EUROPEAN UROLOGY 61 (2012) 164–170

available at www.sciencedirect.com
journal homepage: www.europeanurology.com

European Association of Urology

Surgery in Motion

Modified Supine Percutaneous Nephrolithotomy for Large Kidney and Ureteral Stones: Technique and Results

András Hoznek [a,], Julie Rode [a], Idir Ouzaid [a], Bernard Faraj [a], Michael Kimuli [b], Alexandre de la Taille [a], Laurent Salomon [a], Clément-Claude Abbou [a]*

[a] *Service d'Urologie CHU Henri Mondor, Créteil, France*
[b] *Leeds University Teaching Hospitals, Leeds, United Kingdom*

Article info

Article history:
Accepted April 19, 2011
Published online ahead of print on April 29, 2011

Keywords:
Percutaneous nephrolithotomy
Supine position

Please visit www.europeanurology.com and www.urosource.com to view the accompanying video.

Abstract

Background: Percutaneous nephrolithotomy (PCNL) is the standard treatment for kidney stones >2 cm. Recently, a novel approach in the modified supine lithotomy position has been developed.
Objective: To demonstrate with a video our technique of supine PCNL (sPCNL) and present our experience.
Design, setting, and participants: From September 2009 to August 2010, 47 consecutive patients were prospectively evaluated. There were 31 single, 9 multiple, and 7 staghorn stones. The mean body mass index was 26.1 ± 5 (range: 17.3–45.7), the mean stone size was 29.6 ± 15.3 mm (range: 10–75), and patients' American Society of Anesthesiologists scores were 1, 2, and 3 in 31, 11, and 5 cases, respectively.
Surgical procedure: Patients were positioned in Galdakao-modified supine Valdivia position. The details of the technique are shown in the film.
Measurements: Success was defined as patients free of stones or with residual stone fragments <4 mm.
Results and limitations: Average operative room occupation time was 123.5 ± 51.2 min (range: 50–245). In the single, multiple, and staghorn stone groups, the immediate success rate after sPCNL was 90%, 78%, and 43%, respectively. Complications included one fever, two incidents of pyelonephritis, one renal colic, two urinary fistulae, one postoperative hemorrhage, and one incident of acute urinary retention. Mean hospital stay was 3.4 ± 1.9 d (range: 2–12). Nine patients (19%) had a secondary procedure (extracorporeal shock wave lithotripsy or flexible ureterorenoscopy). At 3 mo, the success rate was 97%, 100%, and 100% in the single, multiple, and staghorn stone groups, respectively. However, the limitation of this study is its design, which is descriptive rather than comparative.
Conclusions: sPCNL is a safe and reproducible method. It offers the advantage of simultaneous retrograde and antegrade endoscopic combined intrarenal surgery, and we believe it is a further advancement in stone management. In addition, it is easier from the anesthetist point of view than the traditional prone approach. In our hands, it meant a simplification of the operative technique, resulting in a more time-efficient procedure.

* Corresponding author. Service d'Urologie CHU Henri Mondor, 51 Av. du Ml. De Lattre de Tassigny, 94010 Créteil-cedex, France.
E-mail address: andras.hoznek@hmn.aphp.fr (A. Hoznek).

0302-2838/$ – see back matter © 2011 European Association of Urology. Published by Elsevier B.V. All rights reserved. doi:10.1016/j.eururo.2011.04.031

1. Introduction

Percutaneous nephrolithotomy (PCNL) in the prone position has been considered the gold standard for the treatment of kidney stones >2 cm. However, during the last few years, a new approach in modified lithotomy position has been proposed with the purpose of simplifying the procedure and improving its efficacy.

The first large clinical series of supine PCNL (sPCNL) was reported by Valdivia-Uria [1]. His technique was further improved by Ibarluzea [2], opening the era of endoscopic combined intrarenal surgery. This approach is becoming increasingly popular worldwide, and its advantages are widely documented: easier anesthesia management, single positioning, and simultaneous anterograde and retrograde access to the urinary tract [2–8]. However, although it is clear that the prone position is no longer the exclusive way to perform PCNL, many urologists remain reluctant to consider the supine position [9,10]. We demonstrate our technique with a video and describe our experience with modified sPCNL in 47 patients and provide the method and the reasons why we adopted this novel technique in our routine.

