Medical Principles and Practice

Med Princ Pract , DOI: 10.1159/000552326
Received: September 20, 2025
Accepted: April 28, 2026
Published online: May 4, 2026

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ISSN: 1011-7571 (Print), eISSN: 1423-0151 (Online)
https://www.karger.com/MPP
Medical Principles and Practice

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Retracted Article

Comparing Spinal and General Anesthesia for prone Percutaneous Nephrolithotomy: A Propensity Score-Matched Study

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Running Title: Spinal vs. General Anesthesia for PCNL

Keywords: General Anesthesia • Percutaneous Nephrolithotomy • Prone Position • Spinal Anesthesia • Stone-free Rate.

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Highlights

- Propensity score–matched analysis of 560 patients showed comparable stone-free and complication rates between spinal and general anesthesia for prone percutaneous nephrolithotomy.
- Spinal anesthesia reduced operative time, anesthesia duration, and hospital stay without compromising surgical efficacy and safety.
- Hemoglobin decrease was greater with general anesthesia.
- Spinal anesthesia is a practical alternative to general anesthesia in higher anesthetic-risk patients.

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Abstract

***Objective*:** This study presents our experience with prone percutaneous nephrolithotomy (PCNL) under spinal anesthesia (SA) performed by a single surgeon. The primary outcome was the incidence of postoperative complications according to the modified Clavien-Dindo classification, and the secondary outcome was the stone-free rate (SFR). ***Methods*:** A total of 778 patients who underwent PCNL for kidney stones by a single surgeon between June 2014 and May 2023 were divided into two groups: Group GA (general anesthesia, *n* = 498) and Group SA (*n* = 280). Demographic and stone characteristics, operative parameters, SFR, and complications were compared between the groups after 1:1 propensity score matching (PSM) based on age, sex, and stone burden. ***Results*:** After propensity score matching (PSM), 280 patients in Group SA were matched with 280 patients in Group GA. No significant differences were observed between the groups in terms of stone number, side, or localization. The use of intercostal access, need for multiple access tracts, and fluoroscopy time were also comparable. However, surgery duration, anesthesia duration, and hospital stay were significantly shorter in Group SA ($p < 0.001$, $p = 0.04$, and $p < 0.001$, respectively). The SFR at the first evaluation and after auxiliary treatments was similar between groups. Overall postoperative complication rates did not differ significantly, and no life-threatening (Clavien-Dindo grade IV-V) complications occurred. ***Conclusions*:** Compared with GA, prone PCNL can be performed safely and effectively under SA, achieving comparable stone-free and complication rates while offering shorter operative time and hospital stay.

Introduction

The urinary stone disease remains a major global health problem with increasing incidence worldwide [1]. Percutaneous nephrolithotomy (PCNL), first introduced in 1976, has become the standard treatment for large or complex renal stones and remains the recommended first-line treatment for high stone burden according to contemporary urological guidelines [2]. Several recent reports demonstrate excellent outcomes with PCNL, with reported stone-free rates (SFR) approaching 90-95% in experienced centers [3 - 5]. Accordingly, contemporary urological guidelines recommend PCNL as the first-line intervention for substantial stone burdens, given its high efficacy in achieving complete stone clearance in a single session [3]. Despite its proven effectiveness, the choice of anesthetic technique for PCNL carries important clinical

implications. PCNL is a technically demanding procedure requiring careful anesthetic management, particularly when performed in the prone position.

General anesthesia (GA) is traditionally preferred because it allows optimal airway control, complete patient immobility, and the possibility of prolonged surgical time if necessary. However, GA may also be associated with respiratory complications, hemodynamic instability, and longer recovery times, particularly in elderly or comorbid patients. Spinal anesthesia (SA) has emerged as an attractive alternative for such cases, obviating the need for tracheal intubation and potentially reducing perioperative morbidity. Indeed, growing evidence indicates that PCNL can be performed safely and effectively under regional anesthesia. Comparative studies have found that SA yields similar stone clearance rates and overall surgical outcomes to that with the GA, while conferring advantages such as reduced intraoperative blood loss, lower transfusion requirements, and decreased postoperative analgesic needs [6 - 12]. This anesthetic approach is especially relevant in patients who are suboptimal candidates for GA, as it minimizes exposure to systemic anesthetic agents and airway instrumentation. Furthermore, regional anesthesia has been successfully applied in other endourological procedures. For example, Olivero et al. [13] reported comparable surgical outcomes and complication rates between SA and GA in retrograde intrarenal surgery (RIRS), supporting the feasibility of regional anesthesia for endoscopic stone surgery [13]. Despite growing interest in SA for PCNL, evidence from large matched cohorts remains limited. Therefore, the aim of the present study was to compare outcomes of prone PCNL performed under SA versus GA in a large single-center cohort using propensity score matching (PSM). The primary outcome was postoperative complications according to the Clavien-Dindo classification, while secondary outcomes included stone-free rate (SFR), operative parameters, and hospitalization duration.

