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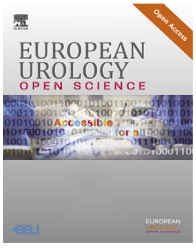

European Association of Urology

Case Report

A New Concept for Minimally Invasive Surgical Treatment in Renal Cancer: The Use of Neuroaxial Anesthesia During Laparoscopic Partial Nephrectomy

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Abstract

A new concept for minimally invasive treatment involves abdominal laparoscopic surgery performed while the patient breathes independently without losing consciousness. Here we report the first series of laparoscopic partial nephrectomy (LPN) performed under neuroaxial anesthesia (NA). From May 2021 to September 2022 we prospectively enrolled selected patients with an organ-confined single renal mass to undergo LPN under NA. Anesthesia was administered using an epidural catheter placed at the level of T7, with additional anesthesia at the level of T10. The rationale was to avoid use of a tracheal tube and the side effects of general anesthesia. Ten patients were enrolled in the study. Targeted sedation was achieved in all cases. In one case, a switch to general anesthesia was needed because of patient anxiety. Food intake started at 12 h after surgery in 9/10 cases; mobilization started from 3 h after surgery. The length of hospital stay was 3 d in 4/10 cases and 4 d in 3/10 cases. This first experience worldwide of LPN performed under NA demonstrates the feasibility and safety of the procedure.

1. Case series

1.1. Background

In the era of precision medicine, the definition of surgical impact should include all perioperative procedures that affect postoperative results and not just the surgical technique itself. A new concept for minimally invasive treatment involves performing abdominal surgery using pneumoperitoneum during which the patient is conscious and breathing independently. This is possible via neuroaxial anesthesia (NA), which minimizes the impact of general

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anesthesia (GA) during surgery and the postoperative period, accelerating recovery and potentially limiting the need for intensive care. The aim of this study was to report the first pioneering case series of laparoscopic partial nephrectomy (LPN) performed under NA.

1.2. Inclusion and exclusion criteria

The inclusion criteria were as follows: patients aged >18 and <75 yr; American Society of Anesthesiologists (ASA) score of I–II; acceptable performance status; and a clinical organ-confined renal mass (cT1a–b) amenable to LPN.

The exclusion criteria were non–organ-confined disease (cT3–4), patients not suitable for major abdominal surgery because of comorbidities, patients not able to understand the informed consent process, and patients with a preference for GA.

1.3. Anesthesiology rationale

The aim of NA in laparoscopy is to control surgical pain induced by local trauma and peritoneal distension of the peritoneum due to CO_2 insufflation, while allowing spontaneous breathing. Contraction of the abdominal wall muscles during surgery is caused by a myotatic reflex evoked by local stimulation of sensitive fibers consequent to peritoneal distension. Anesthetic is administered to block sensitive fibers and thus inhibit the myotatic reflex. Owing to the amount of anesthesia injected, there is minimal movement of the lower limbs. We used the Bromage Motor Blockade Score [1] to measure the strength of lower limb movement intraoperatively and 3 h after surgery. The crucial aim with NA is to relax the abdominal wall muscles without affecting diaphragm contraction, which is stimulated by C4 neural roots, in order to allow spontaneous breathing. For this reason, anesthetic is injected caudally at the level of T7. Another potential criticism is the achievement of standardized sedation. We aimed to reach a target sedation score of 3 according to the dedicated Ramsey Sedation Scale [2], whereby the patient is sleepy but still conscious and can collaborate with the surgeon during the operation. As the patients are awake, they might perceive intraoperative pain. For this reason, we used a visual analog scale (VAS) for pain evaluation [3] intraoperatively and postoperatively.

1.4. Anesthesiology procedure

Midazolam 2.5 mg and dexamethasone 4 mg are administered to achieve initial sedation. A peridural catheter is placed at the level of T7, reaching the peridural space (Fig. 1A), into which two boluses of ropivacaine 20 mg are administered. Subsequently, an empiric needle contact test

