# *How I Do It: ERAS protocol featuring erector spinae plane block for percutaneous nephrolithotomy*

Bertie Zhang, MD,[1] Arinze J. Ochuba, MD,[2] Gregory R. Mullen, MD,[3] Arun Rai, MD,[3] Tareq Aro, MD,[3] David M. Hoenig, MD,[3] Zeph Okeke, MD,[3] Jared S. Winoker, MD[1,3]

[1]The Smith Institute for Urology at Lenox Hill, Zucker School of Medicine at Hofstra/Northwell Health, New York, New York, USA
[2]Johns Hopkins University School of Medicine, Baltimore, Maryland, USA
[3]The Smith Institute for Urology, Zucker School of Medicine at Hofstra/Northwell Health, New Hyde Park, New York, USA

ZHANG B, OCHUBA AJ, MULLEN GR, RAI A, ARO T, HOENIG DM, OKEKE Z, WINOKER JS. How I Do It: ERAS protocol featuring erector spinae plane block for percutaneous nephrolithotomy. *Can J Urol* 2023;30(4):11639-11643.

*Percutaneous nephrolithotomy (PCNL) is the gold-standard treatment for large and complex renal stones. Though associated with higher stone-free rates compared to other minimally invasive stone procedures, this comes at the expense of increased morbidity including postoperative pain and discomfort. We describe our enhanced recovery after surgery (ERAS) protocol for PCNL with emphasis on the use of erector spinae plane blocks to improve patient satisfaction and reduce postoperative opioid use and bother.*

**Key Words:** PCNL, ERAS, regional anesthesia, multimodal pain control

## Introduction

### *Overview of procedure*

Percutaneous nephrolithotomy (PCNL) is the recommended first-line treatment for large and complex renal calculi based on superior stone-free rates and lower retreatment rates compared to less invasive stone interventions.[1] However, these benefits must be weighed against the increased invasiveness and associated morbidity of PCNL, including complication risks and potential for significant postoperative pain and discomfort.

Initially developed for colorectal surgeries, enhanced recovery after surgery (ERAS) protocols employ standardized, multimodal strategies to reduce perioperative stress and promote early recovery after surgery.[2] The cornerstone of ERAS is multimodal analgesia. These regimens leverage the synergistic qualities of multiple non-opioid medications and anesthesia adjuncts to improve overall analgesic effect while reducing the dose of any single agent, thereby minimizing the side effect risks - most notably those associated with opioid use. While pain control garners heavy emphasis, particularly in the face of the opioid epidemic, effective protocols are comprehensive in

Accepted for publication July 2023

Address correspondence to Dr. Bertie Zhang, The Smith Institute for Urology at Lenox Hill, 130 East 77th Street, Black Hall, 5th Floor, New York, NY 10075 USA

mode and scope along the entire perioperative care pathway. ERAS protocols are now commonplace in many surgical subspecialties including vascular, thoracic, and hepatobiliary surgery.[3] In urology, most ERAS experiences comprise application to radical cystectomy, conferring lower complications rates, shorter hospital stays, and earlier return of bowel function.[4] These outcomes have fostered growing urologic interest in application of ERAS pathways to radical prostatectomy and stone surgeries, among others.[5,6]

Regional anesthesia, including neuraxial anesthesia and peripheral nerve blockade, is an important adjunct component of ERAS protocols for their potential to enhance perioperative pain control while reducing the need for narcotics in the early postoperative period.[7] The erector spinae plane (ESP) block is an interfascial plane block that aims to inject local anesthetic into a plane deep to the erector spinae muscle. The purported advantages are its perceived simplicity and safety compared to neuraxial and paravertebral techniques.[8] Cadaveric dye studies have shown that injectate can spread multiple spinal levels cephalad and caudal within the ESP with theorized visceral coverage by either interfascial spread of anesthetic toward the dorsal rami of the spinal nerves or anterior diffusion into the paravertebral space.[9] As a result, it may augment pain coverage for PCNL by blocking visceral sensory input from the kidney and perinephric tissues.