Materials and Methods

This retrospective study was conducted in accordance with the ethical standards of the 1964 Declaration of Helsinki and its later amendments. The institutional review board approved the study protocol (date: 15-08-2024, number: 2024-MCHC-08.203.01). As part of institutional routine practice, all patients had provided written informed consent for the use of their clinical data. We analyzed data from a prospectively maintained departmental database of consecutive patients who underwent prone PCNL between June 2014 and May 2023, and patient anonymity and confidentiality were strictly preserved. Patients were included if they were ≥18 years of age, underwent PCNL during the study period, and had complete perioperative data available. Patients were excluded if they had simultaneous bilateral PCNL, concurrent ureteroscopy during the same session, or missing clinical data.

For each included patient, detailed clinical and perioperative information was collected. We recorded baseline demographic factors (age, sex, comorbidities, and American Society of Anesthesiologists [ASA] score) and stone characteristics, including stone burden, number, location within the kidney and laterality, and any underlying renal anatomical abnormalities. We also noted any previous interventions for stone disease, such as prior ipsilateral stone surgeries or shock wave lithotripsy (SWL). Intraoperative parameters were documented, including the operation duration, total fluoroscopy time, anesthesia time, the number of percutaneous access tracts used and their locations (e.g. upper pole, lower pole), hemoglobin drop, and any complications occurring during surgery –notably whether an intraoperative blood transfusion was required. Postoperative outcomes were likewise recorded, namely the length of hospital stay, the stone-free status at follow-up, and the occurrence of any postoperative complications.

Stone burden was defined as the total stone surface area in square millimeters. The area was calculated by measuring the longest diameter and the perpendicular diameter of the stone on preoperative imaging and applying the formula for an ellipse *(length × width × π/4)*. All patients were evaluated with complete blood count, routine blood biochemistry, urine analysis, urine culture, and anesthesiology consultation. Patients with positive urine culture were treated with antibiotics appropriately and were operated on only after confirmation of a negative culture result. Operative time was defined as the duration from patient positioning to the completion of the procedure, including nephrostomy tube placement and/or skin closure. Stone-free status was defined as complete clearance of stones or the presence of only residual fragments ≤4 mm in size on postoperative imaging, performed as a kidney-ureter-bladder (KUB) X-ray (renal ultrasound for non-opaque stones) two weeks after the operation and a non-contrast computed tomography (NCCT) one month after the operation or auxiliary treatment. Fragments ≤4 mm were considered clinically

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insignificant residual fragments (CIRFs). Postoperative complications occurring within 30 days after surgery were graded according to the modified Clavien-Dindo classes (CDCs).

The type of anesthesia administered was determined by the surgeon, patient, and anesthesiologist. In patients with comorbidities that would complicate GA, such as severe chronic obstructive pulmonary disease, the decision followed an anesthesiology consultation and a thorough discussion of the advantages and disadvantages of SA. In some cases, patients opted for SA based on personal preference after being fully informed about the procedure. Spinal anesthesia was administered at the L3–L4 or L2–L3 interspace using hyperbaric bupivacaine to achieve a sensory block level of approximately T8–T10. In cases of inadequate analgesia or patient discomfort during SA, supplemental intravenous sedation (midazolam or low-dose propofol) was administered, and conversion to GA was considered when necessary. General anesthesia was induced using intravenous propofol and opioid analgesia, and maintained with inhalational or intravenous anesthetic agents with controlled ventilation. Conversion from SA to GA due to inadequate analgesia or patient discomfort was recorded as anesthesia failure.

Because the choice of anesthesia was not randomized, PSM was employed to minimize selection bias between the two groups. A multivariable logistic regression model was constructed to estimate the propensity score (the probability of a patient receiving SA) based on preoperative characteristics. Patient sex, age, and stone burden were included as covariates in this model, as these were considered relevant baseline factors that could differ between anesthesia groups. Patients in the SA group were then matched one-to-one with patients in the GA group using a greedy nearest-neighbor algorithm. A caliper width of 0.25 standard deviations of the logit of the propensity score was used to restrict matches to those with sufficiently close propensity scores, ensuring well-matched pairs while preserving as many cases as possible. This matching process resulted in two balanced cohorts of patients for subsequent outcome comparisons between SA and GA.