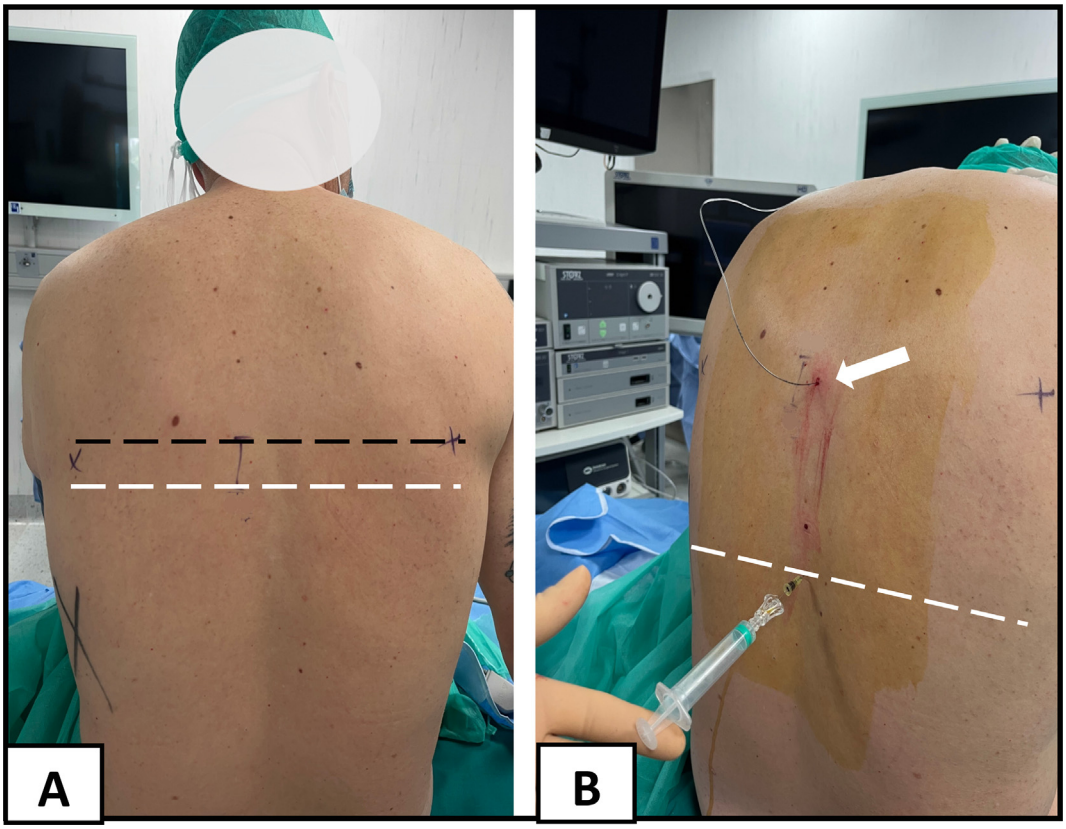

Fig. 1 – Anatomic landmarks for neuroaxial anesthesia. (A) The peridural space is reached via needle puncture in the T7 space between the black and white lines. (B) The white arrow indicates the peridural catheter placed in the T7 space for anesthetic administration; additional peripheral anesthesia is administered via puncture in the T10 space (white line).

is performed to evaluate the efficacy of anesthesia in the surgical area. In cases with suboptimal findings, a third bolus of ropivacaine is administered. To obtain faster (~10 min) intrathecal analgesia at the C3/C4 and L1/L2 levels, additional spinal anesthesia can be administered at the T10 level (Fig. 1B) using levobupivacaine 5 mg, dexmedetomidine 10 μg, metilprednisolone 2 mg, and 2 cm^3 of bidistilled water, with up to 1000 ml of 0.9% NaCl solution administered as a loading volume. Then sedation is achieved via administration of dexmedetomidine 100 μg and ketamine 50 mg in 20 ml of 0.9% NaCl at a rate of 0.1–0.4 μg/kg/h. A booster dose of ropivacaine 20 mg in 20 ml of 0.9% NaCl solution is administered every 60 min to ensure continuous pain control.

Pain was assessed using the VAS during surgery, up to 3 h after the intervention, and on the first and second postoperative days [3]. The Ramsey Sedation Scale [2] was used to assess sedation intraoperatively and at 3, 24, and 48 h after surgery. The Bromage Motor Blockade Score [1] was used to measure the effectiveness of anesthesia during and 3 h after surgery.

1.5. Cases

From May 2021 to September 2022, we enrolled ten patients with a clinical organ-confined renal mass amenable to LPN performed in Romolo Hospital (Rocca di Neto, Italy) by a single expert laparoscopic surgeon (S.A.; Table 1). The surgical technique did not differ from the standard LPN procedure (Fig. 2). One episode of active bleeding from the resection bed was managed conservatively using a dedicated suture and blood transfusion for hemodynamic support.

