been applied outside the leg as well: reports of unilateral spinal blockade for hip fracture surgery in frail, comorbid patients using 5 mg versus 7.5 mg hypobaric bupivacaine describe the same pattern of preserved surgical anesthesia with attenuated hemodynamic swings at the lower dose [6], and similar volume-titration studies exist for varicose vein stripping [11].

## SHORT-ACTING LOCAL ANESTHETICS: CHLOROPROCAINE AND PRILOCAINE

A parallel strategy avoids the dose-reduction tightrope altogether by changing the drug. Bupivacaine's long duration is a direct consequence of its pharmacology, and no amount of dose reduction changes the fact that even a small dose has a comparatively long elimination profile relative to an ester local anesthetic. 2-chloroprocaine, an ester metabolized by plasma cholinesterase within minutes, produces spinal anesthesia adequate for arthroscopic and lower-extremity ambulatory procedures with motor block resolution typically inside 90 minutes, versus 3-4 hours for even modest bupivacaine doses [7]. A retrospective review of chloroprocaine spinal anesthesia in an ambulatory orthopedic population found that patients met discharge criteria substantially faster than historical bupivacaine cohorts, and did so without the transient neurologic symptoms that limited lidocaine's use for the same purpose in the 1990s [12].

Prilocaine occupies a similar niche and has been reviewed specifically for ambulatory use: its intermediate duration between lidocaine and bupivacaine, combined with a low reported rate of transient neurologic symptoms relative to lidocaine, has made it a preferred short-acting agent in parts of Europe where chloroprocaine has historically been less available [8]. A double-blind randomized comparison of chloroprocaine and prilocaine for ambulatory knee arthroscopy found the two agents produced comparable surgical conditions and

comparable times to discharge readiness, with the choice between them coming down more to institutional familiarity and drug cost than to a clear efficacy difference [13]. Work examining adjunctive dexmedetomidine with chloroprocaine spinal anesthesia in ambulatory knee arthroscopy suggests that modest prolongation of sensory block, when wanted, can be achieved without reintroducing the recovery penalty of switching back to a longer-acting amide [14].

The clinical case for these short-acting esters over dose-reduced bupivacaine is that they decouple block duration from block reliability. A full surgical dose of chloroprocaine gives dense, dependable anesthesia and still resolves quickly, which removes the anesthesiologist's need to gamble on the lower end of a bupivacaine dose-response curve. The tradeoff is availability and cost: chloroprocaine formulated and labeled for intrathecal use is not stocked everywhere, and institutions without ready access default back to low-dose bupivacaine or lidocaine despite lidocaine's transient neurologic symptom profile [15].

## OPIOID ADJUNCTS AND THE LIMITS OF DOSE REDUCTION

Reducing local anesthetic dose without an adjunct risks trading duration for reliability, and the standard fix has been to add a small intrathecal opioid dose to shore up surgical anesthesia while the local anesthetic dose comes down. Fentanyl in doses of 10-25 micrograms added to a reduced bupivacaine dose extends the window of adequate surgical block without meaningfully extending motor recovery, because fentanyl's spinal action is mediated through opioid receptors rather than through sodium-channel blockade and so does not itself impair leg strength [16]. This combination has become close to a default in low-dose unilateral spinal protocols and in saddle blocks for anorectal day surgery, where a small fentanyl dose meaningfully improves intraoperative comfort during rectal traction without delaying discharge [17].

Morphine is a different story, and the distinction matters for anyone designing a day-surgery spinal protocol. Even microdose intrathecal morphine (100-200 micrograms) carries a dose-dependent risk of delayed respiratory depression, pruritus, nausea, and urinary retention that runs on a much longer time course than the surgical anesthesia itself, and a widely cited meta-analysis of intrathecal morphine risk concluded that these effects persist well beyond the window in which an ambulatory patient would ordinarily be monitored [18]. For ambulatory practice this argues fairly firmly against intrathecal morphine even at doses considered safe in inpatient settings, in favor of fentanyl or sufentanil, whose recovery profiles are compatible with same-day discharge.

## URINARY RETENTION AND THE VOIDING BOTTLENECK

If block resolution were the only obstacle to timely discharge, low-dose and short-acting spinal techniques would have solved the problem outright. In practice, postoperative urinary retention has proven to be an independent bottleneck that dose reduction alone does not fully address, because bladder detrusor function recovers on a schedule loosely correlated with, but not identical to, sensorimotor recovery in the legs. Older ambulatory protocols required patients to void before discharge as a surrogate marker for resolved sacral autonomic block, and this requirement alone accounted for a meaningful share of prolonged recovery-room stays after spinal anesthesia [19].