### *Relevant historical studies*

Pain during and following PCNL is multifactorial. In a retrospective cohort study, Wu et al identified several risk factors associated with moderate-to-severe pain after PCNL, including the stone size, number of calculi, presence of residual fragments, and operative time.[10] Others have attempted to better elucidate the nature of PCNL-related pain by altering tract size, post-procedural drainage, and other operative factors. Gridley et al reported the first experience with ERAS in stone disease, demonstrating a significant reduction in postoperative opioid use following ureteroscopy without compromising outcomes.[5] This protocol was soon after applied to PCNL by Girgiss and colleagues with similar, desirable outcomes.[6] To date, one randomized clinical trial has investigated use of an ERAS protocol in PCNL. The single-surgeon experience reported significantly lower pain scores with no differences in surgical outcomes, such as stone-free rate, operative time, and complications.[11]

In this article, we detail our initial experience with ERAS for PCNL. This includes a standardized multimodal analgesia regimen featuring ESP blocks for regional analgesia and an opioid prescribing algorithm for post-discharge management. We hope it serves as a primer for urologists and anesthesiologists interested in adopting such protocols into their practice.

## Method and technique

To accommodate interpatient variability in pain perception and postoperative discomfort following PCNL, the ERAS protocol is designed to be both adaptive and comprehensive, spanning all phases of the surgical experience: preoperative, intraoperative, postoperative, and postdischarge.

### *Preoperative management*

The preoperative phase, from initial surgical consultation through the preoperative care unit, comprises patient pain risk stratification and preemptive patient education. The former seeks to identify biopsychosocial factors that may contribute to an individual's perception of pain following surgery. For example, chronic pain conditions, prior or current opioid use, propensity for pain catastrophizing, underlying anxiety disorders, and social support structure, among others. In our practice, preoperative education is delivered via a multimodal approach including verbal, written (paper and electronic), and web-based education geared towards informing patients about the surgical procedure and managing postoperative expectations of pain, discomfort, and convalescence. At the same time, it focuses on strategies and treatments available to them in recovery and emphasizes principles of safe opioid use (if to be prescribed). Pharmacologically, preemptive analgesia with acetaminophen is administered in the preoperative holding area.

### *Intraoperative management and ultrasound-guided erector spinae plane (ESP) block*

After obtaining general endotracheal anesthesia, the patient is carefully positioned into a prone split-leg position. Working in collaboration with our anesthesia colleagues, we defer anesthetic management to the experts, including induction, maintenance, and intraoperative analgesia as there is little evidence to favor one anesthetic technique over another. Congruent with ERAS principles, our anesthesiologists often prefer the use of short-acting premedicants and volatile anesthetics for maintenance to minimize postoperative hangover. Dexamethasone is provided to reduce surgical inflammation and to augment the antiemetic effects of ondansetron. According to our ERAS analgesic regimen, Table 1, ketorolac 15 mg is administered to patients without contraindications.

TABLE 1. **Overview of analgesic components of ERAS for PCNL**

| | |
|---|---|
| Preoperative | [a]Acetaminophen 650 mg PO |
| Intraoperative | [b]Ketorolac 15 mg IV |
| | [c]ESP block (Alternative: [d]Peri-tract local anesthesia) |
| Postoperative (recovery and hospital admission) | [b]Ketorolac 15 mg IV QID |
| | [e]Oxybutynin 5 mg PO TID |
| | Tamsulosin 0.4 mg PO QD |
| | Pain 1-3: [a]Acetaminophen 1000 mg PO QID PRN |
| | Pain 4-6: Oxycodone 5 mg PO QID PRN |
| | Pain ≥ 7: Oxycodone 10 mg PO QID PRN |
| | Breakthrough pain: Hydromorphone 0.4 mg IV or fentanyl 25 mcg IV PRN |
| Discharge | [a]Acetaminophen 650 mg PO 4 times daily x 10 days |
| | [b]Ketorolac 10 mg PO 4 times daily x 5 days |
| | [e]Oxybutynin ER 10 mg PO daily x 10 days |
| | Tamsulosin 0.4 mg PO daily x 10 days |
| | [f]Oxycodone 5 mg PO 4 times daily PRN for severe pain |

[a]Avoid if history of hepatic insufficiency; [b]As permitted by eGFR; avoid if chronic renal insufficiency (Cr > 1.3), or history of peptic or gastric ulcers; [c]Anesthesiology-administered ESP block with 20 mL of 0.25% bupivacaine directed at the ipsilateral transverse process of T12; [d]10 mL of 0.25% bupivacaine injected at 3- and 9 o'clock alongside percutaneous tract(s); [e]Consider reducing or avoiding in patients with history of urinary retention; avoid in narrow-angle glaucoma, neurocognitive disease, or other clinical concerns; [f]Number of tablets prescribed is based on postoperative opioid requirements, see Table 2.