2. Methods

2.1. Patients

Between 1 September 2009 and 30 August 2010, we performed 47 sPCNL procedures. Patient demographics are displayed in Table 1. Preoperative patient evaluation included history, clinical examination, routine laboratory investigations (basal parameters, including serum creatinine, complete blood count [CBC], and coagulation profile), and evaluation of the anesthesiology (American Society of Anesthesiologists) risk before general anesthesia. All patients had an unenhanced computed tomography (CT) scan and a plain film of the abdomen.

Stone size was determined by measuring the longest diameter on preoperative radiologic investigations; in the case of multiple calculi, it was defined as the sum of the longest diameter of each stone. Stone surface area was estimated using the formula described by Tiselius and Andersson (length $\times$ width $\times$ 3.14 $\times$ 0.25) [11].

Patients received low-molecular-weight heparin (LMWH) anticoagulant prophylaxis. A urine analysis was performed 1 wk before surgery; patients with a positive culture received specific antibiotic therapy for 4–7 d, and all others received 1.5 g of cefamandol intraoperatively.

2.2. Surgical technique

The patients were placed in a supine position, with one leg ipsilateral to the stone in extension and the other in flexion (Fig. 1). This position allowed retrograde access to the urinary tract throughout the intervention. The ipsilateral arm crossed the chest. The lumbar region next to the stone was raised to 20 degrees with the help of an inflatable device (Pelvic-Tilt, OR Comfort, Glen Ridge, NJ, USA). This device has a noninflated flap extending from one side. The flap was placed under the lumbar region opposite the stone, while the inflatable portion was placed under the stone. The weight of the patient on the flap prevents lateral shifting of the pillow. The patient was prepped and draped. Two surgeons started to operate simultaneously, allowing them to share operative tasks during the entire intervention.

While one of the surgeons performed cystoscopy and retrograde pyelography, the other proceeded to puncturing the kidney under combined ultrasound and fluoroscopic control with an 18-gauge puncture needle (Fig. 2). If ultrasound-guided renal puncture was unsuccessful because of patient obesity or poor ultrasound penetrability of the tissues, we used the fluoroscopic technique based on cephalad tilting of the C-arm described by Makhoul et al [12]. Details of the operative technique are summarized in Table 2.

The puncture site corresponded to the position of the stone and its largest bulk. The puncture of a posterior lower calyx is preferred by most urologists in Europe because this region is considered an avascular area of the kidney. Upper-pole puncture increases the risk of thoracic and intercostals artery injuries.Once access was established, two guidewires were inserted into the collecting system, a working guidewire and a security guidewire. Insertion was achieved with the help of a Coloplast Colibri nephrostomy set (Humlebæk, Denmark) as follows: After having inserted the first guidewire (Sensor, Boston Scientific, Natick, MA, USA), the tract was dilated with the dilators of the nephrostomy to 8F. The dilator we used is equipped with a peel-away access sheath. The dilator was then removed, leaving the access sheath in the collecting system. A second, Teflon-coated guidewire was introduced into the renal pelvis through the access sheath. This second "safety" guidewire was attached to the skin with an adhesive strip. The nephrostomy was loaded on the Sensor guidewire. This nephrostomy is equipped with a hollow metallic stylet. Pulling or pushing the stylet allows modification of the loop curvature of the nephrostomy, helping to direct the guidewire into the bladder. Once the guidewire had successfully descended into the bladder, the second surgeon exteriorized the tip of the wire through the urethra with the help of a cystoscope. This maneuver permitted obtaining through-and-through guidewire passage.

In all cases, the tract was dilated with a balloon. The size of the balloon was adapted to the patient's anatomy: In the case of narrow caliceal infundibulum, a 24F balloon (Cook Medical) was used. Otherwise, in dilated systems, we preferred the 30F balloon.