Table 1 reports perioperative and pathological data. Over median follow-up of 14 mo (interquartile range 8–20), no relapses, complications, or disease progression events were observed, and all the patients were alive (Table 2).

Targeted sedation was achieved in all cases, reaching a score of 3 on the Ramsey Sedation Scale (Table 3). One patient specifically requested a switch to GA during the operation because of anxiety. In this case, a laryngeal airway mask was sufficient for mechanical ventilation.

2. Discussion

After major surgical procedures, the optimization of the postoperative recovery both in term of quality and time, can be influenced by the disposal of GA side effects. To overcome this limitation, the potential benefits of the use of NA in major urological procedures have been firstly explored in open surgery [4,5]. However, a surgical procedure performed with pneumoperitoneum may pose several potential challenges [6].

The first case of minimally invasive PN under NA was performed as an imperative indication in a 63-yr-old patient with an ASA score of IV and 5.5-cm right-sided cystic renal tumor [7]. The authors did not report any compli-

Table 1 – Demographic, perioperative, and pathologic data for the ten patients

Parameter	Result
Median age, yr (interquartile range)	70 (62–76)
Male, *n* (%)	6 (60)
Median body mass index, kg/m^2 (interquartile range)	28 (25–31)
Median Charlson comorbidity index (interquartile range)	2 (1–3)
Hypertension, *n* (%)	10 (100)
Diabetes, *n* (%)	0 (0)
Vasculopathy, *n* (%)	2 (20)
Cardiopathy, *n* (%)	4 (40)
Median preoperative hemoglobin, g/dl (interquartile range)	14.4 (13.9–14.8)
Median creatinine at recruitment, mg/dl (interquartile range)	0.9 (0.8–1.1)
Median estimated glomerular filtration rate, ml/min (interquartile range)	71.3 (65.2–85)
Median American Society of Anesthesiologists score (interquartile range)	2 (2–2)
Right-sided laparoscopic partial nephrectomy, *n* (%)	6 (60)
Median tumor size, cm (interquartile range)	3 (3–3.7)
Median PADUA nephrometry score (interquartile range))	8 (7–9)
Median operative time, min (interquartile range)	150 (134–181)
Selective clamping, *n* (%)	2 (20)
Median warm ischemia time, min (interquartile range)	16 (15–20)
Median estimated blood loss, ml (interquartile range)	150 (70–230)
Intraoperative complications, *n* (%)	1 (10)
Conversion to open approach, *n* (%)	0 (0)
Median length of hospital stay, d (interquartile range)	4 (3–5)
Median postoperative hemoglobin, g/dl (interquartile range)	11.6 (10.8–12.4)
Postoperative complications, *n* (%)	1 (10)
Clavien grade, *n* (%)	
Grade 1	0 (0)
Grade 2	1 (10)
Grade 3	0 (0)
Grade4	0 (0)
cT stage, *n* (%)	
cT1a	8 (80)
cT1b	2 (20)
pT stage, *n* (%)	
pT1a	5 (50)
pT1b	2 (20)
pT3a	1 (10)
Benign histology (oncocytoma), *n* (%)	2 (20)

Table 2 – Follow-up data

Parameter	Result
Median follow-up, mo (IQR)	14 (8–20)
Tumor recurrence, *n* (%)	0 (0)
Long-term complications, *n* (%)	0 (0)
Median creatinine at last follow-up, mg/dl (IQR)	0.9 (0.88–1.25)
Median eGFR at last follow-up, ml/min (IQR)	62.5 (55.2–79.2)

eGFR = estimated glomerular filtration rate; IQR = interquartile range.

cations related to the anesthesia protocol and the surgery was completed with 25 min of warm ischemia.

Interestingly, none of our patients reported significant pain at the surgical site according to VAS scores (Table 4). Patients were able to eat and drink after 12 h in 9/10 cases and to stand up and walk autonomously at 3–24 h after surgery. Four patients had a hospital stay of 3 d, which is shorter than the minimum of 4 d after GA in our institution.