While the surgical team preps and drapes the lower half of the body for transurethral access, the anesthesiologist simultaneously performs the ESP block. Specifically, a 2-5 MHz curvilinear ultrasound (US) transducer is placed in the parasagittal orientation over the posterior aspect of the T12 transverse process (TP) on the ipsilateral side to identify the erector spinae muscles superficial to the TP. A 22G needle is inserted percutaneously parallel to the spine towards the caudal aspect of the TP, Figure 1. After aspirating to avoid intravascular injection of local anesthesia, correct needle tip position is confirmed by hydrodissection to visualize linear fluid spread under the erector spinae muscles, separating them from the TP, Figure 2. A total of 20 mL of 0.25% bupivacaine is injected for the ESP block.

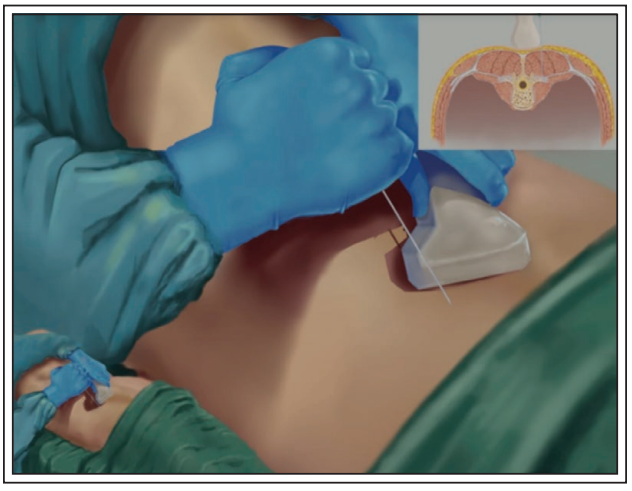

**Figure 1.** Performance of ultrasound-guided ESP block in prone position including orientation of ultrasound transducer and percutaneous needle relative to underlying transverse process of T12.

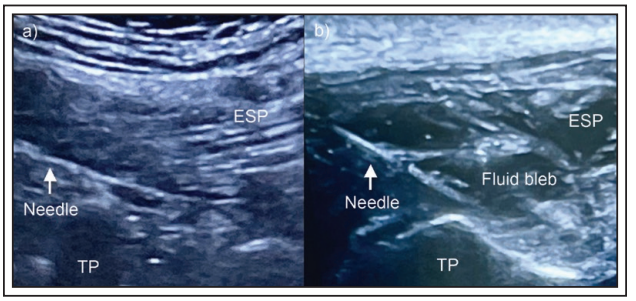


**Figure 2.** Ultrasound-guided ESP block technique. **(a)** The needle is advanced to the caudal aspect of the T12 transverse process (TP) in the parasagittal plane with the erector spinae muscle (ESP) in view. **(b)** During injection of local anesthetic, there is visualization of an expanding fluid bleb between the erector spinae musculature and the transverse process.

TABLE 2. **Equianalgesic conversions for common opioids and prescribing algorithm**

| **Common opioid and dose** | **MME** |
|---|---|
| 5 mg oxycodone PO | 7.5 (1.5x) |
| 2 mg hydromorphone PO | 8.0 (4x) |
| 0.4 mg hydromorphone IV | 8.0 (20x) |
| 25 mcg (0.025 mg) fentanyl | 7.5 (300x) |
| **[a]MME postoperative use** | **Discharge medications (oxycodone)** |
| < 8 MME | No opioids |
| 8-15 MME | 4 tablets |
| > 15 MME | 8 tablets |

[a]Total MME received over the 24-hour period immediately prior to hospital discharge
MME = morphine milligram equivalents

In patients unable to or who refuse to receive an ESP block, 10 mL of 0.25% bupivacaine is alternatively injected at 3- and 9 o'clock alongside the percutaneous tract(s) down to the level of the renal capsule at the conclusion of the procedure.