Procedures were performed with a 22F Olympus OES 4000 reference A3336A (Orangeburg, NY, USA) or Karl Storz 27295AA (Tuttlingen, Germany) nephroscope. In all cases, we used the LithoClast Master (Electro Medical Systems, Nyon, Switzerland) for stone fragmentation. We used a flexible nephroscope (Olympus CYF-5), ureterorenoscope (Olympus URF-P5), or a semirigid ureteroscope (Karl Storz URS 27001K Gautier) whenever we felt it was useful or indispensable.

At the end of the procedure, a nephrostomy was inserted. If no bleeding was observed at the removal of the Amplatz sheath, an 8F

Table 1 – Patient demographics

	Single (*n* = 31)	Multiple (*n* = 9)	Staghorn (*n* = 7)	Overall (*n* = 47)
Gender, M/F, no.	23/8	6/3	2/5	31/16
ASA 1/2/3, no.	25/6/0	3/3/3	3/2/2	31/11/5
BMI (range)	25.9 ± 2.9 (21.5–32)	26.7 ± 9.1 (17.3–45.7)	25.5 ± 5.5 (20.8–32.7)	26.1 ± 5.0
Stone size, mm (range)	21.7 ± 7.2 (10–40)	36.2 ± 10.3 (22–53)	56.4 ± 12.8 (40–75)	29.6 ± 15.3 (10–75)
Stone surface, mm^2 (range)	334 ± 235 (79–1257)	608 ± 792 (118–2640)	1405 ± 865 (471–2531)	540 ± 623 (79–2640)
Side, R/L, no.	16/15	3/6	4/3	23/24

M = male; F = female; ASA = American Society of Anesthesiologists; BMI = body mass index; R = right; L = left.

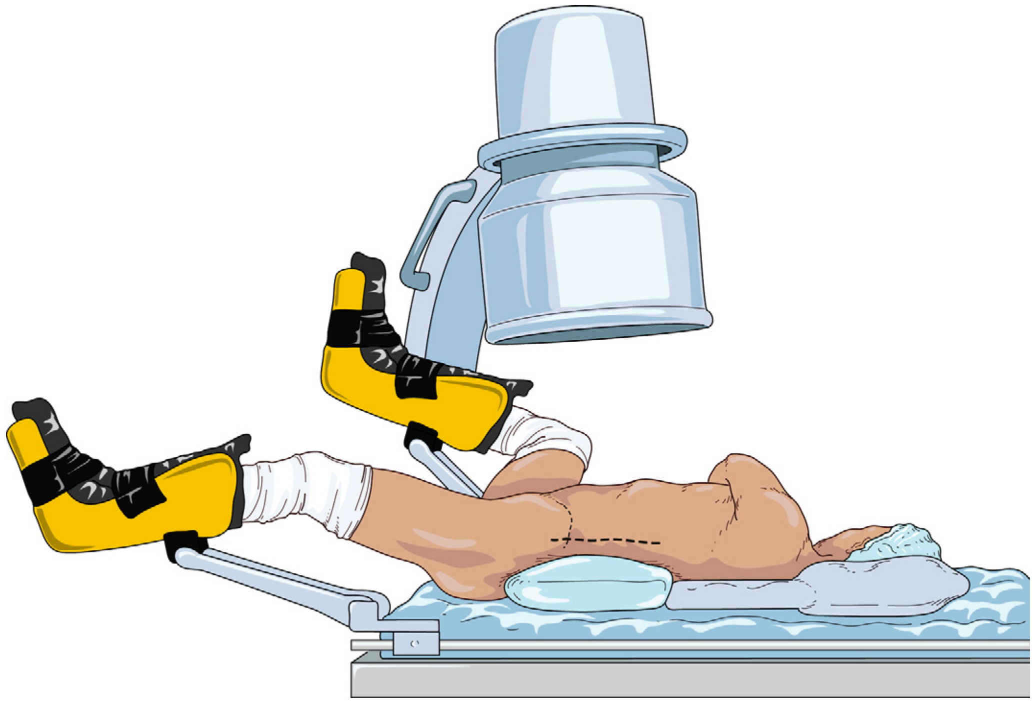

Fig. 1 – Galdakao-modified supine Valdivia position for percutaneous nephrolithotomy.

