Learning of percutaneous nephrolithotomy in supine position. An observational multicenter study

J.H. Amón a,*, D. Pérez Fentes b, L. Resel c, J.A. Galán d, A. Serrano e, A. Servera f, J.L. Alvarez-Osorio g, R. Ballestero h, E. Cao i, M. Arzoz j, P. Navarro k, M. Rigabert l, M. Sánchez m

a Hospital Universitario, Río Hortega, Valladolid, Spain
b Complejo Universitario de Santiago de Compostela, A Coruña, Spain
c Hospital Clínico San Carlos, Madrid, Spain
d Hospital del Vinalopó, Elche, Alicante, Spain
e Hospital Universitario de Guadalajara, Guadalajara, Spain
f Hospital de Manacor, Mallorca, Spain
g Hospital Puerta del Mar, Cádiz, Spain
h Hospital Marqués de Valdecilla, Santander, Spain
i Complejo Universitario de Cartagena, Murcia, Spain
j Hospital German Trias i Pujol, Badalona, Barcelona, Spain
k Complejo Hospitalario Insular Materno-Infantil, Las Palmas de Gran Canaria, Spain
l Hospital Virgen de Arrixaca, Murcia, Spain
m Hospital Universitario Lozano Blesa, Zaragoza, Spain

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Abstract

Objective: To prospectively study the post-operative results and complications of percutaneous nephrolithotomy (PNL) in supine position to assess difficulty of learning it and how experience affects the results. To establish a relative comparison with the data published in the literature on the prone position.

Material and methods: A prospective observational multicenter study on PNL in Valdivia position or in its Galdakao variant was performed. Demographic variables and specific variables related to the lithiasis were collected. Technical aspects, surgery time, success rate and complications according to the Clavien-Dindo classifications were assessed.

Results: A total of 335 PNL in supine position conducted in 13 Spanish centers were registered from September 2008 to June 2011. The man:woman ratio was 1:1.28 and mean age 51.3 ± 14.5 years. 211 (63%) cases were performed by urologists with experience in ≥50 cases and 124 (37%) by urologists with less experience. Mean operation time was 113.3 ± 46.4 min, 106.6 ± 38.2 for the experienced ones vs. 124.9 ± 56.2 in the novice ones (p<0.002). No difference was...
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Introduction

Open surgery of the lithiasis has gradually been replaced by percutaneous nephrolithotomy (PNL) and extracorporeal shock wave lithotripsy (ESWL) since 1980. While at first ESWL was the most used treatment, the worst results with latest-generation lithotripters have determined that the last decade has seen a clear revival of the PNL which, overall, achieves a success rate of 68–75.5%. Since the inception of this technique there have been significant changes in aspects concerning the way of delaying the path and its gauge, the way to fragment the lithiasis, the final drainage, etc.; but perhaps the most significant, because of the importance that it has for the anesthesia of the patient and for making the turning of it unnecessary, has been the change in the surgical position from prone to supine, introduced by Uria Valdivia et al. in 1987. Changing the position of the lower extremities subsequently provided by Ibarluzea et al. has enabled the simultaneous retrograde approach to the renal cavities, so that this position has been pointed out as the new standard for the performance of the PNL.

Despite the many advantages of the supine position, a recent study sponsored by the Clinical Research Office of the Endourological Society (CROES), which was conducted on 5803 patients provided by more than 100 centers in 26 countries throughout the world, clearly shows the pre-eminence of the prone position over the supine one: 80.3% vs. 19.7%, respectively.

In order to increase the knowledge about the use of the supine position for percutaneous surgery, from the Lithiasis, Endourology, and Laparoscopy workgroups of the Spanish

PALABRAS CLAVE
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Decúbito supino;
Resultados;
Complicaciones;
Aprendizaje

El aprendizaje de la nefrolitectomía percutánea en posición supina. Estudio observacional multicéntrico

Resumen

Objetivo: Estudiar prospectivamente los resultados operatorios y las complicaciones de la nefrolitectomía percutánea (PNL) en posición supina para valorar la dificultad de su aprendizaje y cómo afecta la experiencia a los resultados. Establecer una comparación relativa con los datos publicados en la literatura acerca de la posición en prono.

Materiales y métodos: Estudio prospectivo observacional multicéntrico sobre NLP en posición de Valdivia o en su variante de Galdácano. Se recogen variables demográficas y variables específicas dependientes de la litiásis. Se valoran aspectos técnicos, tiempo quirúrgico, tasa de éxito y complicaciones según la clasificación de Clavien-Dindo.

Resultados: Desde septiembre de 2008 a junio de 2011 se han registrado 335 NLP en posición supina realizadas en 13 centros españoles. La proporción hombre/mujer fue 1:1,28 y la edad media 51,3 ± 14,5 años; 211 (63%) casos fueron realizados por urólogos con experiencia de ≥ 50 casos y 124 (37%) por urólogos con menos experiencia. El tiempo operatorio medio fue 113,3 ± 46,4 min, 106,6 ± 38,2 en experimentados vs. 124,9 ± 56,2 en noveles (p < 0,002). No se detectó diferencia en el tamaño medio de la litiásis, pero en el grupo con experiencia se trató una mayor proporción de casos coraliformes y de litiásis múltiples que en el grupo novela (p < 0,001). La tasa de éxito evaluada como ausencia total de restos litiásicos fue 69,6%, sin diferencias entre grupos (68,2 vs. 71,8%). En 102 (30,6%) pacientes hubo litiásis residual, precisando tratamiento complementario 60 (17,9%). La tasa relativa de éxito global fue 82,1% y la tasa de complicaciones 25,4%, sin detectarse diferencias entre grupos. No obstante, el grupo novela presentó mayor número de complicaciones mayores (p < 0,001).