All statistical analyses were performed using R software (version 4.3; R Foundation for Statistical Computing, Vienna, Austria). Continuous variables were summarized as medians with interquartile ranges (IQRs), and categorical variables were presented as frequencies (*n*) and percentages. The distribution of continuous data was assessed with the Shapiro-Wilk test for normality. Depending on the distribution, group comparisons for continuous variables were done using the independent Student's *t*-test (for approximately normally distributed data) or a Mann-Whitney *U* test (for non-normally distributed data). Categorical variables were compared using the chi-square test or Fisher's exact test when expected cell counts were small. All hypothesis tests were two-sided, and a *p*-value < 0.05 was considered statistically significant.

Results

Out of 843 total patients, 65 were excluded, and 778 patients were divided into two groups: Group GA (*n* = 498) and Group SA (*n* = 280). Selected characteristics of the overall cohort and the two groups before PSM are presented in "Supplemental Table 1". After 1:1 PSM, 560 patients (280 SA and 280 GA) were analyzed (Fig. 1). Demographic, stone, and operative characteristics of all and propensity-score matched patients are listed in "Table 1". Among 280 patients who underwent PCNL under SA, 69 (24.6%) had comorbidities that could complicate GA (i.e., ASA scores of 3 and 4), and 19 (6.8%) were unable to tolerate SA due to discomfort or anxiety and required supplemental intravenous sedation; no cases required conversion to GA.

Baseline demographics were similar: the median age was 48 years in both groups ($p = 0.98$) and approximately 60% were male ($p = 0.86$). However, distribution of ASA scores differed significantly between the groups ($p = 0.02$). In particular, higher ASA scores were more frequent in the SA group. With pairwise comparison, the number of patients differed significantly between groups for ASA scores except ASA 3 ($p <$ [illegible] the other comparisons).

Most operations were primary procedures (≈80% in each group, $p = 0.07$) and stone characteristics were well balanced. The median number of stones was 1 in both arms (IQR: 1-1). Stone burden (median: 550 mm^2) and laterality (≈52% right-sided) did not differ between the groups. Stone location distribution was also comparable. The type of percutaneous access was likewise similar: subcostal access was used in 90% of cases in each group ($p = 0.77$). Supracostal access was required in a minority of patients and did not differ significantly between the groups. The median number of tracts was 1 in both cohorts (IQR: 1-1; >90% one access, $p = 0.06$).

Despite similar anatomy and stone factors, operative parameters favored SA. The median anesthesia time (13 vs. 21 minutes, $p = 0.04$) and operative time (59 vs. 69 minutes, $p < 0.001$) were significantly shorter in the

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SA group. The median fluoroscopy time was comparable (4.1 vs. 4.4 minutes, $p = 0.57$), whereas hospital stay was shorter in the SA group (median 40 vs. 48 hours, $p < 0.001$). Patients in GA group experienced a greater postoperative hemoglobin decrease compared with those in SA group (2.1 vs. 1.4 g/dL, $p < 0.001$). Initial stone clearance was similar between groups. The SFR on first evaluation was 74.5% overall (71.4% GA vs. 77.5% SA, $p = 0.12$). Use of auxiliary treatments (SWL, semi-rigid/flexible ureteroscopy, or second-look PCNL) was comparable between the groups. After all adjunct procedures, the final SFR reached 91.6% in the matched cohort (90% GA vs. 93.2% SA, $p = 0.22$), indicating comparable efficacy (Table 2). The rate of CIRFs was also similar (6.4% GA vs. 5% SA at the second evaluation, $p = 0.58$).

Overall complication rates did not differ significantly by anesthetic technique. In the matched cohort, no complication occurred in 74.3% of GA patients and 79.3% of SA patients ($p = 0.16$). Complications were graded according to the modified Clavien-Dindo classification, and their distribution across grades was comparable. No Clavien-Dindo grade IV or V (life-threatening or fatal) complications were observed in either group. The most common specific complications were hematuria, urinary tract infection, hypotension (more frequently observed in the SA group), dysuria, and fever, with similar rates in both groups. Blood transfusion was required in 5.0% of GA patients and 3.9% of SA patients (Table 3).