nephrostomy was placed. Otherwise, in the case of venous bleeding, a 24F Foley catheter was inserted, with the balloon inflated to 3 ml. We did not observe in this series any arterial bleeding. In the majority of cases, the ureter was drained with a double-J stent or, occasionally, with a ureteral catheter. All patients had a Foley bladder catheter for one night.

2.3. *Postoperative care*

All patients were given LMWH perioperatively. In the typical patient, the nephrostomy and the bladder catheter were removed the first day after surgery. A full CBC was run and serum creatinine checked the first postoperative day.

Radiologic examination was undertaken on the first postoperative day and was individually tailored. For patients with strongly radio-opaque calculi and normal body habitus, a kidney-ureter-bladder was performed. In obese patients, especially those with low-density, bulky, or complex calculi, we preferred nonenhanced CT scans. If no complications occurred, patients were routinely discharged the second postoperative day.

If the patient had no residual stones, the ureteral catheter was removed before the patient left the hospital. In patients with a double-J stent, if no residual stones were present, the stent was removed 1 wk after surgery in the outpatient department. Patients having a double-J stent and residual fragments underwent preferably a flexible URS or, occasionally, extracorporeal shock wave lithotripsy (ESWL) 2–3 wk after PNCL.

Table 2 – Operative technique

	Single (n = 31)	Multiple (n = 9)*	Staghorn (n = 7)	Overall (n = 47)
Puncture				
Superior calyx:	3	–	–	3
Midcalyx:	3	2	2	7
Inferior calyx:	25	7	5	37
Amplatz sheath:				
30F	20	7	5	32
24F	11	2	2	15
Use of flexible nephroscope	7	3	3	13
Use of flexible ureterorenoscope	1	3	4	8
Use of semirigid ureteroscope	–	3	–	3
OR occupation, min (range)	118 ± 48 (50–240)	110 ± 30 (80–140)	192 ± 74 (140–245)	123.5 ± 51.2 (50–245)
Drainage nephrostomy:				
8F	25	9	5	39
24F	6	–	2	8
Double-J stent	24	6	7	37
Ureteral catheter	7	3	–	10

OR = operating room.
* Three patients in the “multiple” group also had simultaneous lumbar ureteral stones treated with semirigid ureteroscopy, while the other stones were removed with the nephroscope.

Table 3 – Results

		Single ($n = 31$)	Multiple ($n = 9$)	Staghorn ($n = 7$)	Overall ($n = 47$)
Results	Evaluation:				
	CT	11	5	2	18
	KUB	20	4	5	29
	Success (%)	28/31 (90)	7/9 (78)	3/7 (43)	38/47 (80.9)
	Hospital stay, d (range)	3.1 ± 1.2 (2–6)	4 ± 2.2 (2–9)	3 ± 3.5 (2–12)	3.4 ± 1.9 (2–12)
Complications	Clavien grade 1, no. (%)	Transfusion: 1 Fever: 1 Renal colic: 1	–	Urinary retention: 1 Urinary fistula: 1	5/47 (10.6)
	Clavien grade 2, no. (%)	Postoperative hemorrhage: 1 Urinary fistula: 1	–	Pyelonephritis: 2	4/47 (8.5)
	Overall, no. (%)	–	–	–	9/47 (19.1)
Further treatment	ESWL, no.	1	–	2	3
	Flexible URS, no.	2	2	2	6
Success rate at 3 mo, no. (%)	–	30/31 (97)	9/9 (100)	7/7 (100)	46/47 (97.9)

CT = computed tomography; KUB = kidney–ureter–bladder; ESWL = extracorporeal shock wave lithotripsy; URS = ureterorenoscopy.