### *Postoperative management*

A standardized, multimodal pain regimen of both standing and as needed (PRN) medications is ordered for the postoperative phase, including recovery room and subsequent hospital admission. Unless otherwise contraindicated, all patients receive ketorolac, oxybutynin, and tamsulosin, Table 1. PRN medications are administered based on a 10-point Likert pain scale: acetaminophen for mild pain (score 1-3), oxycodone 5 mg for moderate pain (score 4-7), oxycodone 10 mg for severe pain (score 8-10), and IV opioids for breakthrough pain, Table 1.

## Discharge management

Our patients typically spend one night (less than 24 hours total) in the hospital and are discharged home with four non-opioid medications: acetaminophen, ketorolac, tamsulosin, and oxybutynin extended release (ER). Prescribing discharge opioid medications is guided by total postoperative morphine milligram equivalents (MME) received over the 24-hour period prior to hospital discharge, Table 2.

## Discussion

Following the initial description of ERAS for colorectal surgery, there are now more than two dozen formal ERAS guidelines spanning numerous surgical subspecialties and innumerable reported experiences in the literature.[2] Traditionally, these pathways have been geared toward patients undergoing major surgery. Though widely adopted for several index surgeries, the adoption of ERAS protocols for other surgeries has been relatively slow despite an abundance of published experiences. By comparison, the development of ERAS for stone surgery has garnered minimal interest to this point.[5,6]

Skeptics might argue that pain associated with PCNL is not significant enough to warrant the time, effort, and multidisciplinary buy-in to implement a protocolized pathway. However, postoperative pain is frequently underestimated and undertreated. Many patients likely experience moderate-to-severe pain after PCNL with one study reporting a 67% incidence.[10] Moreover, a noteworthy study evaluating Healthcare Cost and Utilization Project data found that the rates of opioid dependence and overdose following urological surgeries were highest in patients who underwent stone surgeries (0.15%).[12]

It is also worth highlighting that pain alone is a poor metric of postoperative experience and overlooks bothersome non-painful sensations and "discomfort" - the hallmarks of stone surgery. Bladder spasms, stent colic, and a wide spectrum of bothersome symptoms following PCNL are targeted with this standardized protocol.

The development of our protocol was borne out of the imperative to address unnecessary opioid use and improve patient experiences and recovery following PCNL. Preemptive patient education and surgical counseling tailored to the individual was established as a critical first step. Postoperative pain has been shown to be directly correlated with pain expectations, the quality of preoperative education, and psychosocial factors such as previous pain experiences,

anxiety, and pain catastrophizing.[13] The selection of perioperative non-narcotic medications was informed by the pathophysiology of surgical pain and other common symptoms, such as urinary urgency and stent colic. Based on a growing body of support for opioid-sparing analgesic effect in patients undergoing PCNL,[14] the ESP block was employed for its favorable benefit-to-risk profile, offering potential visceral pain coverage while avoiding the risks associated with neuraxial and paravertebral approaches. Earlier iterations of our protocol included preoperative and post-discharge gabapentinoids, which have been adopted in the aforementioned stone surgery ERAS protocols.[5,6,11] These medications have gained popularity in off-label perioperative use to potentially reduce acute postoperative pain, cumulative opioid use, and the incidence of chronic pain after surgery. In consultation with our anesthesiology collaborators, we omitted these agents from the protocol due to divergent outcomes surrounding their use as analgesic adjuncts weighed against their potential side effects. Finally, post-discharge opioid prescribing was standardized and guided by inpatient MME usage, an indicator of individualized pain perception and future opioid requirements.