Discussion

The current analysis of a large propensity-score-matched cohort (560 patients) confirms that PCNL can be performed safely under either SA or GA with comparable efficacy. In our series, the SFR at final evaluation was similarly high in both groups (93.2% SA vs. 90.0% GA; $p = 0.22$), and overall complication rates did not differ significantly. In fact, the majority of patients in each group had no complications (79.3% SA vs. 74.3% GA; $p = 0.16$), and the incidence of clinically significant (CDC ≥ III) events was equally low. Our results are largely consistent with the emerging consensus that SA is a viable alternative to GA for PCNL. Multiple recent studies, including randomized trials and meta-analyses, have reported similar SFRs and overall safety, with SA offering some perioperative advantages [14 - 18]. In our data, the profile of complications (urinary tract infections, bleeding, etc.) was also comparable; minor complications (CDC I-II) occurred in similar proportions in both groups, and no CDC IV-V events occurred in either arm. Despite these overall similarities, SA conferred several procedural advantages in our study. Spinal anesthesia was associated with significantly shorter operative time, anesthesia time, and hospitalization. Median surgery duration was 59.0 minutes in the SA group vs. 69.0 minutes with GA ($p < 0.001$), and median hospital stay was 40.0 hours vs. 48.0 hours ($p < 0.001$). Although this 10-minute difference in operative time reached statistical significance, its clinical relevance should be interpreted cautiously given the overall duration of PCNL procedures. Nevertheless, shorter anesthesia exposure and earlier postoperative recovery may contribute to improved perioperative efficiency. These findings are consistent with prior reports of Rachman et al. [15] and Shahait et al. [16]. The shorter duration with SA likely reflects the practical advantage of avoiding endotracheal intubation. We also observed a modest but significant reduction in anesthsia time in the SA group, which was as expected.

Although the postoperative hemoglobin decrease was statistically higher in GA group than in SA group (2.1 vs 1.4 g/dL, $p < 0.001$), the absolute difference was small (0.7 g/dL**)**. Given the large sample size, modest differences may reach statistical significance. Moreover, hemoglobin declines in both groups were within the range typically reported after PCNL in the literature (approximately 1–2 g/dL), suggesting limited clinical significance. These findings are consistent with previous comparative studies and meta-analyses reporting slightly lower blood loss and hemoglobin decrease with spinal compared with general anesthesia in PCNL, although the magnitude of this effect is generally small [19]. Importantly, these efficiency gains and improvements did not come at the cost of efficacy. Final SFR was high and nearly identical in both groups (90% GA vs. 93.2% SA; $p = 0.22$). Even after first-look imaging, SFR was statistically similar (71.4% GA vs. 77.5% SA; $p = 0.12$). These results suggest that SA does not compromise stone clearance, a finding also reported by previous studies [14, 15]. Thus, from a urologist's perspective, the choice of anesthesia appears not to affect the fundamental effectiveness of PCNL in eliminating stones. From an anesthsiologist's perspective, however, SA provides reduced anesthesia and allow surgical treatment of patients with more severe comorbidities.

Indeed, an important observation in our cohort was the higher proportion of patients with elevated ASA scores in the ASA group. A considerable number of patients with ASA III and IV status underwent PCNL under SA, reflecting the clinical preference for regional anesthesia in patients with higher anesthetic risk.

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The comparable outcomes observed in these patients suggest that SA may represent a particularly useful alternative in carefully selected high-risk individuals.

Regarding complications, our propensity-score-matched comparison detected no statistically significant differences between anesthesia types. The overall complication profile was similar: for example, low-grade events such as dysuria, fever, hematuria, and perirenal hematoma occurred in comparable proportions in both groups. Even the rate of higher-grade complications was similar (CDC ≥III in roughly 6% of patients in each arm). This parallels concurred with prior findings that SA and GA yield equivalent safety for PCNL. Giulioni's meta-analysis concluded that overall complication rates did not differ between GA and spinal/epidural anesthesia [14]. Similarly, in our study, neither transfusion rates nor need for auxiliary interventions differed significantly. Rachman et al. [15], reported a trend favoring GA–fewer grade II and ≥III complications–but the differences were modest (odd ratios around 0.65 - 0.68), and other authors have not confirmed a clear advantage. [15]. Burlukkara et al. [12] found no significant difference in hemoglobin drop, transfusion requirement, or SFR between GA and combined spinal-epidural anesthesia. [12] Several recent studies report that SA can cause slightly more hypotension and minor side effects than GA. For example, Srinivasa et al. [17] found postoperative hypotension in 17% of SA patients vs. only 7% in GA patients. Likewise, a pooled meta-analysis showed that patients under regional (including spinal and epidural anesthesia had a 3.13-fold higher risk of intraoperative hypotension compared to GA [18]. Minor complications like headache (often from dural puncture) and low back pain were also more common with SA [20, 21]. Importantly, none of these studies demonstrated increased rates of serious complications with SA, and recent meta-analyses conclude that overall complication rates are comparable between SA and GA [15, 16].