Complications were graded according to the modified Clavien classification [13]. *Fever* was defined as temperature ≥38.5 °C. *Hemorrhage* was defined as bleeding significantly altering the postoperative course and necessitating specific measures, such as hospitalization, bladder irrigation, or transfusion. *Treatment success* was defined as patients stone free or with residual fragments < 4 mm [14].

3. Results

Results are summarized in Table 3. Access creation was performed under ultrasound and fluoroscopic control. All patients had a single puncture site through the lower calyx in 37 cases, through the midcalyx in 7 cases, and through the upper calyx in 3 patients. The nephrostomy tract was developed with the help of a balloon. In 32 patients, a 30F Amplatz sheath was inserted; a 24F sheath was used in the remaining 15 patients.

A retrograde URS (semirigid or flexible) was performed in 11 cases, and a flexible nephroscopy was performed in 13 cases (see Table 2). Reporting of operative time is controversial, because usually in the literature, the starting event and the end of the procedure are not well defined. We preferred to report operative room occupation time, which was an average of 123 min in the whole series. There were no intraoperative complications.

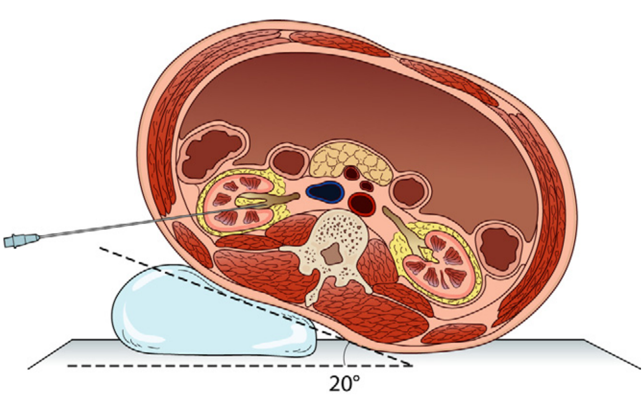

Fig. 2 – Trajectory of the puncture needle during supine percutaneous nephrolithotomy.

As mentioned earlier, the choice of postoperative drainage was made individually. If no bleeding was observed at the skin incision, an 8F nephrostomy was inserted. In the case of venous bleeding, a Foley catheter was used, with the balloon inflated to 3 ml. The ureter was drained with a double-J stent in 37 patients and with a ureteral catheter in 10 patients.

Postoperative complications included renal colic in one patient after removal of the ureteral catheter, without the presence of a residual stone. This patient probably had postoperative ureteral edema and was treated with a double-J stent for 1 wk. In two cases, a urinary fistula was observed. The fistulae were managed conservatively with a colostomy pouch at the level of the percutaneous incision and healed spontaneously within 48 h in one patient. In the other patient, it necessitated additional drainage with a bladder catheter for 5 d.

One patient presented with acute urinary retention and another with transient fever without bacteriologic evidence of infection. Two patients presented with severe pyelonephritis, both in the staghorn calculus group. The results in terms of full success (stone free + residual fragments < 4 mm) were 90%, 78%, and 43% in the single-stone, multiple-stone, and staghorn stone groups, respectively. The hospital stay was 3.4 d (range: 2–12) in the whole series. For more details, see Table 3. One patient was readmitted 1 d postoperatively with acute gross hematuria. His hemoglobin level was stable and did not require blood transfusion. He was treated conservatively with continuous-flow bladder irrigation for 5 d. Nine patients (19%) had further treatment with ESWL or flexible URS. The success rate at 3 mo increased to 97%, 100%, and 100% in the single-stone, multiple-stone, and staghorn stone groups, respectively.

4. Discussion

The advantages of the Galdakao-modified supine Valdivia (GMSV) position have been well documented and include, among other things, a unique positioning that is more comfortable from an anesthetist point of view and less time-consuming because of the possibility of simultaneous anterograde and retrograde access to the collecting system. These features definitely represent an added value for the patient, the surgeon, and the anesthetist when compared to the classic prone position.