### *Recommendations for development and adoption of PCNL ERAS in practice*

Successful implementation of an ERAS protocol requires mutual buy-in and coordination between all stakeholders: surgeons, anesthesiologists, nursing, and patients. Expectedly, this has been and continues to be an iterative process. Regular assessment should focus on patient outcomes, workflow feasibility, and costs. Along with constant communication between stakeholders, this allows for impactful periodic refinements. All elements of the protocol are not always possible in every patient; for example, supine PCNL positioning, anesthesiology discomfort with ESP blockade, and various patient-related factors, to name a few. In these scenarios, we still advocate for a multimodal approach to pain control employing various non-narcotic analgesics and emphasis on preoperative education. Though the benefit of this and many published ERAS protocols are not yet evidence-supported, it is generally accepted that the individual elements of an ERAS program are still beneficial in isolation or in combination.[15]

## Conclusion

The influence of surgical pain and discomfort on health-related quality of life and patient outcomes cannot be overstated. Collective efforts should be devoted to developing comprehensive strategies that minimize narcotic use and improve patient experiences. Implementation of an ERAS protocol with ESP blocks in PCNL represents a feasible approach to achieve this goal. □

References


1. Assimos D, Krambeck A, Miller NL et al. Surgical management of stones: American Urological Association/Endourological Society Guideline, part II. *J Urol* 2016;196(4):1161-1169.
2. History. ERAS Society. Available from URL: https://erassociety.org/about/history/. Accessed March 29th, 2023.
3. Melnyk M, Casey RG, Black P, Koupparis AJ. Enhanced recovery after surgery (ERAS) protocols: time to change practice? *Can Urol Assoc J* 2011;5(5):342-348.
4. Cerantola Y, Valerio M, Persson B et al. Guidelines for perioperative care after radical cystectomy for bladder cancer: enhanced recovery after surgery (ERAS®) society recommendations. *Clin Nutr* 2013;32(6):879-887.
5. Gridley C, Robles J, Calvert J et al. Enhanced recovery after surgery protocol for patients undergoing ureteroscopy: Prospective evaluation of an opioid-free protocol. *J Endourol* 2020;34(6):647-653.
6. Girgiss CBL, Berger JH, Chen TT. Standardizing perioperative medications to be used in an Enhanced Recovery After Surgery program is feasible in percutaneous nephrolithotomy patients. *J Endourol* 2020;36(10):1265-1270.
7. Mancel L, Van Loon K, Lopez AM. Role of regional anesthesia in enhanced recovery after surgery (ERAS) protocols. *Curr Opin Anaesthesiol* 2021;34(5):616-625.
8. Tulgar S, Ahiskalioglu A, Cassai AD, Gurkan Y. Efficacy of bilateral erector spinae plane block in the management of pain: current insights. *J Pain Res* 2019;27(12):2597-2613.
9. Zhang J, He Y, Wang S et al. The erector spinae plane block causes only cutaneous sensory loss on ipsilateral posterior thorax: a prospective observational volunteer study. *BMC Anesthesiol* 2020;20(1):88.
10. Wu H, Ding T, Yan S, Huang Z, Zhang H. Risk factors for moderate-to-severe postoperative pain after percutaneous nephrolithotomy: a retrospective cohort study. *Sci Rep* 2022;12(1):8366.
11. Li Q, Wan L, Liu S et al. Clinical efficacy of enhanced recovery after surgery in percutaneous nephrolithotripsy: a randomized controlled trial. *BMC Urol* 2020;20(1):162.
12. Shah AS, Blackwell RH, Kuo PC, Gupta GN. Rates and risk factors for opioid dependence and overdose after urological surgery. *J Urol* 2017;198(5):1130-1136.
13. Ip HYV, Abrishami A, Peng PWH, Wong J, Chung F. Predictors of postoperative pain and analgesic consumption: a qualitative systematic review. *Anesthesiology* 2009;111(3):657-677.
14. Winoker JS, Koo K, Alam R, Matlaga BR. Opioid-sparing analgesic effects of peripheral nerve blocks in percutaneous nephrolithotomy: a systematic review. *J Endourol* 2022;36(1):38-46.
15. Simpson JC, Moonesinghe SR, Grocott MPW et al. Enhanced recovery from surgery in the UK: an audit of the enhanced recovery partnership programme 2009-2012. *Br J Anaesth* 2015;115(4):560-568.