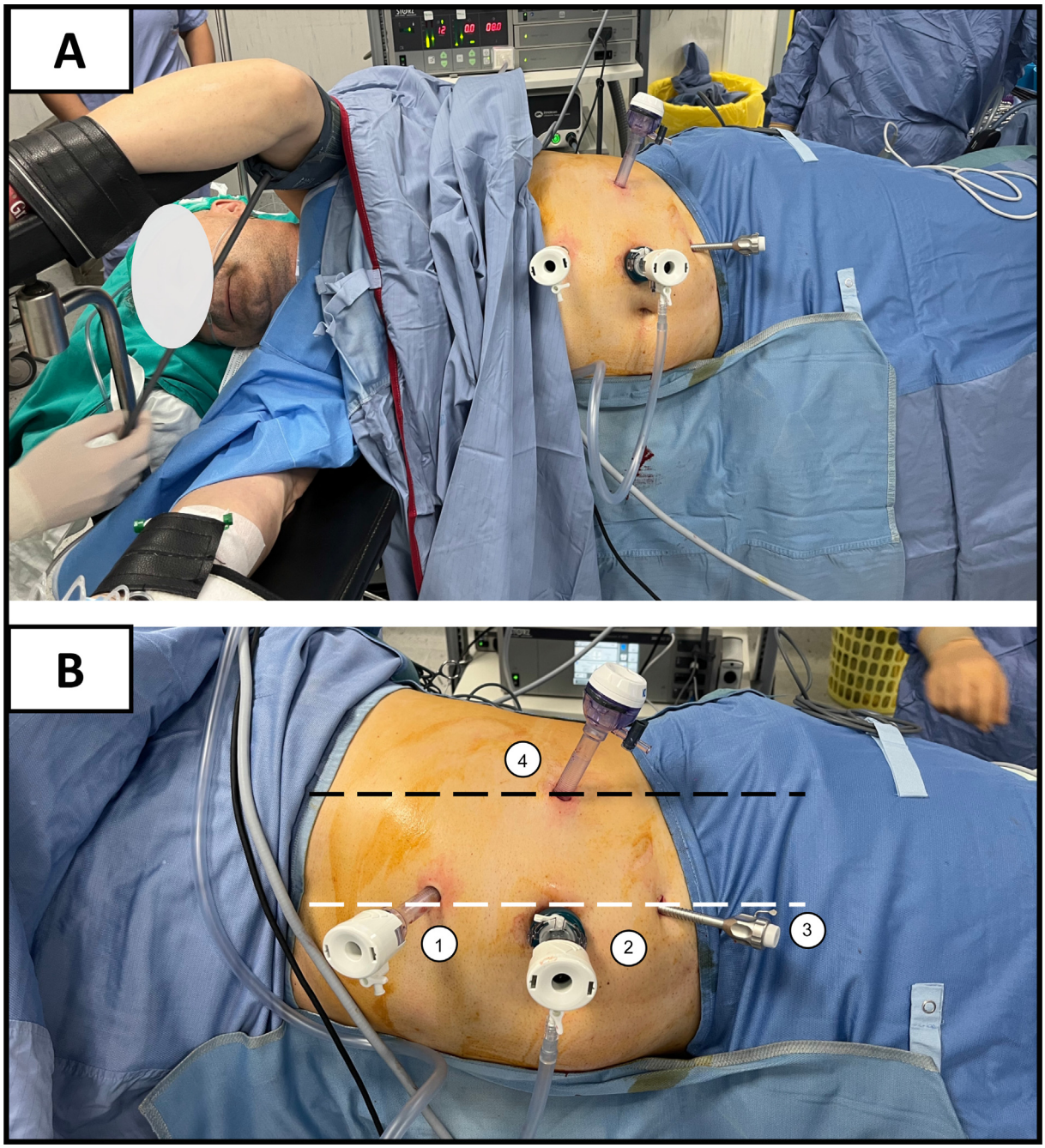

Fig. 2 – Patient positioning and trocar placement. (A) The patient is placed in a 60° flank position; the patient is awake and thus no tracheal tube is inserted. (B) A Hasson 12-mm optic trocar (2) is placed on the pararectal line above the umbilicus. A 12-mm trocar (1) is placed on the pararectal line, 8–10 cm above the optic trocar. A 5-mm assistant trocar (3) is placed on the pararectal line, 8–10 cm below the optic trocar. A 12-mm trocar (4) is placed on the midclavicular line.