However, although the supine position is becoming more and more accepted and popular worldwide, many urologists remain reluctant to use a method other than the classical prone position or one of its variants [9,15]. In our department, we switched to the GMSV position in 2008. As a teaching hospital, we always have a second surgeon (typically a resident) available, which allows rationalizing the different surgical tasks throughout the whole procedure, thus improving its efficacy.

Although severe anesthesia complications are seldom reported with the prone position, it is generally accepted that the supine position is more comfortable for the anesthetist, especially in obese or high-risk anesthesia patients [4,16]. In our experience, the absence of repositioning and the ability to coordinate the work of two surgeons resulted in an approximately 30-min gain in operative time. This shortening in operative time is confirmed by a recent meta-analysis based on two randomized controlled trials and two case-control studies including 389 patients [17]. Liu et al reported a 24.8-min shortening in operating time, which represents an important 28% reduction compared to the prone position.

In the present series, the puncture of the renal cavities was performed with combined ultrasound- and fluoroscopy-guided control. In some patients, ultrasound-guided renal puncture was unsuccessful because of patient obesity, undilated target calyx, or poor ultrasound penetrability of the tissues. In such circumstances, we used a purely fluoroscopic method, as described by Makhoul et al, based on cephalad tilting of the C-arm [12]. The supposed difficulty resulting from the hypermobility of the kidney in the supine position never jeopardized puncture or dilation.

The tract dilation was systematically performed with a balloon device. The diameter of the Amplatz sheath was selected according to the size of the calyx and caliceal infundibulum. A large (30F) Amplatz sheath allows removal of fragments up to 1 cm, whereas a smaller (24F) Amplatz sheath is less traumatic in the case of a narrow caliceal infundibulum.

The choice of the nephroscope is of utmost importance. On older nephroscopes, the cranked or 45° offset optic and the light cable are on the opposite sides of the shaft. Therefore, in a supine position, collision of this type of nephroscope may occur with the operative table, resulting in limited maneuverability. Presently, all major manufacturers make models on which the optical, irrigation line, and light cable are on the same side of the shaft. With such nephroscopes, we have never encountered any problem resulting from diminished manoeuvrability. No intraoperative complications occurred in our patients; in particular, we did not experience colonic injury.

The fear of increased risk of colonic or splanchnic injury in the supine position is unfounded. Indeed, in the prone position, because of the abdominal compression, the colon tends to move laterally and posteriorly to the kidney [18,19]. In the supine position, rather than making the colon more vulnerable to injury, the colon floats away from the kidney. However, this difference is of only hypothetical importance, and the best way to avoid colonic injury is to perform preoperative evaluation and planning with CT scans and puncturing under ultrasound control [20].

The rationale of postoperative drainage is to guarantee hemostasis, prevent urine extravasation, facilitate tract healing, and prevent ureteral obstruction resulting from residual stones or edema. There is no consensus regarding the size of the nephrostomy (large, small, or tubeless nephrostomy) and the type of ureteral drainage (ureteral catheter or double-J stent). The choice depends on the results and difficulties encountered during the surgical procedure, the preference and habits of the surgeon, and his or her priorities. In this series, we did not perform any completely tubeless procedures: We prefer to leave a small, 8F nephrostomy until the next day to be sure the patient has no abdominal pain or fever suggesting colonic injury or infection. In the latter situation, the nephrostomy should be left until resolution of the complication. There is growing evidence that a smaller nephrostomy is better tolerated than a large one and decreases the risk of postoperative urinary fistula [21]. A larger, 24F nephrostomy (Foley catheter) was used only in cases of persistent venous bleeding after the removal of the Amplatz sheath. Regarding ureteral drainage, we favored a double-J stent, because it allowed us to obtain a highly reproducible and predictable hospital stay. In this series, 66% of patients left the hospital by postoperative day 3. If on the control CT scan or plain film of the abdomen there was a significant ($\geq$4 mm) residual stone, the patient was scheduled for a flexible URS or ESWL. The presence of a double-J stent greatly facilitates a second-look flexible URS. Otherwise, in the absence of significant fragments, the double-J stent was removed 1 wk postoperatively.