These findings must be interpreted in light of both the strengths and limitations of our study. On the positive side, our large cohort (n = 560) and rigorous PSM bolster confidence that baseline patient and stone characteristics were well balanced between groups. Key factors like age, stone burden, laterality, and number of stones were nearly identical (Table 1), reducing confounding. Thus, the observed differences in outcomes can more credibly be attributed to the anesthetic technique itself rather than patient selection. We also included a broad spectrum of cases (primary and re-treatment PCNL, multiple stones, etc.), making our findings widely applicable.

However, several limitations should be acknowledged. First, the retrospective design precludes random assignment and residual confounding may persist. For example, the surgeon or anesthesiologists might have chosen SA for patients perceived to be higher-risk cases (ASA III/IV). Second, although PSM was performed using patient sex, age, and stone burden, other potentially relevant variables could not be included. Third, the study period spanned nearly ten years, during which surgical experience and institutional practice patterns may have evolved. Consequently, a potential learning-curve effect over time cannot be entirely excluded. Fourth, pain scores, opioid/non-opioid analgesic requirements, readmission rates, and patient-reported outcomes, such as intraoperative discomfort during positioning, shivering, or patient satisfaction with the anesthetic technique, were not availavle due to the retrospective nature of the study. In addition, pain management differed by design: SA patients, by definition, received intraoperative regional anesthesia, which may have improved postoperative pain control and thus shortened hospitalization. Indeed, other reports note reduced postoperative pain scores and analgesic needs with SA or epidural techniques [7 - 11]. Fifth, SA carries risks such as transient hypotension, paresthesia, or rare neurologic complications. Centers inexperienced with SA for prone procedures might have different complication profiles than ours. Sixth, although a single surgeon's data ensures consistency in surgical technique, it limits the generalizability of the findings to other surgeons or institutions. Sixth, the first evaluation of stone-free status relied on KUB X-ray or renal ultrasound, which may underestimate small residual fragments compared with CT imaging.

Nevertheless, GA remains valuable, especially in complex cases or where SA is contraindicated. GA allows easier airway control and may be more comfortable for some surgeons and patients. Our data do not suggest that GA is inferior; instead, it appears equally effective with only modest differences in certain perioperative parameters. Ultimately, the choice between SA and GA should be individualized based on patient characteristics (e.g. pulmonary disease, obesity), anesthesiologist expertise, and institutional experience. For instance, patients with chronic cardiopulmonary issues might benefit from avoiding the risks of GA, whereas coagulopathy or spine pathology might preclude neuraxial blocks.

Conclusion

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Our study adds to growing evidence that PCNL under SA is an efficient and safe option. In a large propensity-score-matched cohort, SA yielded shorter operative times and hospital stays without compromising stone clearance or increasing complications. Future prospective trials–ideally randomized trials–are needed to further clarify the optimal anesthetic approach and evaluate patient-reported outcomes such as postoperatie pain and satisfaction.

Acknowledgements

None.

Statement of ethics

The Institutional Review Board of the Shandong Provincial Maternal and Child Health Care Hospital Affiliated to Qingdao University approved the study protocol (date: 15-08-2024, number: 2024-MCHC-08.203.01). This retrospective study was conducted in accordance with the ethical standards of the 1964 Declaration of Helsinki and its later amendments. As an institutional routine, all patients had provided written informed consent for the use of their data at any time.

Conflict of interest

The authors declare that they have no competing interests.

Funding

None.

Data availability statement

Data are available upon reasonable request to the corresponding author.

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Figure legends

Fig. 1: Flowchart for patient selection

Fig. 2: Bar graphs showing the distribution of ASA scores between the general and spinal anesthesia groups.