Table 3 – Intraoperative data

Case	Mean blood pressure (mm Hg)[a]		HbS (%)	Ramsey score	VAS score	Switch to GA	Bromage score
	Systolic	Diastolic					
1	110	80	98	3	0	No	4
2	115	90	98	3	0	No	4
3	95	55	94	3	0	No	3
4	110	75	96	3	0	No	4
5	85	60	93	3	0	No	4
6	100	70	99	3	1	No	3
7	110	80	99	1	2	Yes	4
8	95	50	95	3	0	No	4
9	90	70	94	3	0	No	4
10	115	95	98	3	0	No	4

HbS = approximated mean blood hemoglobin saturation measured at the beginning of surgery and every 30 min until the end of the operation; VAS = visual analog scale for pain; GA = general anesthesia.
[a] Approximated mean of blood pressure measured at the beginning of surgery and every 30 min until the end of the operation.

Table 4 – Postoperative data

Case	Ramsey score[a]	Bromage score[a]	VAS pain score			PONV	POFI (h)	POM (h)	LOS (d)	Satisfaction score[b]
			3 h	24 h	48 h					
1	2	4	0	0	0	No	12	4	3	5
2	2	4	0	0	0	No	12	13	4	5
3	2	3	0	0	0	No	12	24	5	5
4	2	4	0	0	0	No	12	24	5	5
5	2	4	0	0	0	No	12	3	3	5
6	2	3	1	0	0	No	12	4	4	5
7	2	4	0	0	0	Yes	24	26	8	4
8	3	4	0	0	0	No	12	6	3	5
9	2	4	1	1	0	No	12	3	3	5
10	2	4	0	0	0	No	12	10	4	5

PONV = postoperative nausea/vomiting; POFI = time to postoperative food intake; POM = time to postoperative mobilization; LOS = length of hospital stay from surgery to discharge.
[a] Assessed at 3 h after surgery
[b] Satisfaction was measured using Likert scores (range 0–5 points) for preoperative counseling, intraoperative pain/discomfort, intraoperative collaboration with the anesthesiologist, postoperative recovery in terms of mobilization and eating, and overall satisfaction.

These improvements may potentially affect the global costs of surgery and increase patient satisfaction.

The first advantage of avoiding GA is the negative physiological ventilation pressure, which minimizes the risk of atelectasis and dysventilation in comparison to mechanical ventilation for patient treated with curare, resulting in potential hemodynamic stability and perfusion advantages. This issue may be a game-changer in patients with cardiopathy who are amenable to laparoscopic or robotic surgery. Moreover, preservation of patient consciousness may significantly reduce the risk of postoperative delirium. In addition, optimization of postoperative pain control may reduce the administration of nonsteroidal anti-inflammatory drugs and their impact on renal function and anti-aggregation activity, as well as the need for opioid medication, which can potentially cause immunosuppression, a reduction in ejection fraction, postoperative delirium, stypsis, nausea, and emesis.

According to these results, NA may reduce the global costs of surgery via earlier discharge and a possible significant reduction in postoperative GA-related complications. Moreover, given the potential for intraoperative hemodynamic advantages and a reduction in postoperative delirium, NA may facilitate radical treatment in patients with high anesthesiology risk who would otherwise undergo focal therapies.

A potential criticism could be that GA may be required in cases of emergency. However, during surgery patients can be rapidly switched from NA to GA, as for any other intervention performed under peripheral anesthesia. Specifically, the patient is sedated and rapidly placed in a supine position and a tracheal tube is inserted to allow mechanical breathing. In our series, one patient requested an intraoperative switch to GA because of anxiety. Mechanical ventilation was performed using a laryngeal airway mask in this case.

Notably, despite the wide distribution of robotic platforms, we decided to initially test NA during LPN because laparoscopy allows easier management of the operative field in comparison to robot-assisted surgery.

In conclusion, this first case series worldwide of LPN performed under NA demonstrates the feasibility and safety of the procedure. Future perspectives include a randomized controlled trial to demonstrate the noninferiority of NA in comparison to GA in LPN. A future pivotal prospective trial will test NA in robotic surgery. Another possible application of this anesthesiology protocol might be for older and frail patients, who are usually not fit for a minimally invasive

surgical approach. Results from studies assessing these options may pave the way towards defining a more comprehensive concept of minimally invasive surgery.

Conflicts of interest: The authors have nothing to disclose.

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