Two patients presented with transient urinary leak at the nephrostomy site. Both patients were drained with double-J stents and were conservatively treated by attaching a colostomy bag at the nephrostomy site for a few days.

Our results in terms of stone clearance seem to be similar to other series. However, this is not a comparative study, and evaluating results related to other series has a questionable level of scientific evidence [22]. Furthermore, the efficiency of this novel approach remains controversial, and many urologists remain faithful to classical prone position. Two review articles identified a "trend in favour of better outcomes in the prone position over the supine position" [9] and recommend the supine position only in "carefully selected patients" [10]. But these studies included mostly case series and only a few comparative studies. Furthermore, it is rather hazardous to make conclusions based on noncomparative studies because of the extensive heterogeneity of reporting the results [22]. More recently, a meta-analysis based exclusively on higher-evidence-level randomized comparative studies confirmed that the simplification of the procedure in the supine position invariably leads to a significant and clinically relevant reduction in operative time while maintaining equivalent stone-free rates and similarly low complications [17].

The main indication for PCNL is to optimize stone clearance in the shortest time whilst at the same time minimizing any complications. We believe that in appropriate hands, either the supine or the prone approach can accomplish this goal. The choice of the approach depends on several factors. The human factors include the experience, training, preference, and convictions of the surgeon; the level of standardization of the procedure; the availability of a second surgeon; and the number and skills of paramedical staff. In addition, logistic factors include the organization and ergonomics of the operative room and the availability of appropriate technical equipment. It is certainly not judicious to try to extrapolate the experience of a given surgical team to the rest of the urologic community.

5. Conclusions

The modified supine lithotomy position for PCNL is here to stay. Its ability to offer combined antegrade and retrograde access to the urinary tract means a significant progress in stone surgery. For many urologic centers with appropriate equipment, especially new-generation nephroscopes, this novel approach may be more favorable for the patient, the operative theatre team, and the anesthetist when compared to the classic prone position. Stone clearance and morbidity seem to be similar. Because of the rationalization and simplification of the surgical steps, the operative time may be shortened, especially if two surgeons are available. It is likely that, as experience with the modified supine lithotomy position grows, this approach will gain increasing acceptance among urologists in the coming years.

Author contributions: András Hoznek had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: Hoznek.
Acquisition of data: Faraj, Ouzaid, Rode.
Analysis and interpretation of data: Faraj, Ouzaid, Rode.
Drafting of the manuscript: Hoznek.
Critical revision of the manuscript for important intellectual content: Abbou.
Statistical analysis: Faraj.
Obtaining funding: None.
Administrative, technical, or material support: de la Taille, Salomon.
Supervision: Abbou.
Other (specify): None.

Financial disclosures: I certify that all conflicts of interest, including specific financial interests and relationships and affiliations relevant to the subject matter or materials discussed in the manuscript (eg, employment/ affiliation, grants or funding, consultancies, honoraria, stock ownership or options, expert testimony, royalties, or patents filed, received, or pending), are the following: None.

Funding/Support and role of the sponsor: None.

Appendix A. Supplementary data

The Surgery in Motion video accompanying this article can be found in the online version at doi:10.1016/j.eururo.2011.04.031 and via www.europeanurology.com.