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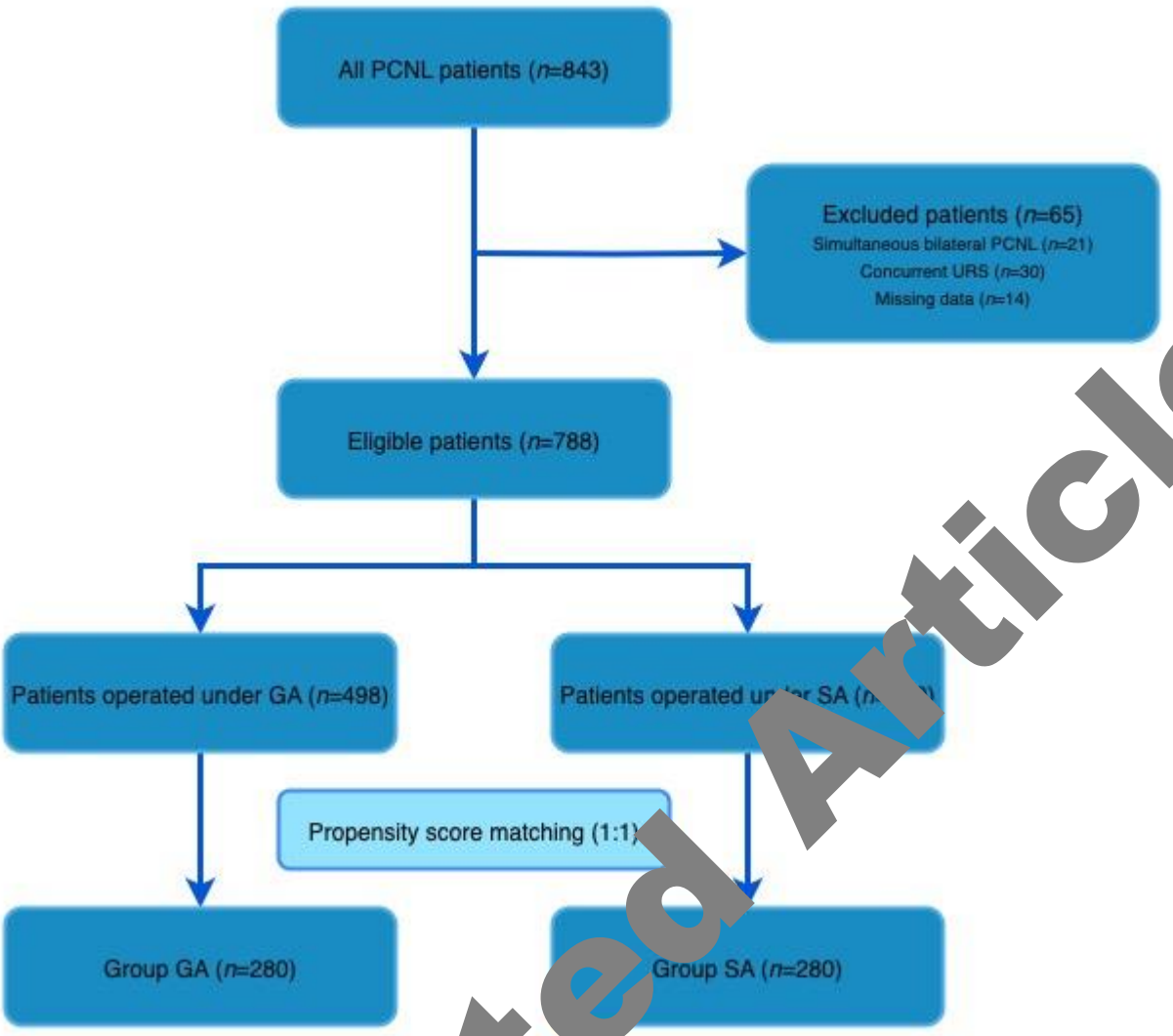