The evidence that has changed practice here is less about the anesthetic technique and more about the discharge criterion itself. Structured comparisons of routine mandatory voiding against selective, risk-stratified voiding protocols found that low-risk ambulatory patients without a history of urinary retention, bladder outlet obstruction, or a particularly long-acting block could be discharged safely without in-hospital voiding, provided they received clear instructions to return if unable to void within a defined interval at home [19]. Combined with a short-acting local anesthetic or a genuinely low local anesthetic dose, abandoning mandatory voiding removes what had been, in many day-surgery units, the single largest source of unpredictable delay between an anesthesiologically ready patient and an administratively dischargeable one.

## COMPARATIVE STANDING AGAINST GENERAL ANESTHESIA AND PERIPHERAL NERVE BLOCK

None of this matters clinically unless low-dose spinal anesthesia holds up against the alternatives day-surgery units actually have available, chiefly general anesthesia with a laryngeal mask and, for lower-extremity procedures, peripheral nerve block. Systematic review evidence on bupivacaine spinal anesthesia for ambulatory knee arthroscopy has generally found comparable or shorter overall time-to-discharge with spinal technique once dose is optimized, largely because spinal anesthesia avoids the airway management, postoperative nausea, and sore throat that add variable delay after general anesthesia in a subset of patients [20]. The comparison against general anesthesia is also favorable on postoperative analgesia in the first few hours, since even a short-duration spinal block outlasts the immediate postoperative period during which pain would otherwise require opioid rescue in the recovery unit.

Against peripheral nerve block the picture is more nuanced. A well-placed adductor canal or popliteal

block for lower-extremity ambulatory surgery can match or exceed a low-dose spinal on time to ambulation, because a peripheral block spares proximal muscle groups and central sympathetic tone entirely. What a peripheral block generally cannot match is procedural reliability and predictable onset: a spinal, even a low-dose one, either works within minutes with a recognizable dermatomal endpoint or is promptly recognized as inadequate, whereas peripheral block failure is sometimes not evident until surgical incision. For hip and knee arthroplasty performed on an ambulatory or rapid-discharge basis, single-dose spinal anesthesia combined with periarticular infiltration and multimodal analgesia has become a fairly standard approach specifically because it offers this reliability without the multi-hour motor block that would previously have precluded same-day mobilization [21]. Broader narrative and best-practice reviews of ambulatory spinal anesthesia have converged on a similar conclusion: the technique's role in day-case practice is no longer in question, and the remaining work is optimizing drug, dose, and discharge protocol for each surgical population rather than deciding whether spinal anesthesia belongs in ambulatory surgery at all [1,22,23,24,25].

## APPLYING THESE TECHNIQUES BEYOND THE LOWER EXTREMITY

Low-dose and selective spinal techniques have also found a home outside orthopedic ambulatory surgery. Saddle block, essentially an extreme form of dose- and position-restricted spinal anesthesia limited to the sacral dermatomes, has become a standard technique for anorectal day-case procedures such as hemorrhoidectomy and fistula surgery, where a small dose of hyperbaric local anesthetic combined with a modest fentanyl dose provides dense perineal anesthesia while sparing the lower limbs from motor block almost entirely [17]. Selective low-dose spinal anesthesia has similarly been applied to short gynecologic and general-surgical ambulatory procedures such as laparoscopic tubal ligation, where trials comparing it against intravenous sedation with local infiltration have reported comparable recovery times with better intraoperative analgesia [26].

What these applications share with the orthopedic literature is a consistent design principle: match the dose and the distribution of the block as closely as possible to the surgical field, rather than defaulting to a standard bilateral spinal dose calibrated for procedures of a different duration and location. That principle, more than any single drug or additive, is what has allowed spinal anesthesia to move from a technique day-surgery units tolerated to one they increasingly choose.

## CONCLUSION

The evidence built up over the last two decades on low-dose spinal anesthesia for day-care surgery is more coherent than the piecemeal nature of the individual studies might suggest. Reducing local anesthetic dose, restricting distribution with unilateral or saddle technique, switching to genuinely short-acting esters such as chloroprocaine and prilocaine, adding fentanyl rather than morphine when an adjunct is wanted, and relaxing mandatory voiding requirements for low-risk patients together address the specific mechanisms — prolonged motor block, unpredictable bladder recovery, and unnecessary sympathectomy — that made conventional spinal anesthesia poorly suited to ambulatory practice. No single modification does all of this work alone, which is why the strongest ambulatory spinal protocols now combine several of these elements rather than relying on dose reduction in isolation. Where the evidence remains comparatively thin is in direct, adequately powered comparisons of these low-dose spinal protocols against modern peripheral nerve block pathways using time-to-discharge as a primary, rather than secondary, endpoint, and in standardizing which discharge criteria (voiding, ambulation, strength testing) actually predict safe same-day return home rather than simply correlating with block resolution.