References

[1] Valdivia Uría JG, Valle Gerhold J, López López JA, et al. Technique and complications of percutaneous nephroscopy: experience with 557 patients in the supine position. J Urol 1998;160:1975–8.
[2] Ibarluzea G, Scoffone CM, Cracco CM, et al. Supine Valdivia and modified lithotomy position for simultaneous anterograde and retrograde endourological access. BJU Int 2007;100:233–6.
[3] De Sio M, Autorino R, Quarto G, et al. Modified supine versus prone position in percutaneous nephrolithotomy for renal stones treatable with a single percutaneous access: a prospective randomized trial. Eur Urol 2008;54:196–203.
[4] Manohar T, Jain P, Desai M. Supine percutaneous nephrolithotomy: effective approach to high-risk and morbidly obese patients. J Endourol 2007;21:44–9.
[5] Ng MT, Sun WH, Cheng CW, Chan ES. Supine position is safe and effective for percutaneous nephrolithotomy. J Endourol 2004;18: 469–74.
[6] Scoffone CM, Cracco CM, Cossu M, Grande S, Poggio M, Scarpa RM. Endoscopic combined intrarenal surgery in Galdakao-modified supine Valdivia position: a new standard for percutaneous nephrolithotomy? Eur Urol 2008;54:1393–403.
[7] Shoma AM, Eraky I, El-Kenawy MR, El-Kappany HA. Percutaneous nephrolithotomy in the supine position: technical aspects and functional outcome compared with the prone technique. Urology 2002;60:388–92.
[8] Steele D, Marshall V. Percutaneous nephrolithotomy in the supine position a neglected approach? J Endourol 2007;21:1433–7.
[9] de la Rosette JJMCH, Tsakiris P, Ferrandino MN, Elsakka AM, Rioja J, Preminger GM. Beyond prone position in percutaneous nephrolithotomy: a comprehensive review. Eur Urol 2008;54: 1262–9.
[10] Basiri A, Mohammadi Sichani M. Supine percutaneous nephrolithotomy, is it really effective? A systematic review of literature. Urol J 2009;6:73–7.
[11] Tiselius H-G, Andersson A. Stone burden in an average Swedish population of stone formers requiring active stone removal: how can the stone size be estimated in the clinical routine? Eur Urol 2003;43:275–81.
[12] Makhoul B, Yatim M, Guinard J, Fourcade RO. Comment ponctionner un rein pour réaliser une néphrolithotomie percutanée? Ann Urol (Paris) 2006;40:139–48.
[13] Tefekli A, Ali Karadag M, Tepeler K, et al. Classification of percutaneous nephrolithotomy complications using the modified Clavien grading system: looking for a standard. Eur Urol 2008;53: 184–90.
[14] Srisubat A, Potisat S, Lojanapiwat B, Setthawong V, Laopaiboon M. Extracorporeal shock wave lithotripsy (ESWL) versus percutaneous nephrolithotomy (PCNL) or retrograde intrarenal surgery (RIRS) for kidney stones. Cochrane Database Syst Rev 2009, CD007044.
[15] Ray AA, Chung DG, Honey RJ. Percutaneous nephrolithotomy in the prone and prone-flexed positions: anatomic considerations. J Endourol 2009;23:1607–14.
[16] Papatsoris A, Masood J, El-Husseiny T, Maan Z, Saunders P, Buchholz NP. Improving patient positioning to reduce complications in prone percutaneous nephrolithotomy. J Endourol 2009; 23:831–2.
[17] Liu L, Zheng S, Xu Y, Wei Q. Systematic review and meta-analysis of percutaneous nephrolithotomy for patients in the supine versus prone position. J Endourol 2010;24:1941–6.
[18] Hopper KD, Sherman JL, Luethke JM, Ghaed N. The retrorenal colon in the supine and prone patient. Radiology 1987;162:443–6.
[19] Tuttle DN, Yeh BM, Meng MV, Breiman RS, Stoller ML, Coakley FV. Risk of injury to adjacent organs with lower-pole fluoroscopically

guided percutaneous nephrostomy: evaluation with prone, supine, and multiplanar reformatted CT. J Vasc Interv Radiol 2005;16: 1489–92.
[20] Cracco CM, Scoffone CM, Scarpa RM. New developments in percutaneous techniques for simple and complex branched renal stones. Curr Opin Urol 2011;21:154–60.
[21] De Sio M, Autorino R, Quattrone C, Giugliano F, Balsamo R, D'Armiento M. Choosing the nephrostomy size after percutaneous nephrolithotomy. World J Urol. In press. DOI:10.1007/s00345-010-0587-6.
[22] Hyams ES, Bruhn A, Lipkin M, Shah O. Heterogeneity in the reporting of disease characteristics and treatment outcomes in studies evaluating treatments for nephrolithiasis. J Endourol 2010;24:1411–4.