Fig. 1

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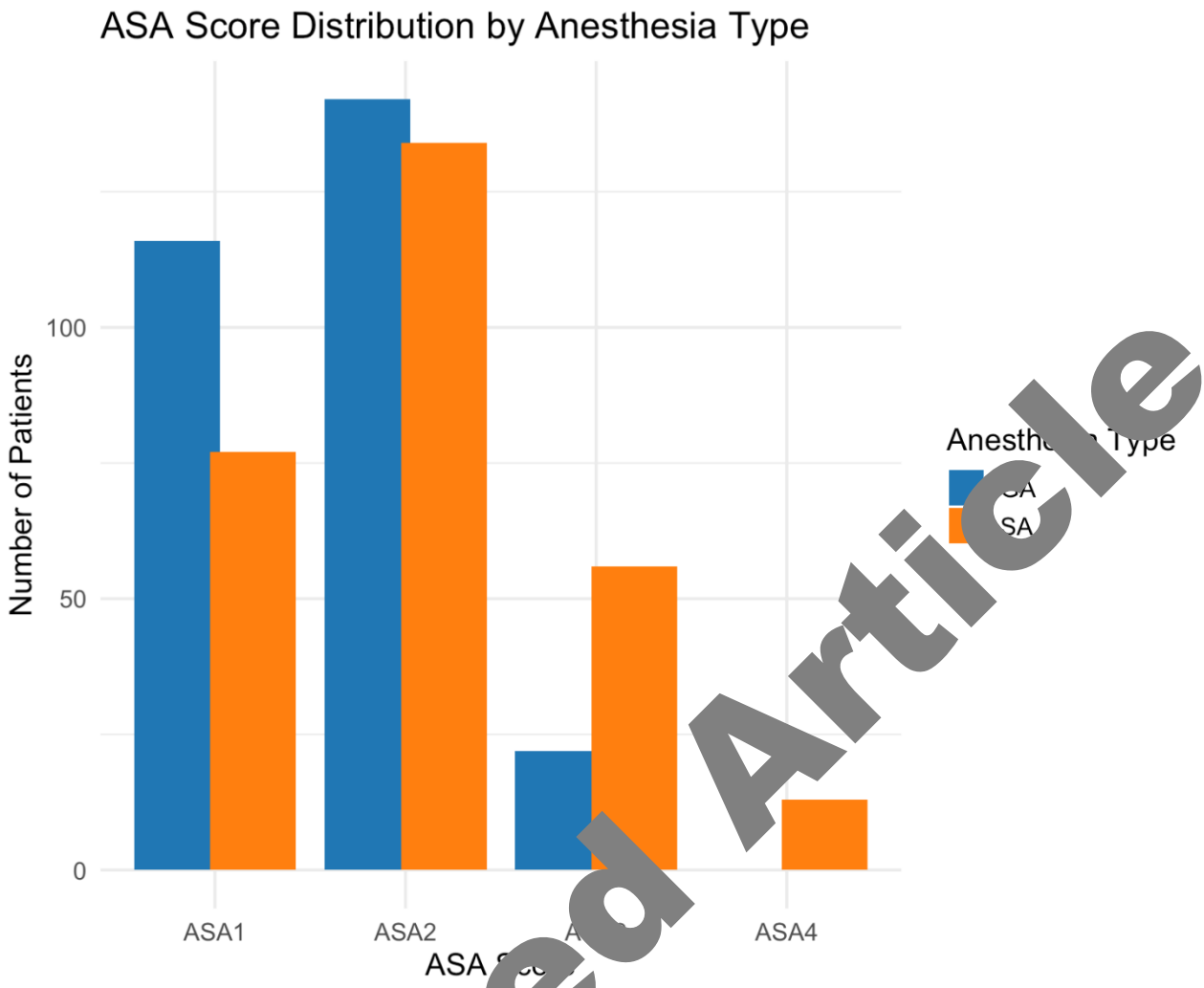


Fig. 2

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Table 1: Patient characteristics for all patients and general and spinal anesthesia groups after propensity score matching.

		All patients *n*=560		GA group *n*=280		SA group *n*=280		*p*-value
Age (years), median (IQR)		48	35-59.3	48	35-60	48	35-58.3	0.98
Gender (male)		368	65.7%	185	66.1%	183	65.6	0.86
ASA score	1	193	33.5%	116	41.4%	77	27.5%	**<0.001**
	2	276	49.3%	142	50.7%	134	47.9%	
	3	78	13.9%	22	7.9%	56	20%	
	4	13	2.3%	0	0	13	4.6%	
Surgery type	Primary	449	80.2%	216	77.1%	233	83.2%	0.07
	Secondary	111	19.2%	64	22.9%	47	16.8%	
Stone number	Median (IQR)	1	1-1	1	1-1	1	1-1	0.43
	1	440	78.6%	213	76.1%	227	81.1%	
	2	86	15.4%	46	16.4%	40	14.3%	
	3	16	2.8%	10	3.6%	6	2.1%	
	4-9	18	3.2%	11	3.9%	7	2.5%	
Stone burden (mm^2), median (IQR)		550	400-700	553	400-693	548	386-700	0.9
Kidney side	Right	294	52.5%	144	51.4%	150	53.6%	0.61
	Left	266	47.5%	136	48.6%	130	46.4%	
Stone localization	Renal pelvis	62	11.1%	35	12.5%	27	9.6%	0.24
	Upper calyx	48	8.5%	25	8.9%	23	8.2%	
	Mid calyx	56	10%	30	10.7%	26	9.3%	
	Lower calyx	277	49.5%	125	44.6%	152	54.3%	
	Multiple calyx	117	20.9%	65	23.2%	52	18.6%	
Access type	Subcostal	506	90.4%	252	90%	254	90.7%	0.77
	Supracostal	54	9.6%	28	10%	26	9.3%	
Access number	Median (IQR)	1	1-1	1	1-1	1	1-1	0.64
	1	511	91.1%	248	88.6%	262	93.6%	0.06
	2	47	8.4%	31	11.1%	16	5.7%	
	3	2	0.5%	1	0.3%	2	0.7%	
Hemoglobin drop (g/dL) median (IQR)		1.8	1.3-2.7	2.1	1.3-2.8	1.4	1.1-2.3	**<0.001**
Anesthesia duration (min), median (IQR)		18	12-29	21	17-37	13	11-27	**0.04**
Surgery duration (min), median (IQR)		63	55-77	69	59.8-90	59	50-68.3	**<0.001**
Fluoroscopy time (min), median (IQR)		4.2	2.6-6.6	4.1	2.5-6.1	4.4	2.8-6.7	0.57
Length of hospital stay (hours), median (IQR)		44	36-52	48	40-60	40	33.8-48	**<0.001**