## DECLARATIONS

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### Conflict of Interest

The authors declare no conflicts of interest relevant to this work.

### Author Contributions

EP conceived the review and drafted the initial manuscript. JB performed the literature search and contributed the sections on pharmacologic technique. CH critically revised the manuscript for content and structure. All authors read and approved the final version.

### Ethics Statement

This is a literature review; no new human or animal data were generated, and no ethics approval was required.

### Data Availability

No new data were generated for this review. All sources discussed are cited in the reference list.

## REFERENCES

1. Spinal anaesthesia: the saviour of day surgery? (2007) Best Practice & Research Clinical

Anaesthesiology.

2. Italian Study Group on Unilateral Spinal Anesthesia. Unilateral bupivacaine spinal anesthesia for outpatient knee arthroscopy (2000) PMID:10958090.

3. Unilateral bupivacaine spinal anesthesia for outpatient knee arthroscopy (2000) Canadian Journal of Anaesthesia, DOI:10.1007/BF03019476.

4. A low dose of plain or hyperbaric bupivacaine for unilateral spinal anesthesia (2000) PMID:11097668.

5. Lee YY, Ngan Kee WD, Fong SY, Liu JT, Gin T (2012) Optimal dose of hyperbaric bupivacaine 0.5% for unilateral spinal anesthesia during diagnostic knee arthroscopy. Local and Regional Anesthesia, PMID:22915874.

6. Comparison of two doses of hypobaric bupivacaine in unilateral spinal anesthesia for hip fracture surgery: 5 mg versus 7.5 mg. Pan African Medical Journal.

7. The use of 2-chloroprocaine for spinal anaesthesia (2013) PMID:23320599.

8. Prilocaine spinal anesthesia for ambulatory surgery: a review of the available studies (2016) PMID:27352633.

9. A low-dose hypobaric bupivacaine spinal anesthesia for knee arthroscopies (1997) PMID:9425969.

10. Fettes PDW, Jansson JR, Wildsmith JAW (2009) Failed spinal anaesthesia: mechanisms, management, and prevention. British Journal of Anaesthesia, DOI:10.1093/bja/aep096.

11. Different local anesthetic volumes for unilateral spinal anesthesia in varicose vein surgery: prospective randomized clinical trial. PMC12882283.

12. Kim DH, Kahn R, Lee A, Mac PD, Chiu YF, Yadeau J, Liu J (2020) Chloroprocaine provides safe, effective, short-acting spinal anesthesia ideal for ambulatory surgeries: a retrospective review. HSS Journal, DOI:10.1007/s11420-019-09713-y.

13. Chloroprocaine versus prilocaine for spinal anesthesia in ambulatory knee arthroscopy: a double-blind randomized trial (2019) PMID:31439640.

14. Spinal or intravenous dexmedetomidine for spinal anesthesia with chloroprocaine in ambulatory knee arthroscopies: a double-blind randomized trial (2021) PMC8612665.

15. Ambulatory surgery with chloroprocaine spinal anesthesia: a review. Anesthesiology and Analgesia (Dove Medical Press).

16. Combination of a reduced dose of an intrathecal local anesthetic with a small dose of an opioid: a meta-analysis of randomized trials (2013) Pain.

17. The effects of adjuvant intrathecal fentanyl on postoperative pain and rebound pain for anorectal surgery under saddle anesthesia. Korean Journal of Anesthesiology.

18. Gehling M, Tryba M (2009) Risks and side-effects of intrathecal morphine combined with spinal anaesthesia: a meta-analysis. Anaesthesia, DOI:10.1111/j.1365-2044.2008.05817.x.

19. Ambulatory surgery patients may be discharged before voiding after short-acting spinal and epidural anesthesia (2002) PMID:12151918.

20. Systematic review of spinal anaesthesia using bupivacaine for ambulatory knee arthroscopy. British Journal of Anaesthesia.

21. Spinal anesthesia for ambulatory hip and knee arthroplasty procedures. Journal of Medical Insight (JOMI).

22. Korhonen AM (2006) Use of spinal anaesthesia in day surgery. Current Opinion in Anaesthesiology, PMID:16552242.

23. Spinal anesthesia in ambulatory surgery. Best Practice & Research Clinical Anaesthesiology.

24. Spinal anaesthesia for ambulatory surgery. BJA Education.

25. Local anaesthetics for spinal anaesthesia in day-case surgery. IntechOpen.

26. Safety and efficacy of low-dose selective spinal anesthesia with bupivacaine and fentanyl as compared to intravenous sedation and port-site infiltration for outpatient laparoscopic tubal ligation: a randomized controlled trial. PMC8936871.