All values are given as *n* (%), unless mentioned otherwise.
GA: General anesthesia, IQR: Interquartile range, SA: Spinal anesthesia.

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Table 2: Stone-free rates and stone analysis for all patients and general and spinal anesthesia groups after propensity score matching.

		All patients *n*=560		GA group *n*=280		SA group *n*=280		*p*-value
SFR @ 1st evaluation		417	74.5%	200	71.4%	217	77.5%	0.12
Auxiliary treatment	SWL	72	12.9%	40	14.3%	32	11.4%	0.36
	URS/RIRS	66	11.8%	29	10.4%	37	13.2%	
	PCNL (2nd look)	41	7.3%	22	7.9%	19	6.8%	
SFR @ 2nd evaluation		481	85.9%	234	83.6%	247	88.2%	0.14
CIRF rate @ 2nd evaluation		32	5.7%	18	6.4%	14	5%	0.58
Final stone-free rate		513	91.6%	252	90%	261	93.2%	0.
Stone analysis	Mixed*	253	45.2%	125	44.6%	128	45.7%	
	CaOx	169	30.2%	81	28.9%	88	31 %	
	CaP	38	6.8%	20	7.1%	1	4%	
	Struvite	33	5.9%	15	5.4%	18	6.4%	0.76
	Uric acid	30	5.3%	16	5.7%	14	5%	
	Cystine	7	1.3%	5	1.8%	2	0.7%	
	Unknown	30	5.3%	18	6.4%	12	4.3%	

All values are given as *n* (%).
* CaOx is the predominant stone type in mixed stones.
CaOx: Calcium oxalate, CaP: Calcium phosphate, CIRF: clinically insignificant residual fragment, GA: General anesthesia, PCNL: Percutaneous nephrolithotomy, RIRS: Retrograde intrarenal surgery, SA: Spinal anesthesia, SFR: Stone-free rate, SWL: Shock wave lithotripsy, URS: Ureterorenoscopy.

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Table 3: Distribution of complications graded according to the Clavien-Dindo classification.

Complications	All patients *n*=560		GA group *n*=280		SA group *n*=280		*p*-value
No complication	430	76.8%	208	74.3%	222	79.3%	0.16
Grade 1	245	43.8%	111	39.6%	134	47.9%	0.05
Dysuria	44	7.9%	20	7.1%	24	8.6%	
Fever	39	7%	21	7.4%	18	6.4%	
Headache	46	8.2%	14	5%	32	11.4%	0.18
Hematuria	81	14.5%	41	14.6%	40	14.3%	
Perirenal hematoma	35	6.3%	15	5.4%	20	7.1%	
Grade 2	142	25.4%	73	26.1%	72	25.7%	0.0
Blood transfusion	25	4.5%	14	5%	11	3.9%	
Fever	32	5.7%	17	6.1%	15	5.4%	0.87
Hematuria (>48 h)	33	5.9%	15	5.4%	18	6.4%	
UTI	52	9.3%	27	9.6%	25	8.9	
Grade 3a	13	2.3%	7	2.5%	6	%	0.78
Prolonged drainage (>24 h)	13	2.3%	7	2.5%	6	2.1%	
Grade 3b	22	3.9%	10	3.6%	12	4.3%	0.66
Need for URS	17	3%	8	2.9%	9	3.2%	0.99
Perirenal hematoma	5	0.9%	2	0.7	3	1.1%	

All values are given as *n* (%).
GA: General anesthesia, SA: Spinal anesthesia, URS: Ureterorenoscopy, UTI: Urinary tract infection.

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