Conclusión: La NLP en supino está teniendo una rápida y consolidada difusión en nuestro entorno, y su efectividad y seguridad parece equivalente a la descrita en la literatura para la NLP en prono. Resulta posible conseguir buenos resultados con una modesta curva de aprendizaje. La tasa de complicaciones mayores asociadas al procedimiento disminuye con la experiencia.

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Association of Urology (AEU), it has been suggested to conduct a multicenter prospective observational study assessing the indications, results, and safety of the supine position to conduct the PNL and compare these results to those of the PNL in prone position in light of the existing literature.

**Patients and methods**

We designed a prospective observational study within the scope of the AEU open to all centers performing the PNL in Valdivia supine or in its Galdácano variant. The inclusion of patients was carried out over a period of 30 months.

The only criterion for inclusion of patients in each center was the indication for PNL in supine position as primary treatment of renal lithiasis or prior endourological treatment failure. In the inclusion of centers, we did not consider previous experience with the procedure as a limiting criterion. Thus, centers with extensive experience took part in the study along with others with less practice that were making their learning curve. However, in the analysis of results, centers with more or less experience were differentiated taking as threshold of overcoming the learning curve the performance of 50 surgeries.

The data were included in encrypted form in a central database designed by the technician of the AEU, to which each researcher had access after validation by the study coordinator.

As preoperative data, we collected the demographic characteristics of the patients, their comorbidity, the anesthetic risk, previous history of endourological or surgical performance on the lithiasis, and various data on the lithiasis. These specific data include the location, number, size, and morphology thereof, as well as the possible existence of renal malformation. We also assessed the preoperative hemoglobin and creatinine, the urine culture status, and the use of antibiotic prophylaxis.

The main intraoperative data assessed include the surgical time and the various aspects of the technique, such as the guide of the puncture by ultrasound or fluoroscopy, the way to prolong the tract (using Amplatz, Allken, or balloon), the size of it, the approached calyx, the number of paths made, the energy used in lithotripsy, the use of approaches combined with ureteroscopy (URS), the occurrence of intraoperative complications, and the use of excretory drainage with nephrostomy and ureteral catherization.

Among the postoperative data, we evaluated the absence or permanence of lithiasic fragments, their number and size, and the need for repeated or complementary treatment. The complications that occurred were classified according to the Clavien–Dindo classification. The postoperative hemoglobin, the need for transfusion, and the number of transfused units were assessed.

In the statistical analysis, the quantitative variables were described as mean ± standard deviation (SD) and their normality established with the Kolmogorov–Smirnov test. The qualitative variables were described using percentages. We used the Chi-square test with Fisher’s exact test to study the association between qualitative variables. In order to study the differences between means we used Student’s ‘t’ test or the Mann–Whitney U test, depending on the application conditions. The statistical analysis was performed using the SPSS v. 15.0 program. Data loss was lower than 15% in the studied variables.

**Results**

From September 2008 to June 2011, we performed the PNL in supine position in 335 patients, in a total of 13 Spanish centers. A group of 211 (63%) cases were performed by urologists with prior experience in the procedure; that is, that before the start of the study they had performed more than 50 similar procedures. Another 124 (37%) cases were performed by specialists who were carrying out their learning curve; that is, they had performed fewer than 50 procedures when they participated in the study.

**Demographic results**

The cohort of patients included 147 (43.9%) men and 188 (56.1%) women, with a male/female ratio of 1:1.28. The mean age was 51.3 ± 14.5 years. A total of 140 (41.7%) patients had comorbidities, especially hypertension and diabetes mellitus. The distribution of these data, together with the BMI and the ASA score, are expressed in Table 1.

The location of the lithiasis was right in 140 (41.8%) and left in 195 (58.2%), representing a right/left ratio of 1:1.39. 50.1% of the patients (168) had a history of surgery or previous endourological procedure due to lithiasis. In 6 cases (1.8%) the patient had a single kidney; in 2 patients (0.6%) there was congenital malformation (horseshoe kidney), in 2 (0.6%) renal graft, and in 7 (2.1%) urinary diversion (Table 2).

**Characteristics of the lithiasis**

The average size of the lithiasis was 970 ± 881 mm². In 51 patients (15.2%) the lithiasis was assessed as complete staghorn, with an average size of 2041 ± 967 mm², and
in 77 (23%) as pseudocoraliform, with an average size of 1105 ± 827 mm². In 184 patients (54.9%) the lithiasis was unique, affecting the pelvis or the calyces, with an average size of 678 ± 669 mm². In 23 cases (6.9%) the lithiasis was multiple and the average lithiasic area in these cases was 860 ± 767 mm².

There were no differences in the size of the stones operated by groups with different experience, but such were there in the type of lithiasis (p < 0.001), and there being a greater percentage of staghorn lithiasis and multiple calculi in the group of most experienced surgeons (16 vs. 7.3% and 7.5 vs. 5.6% for both types of lithiasis, respectively). Data relating to the type of lithiasis operated and the size thereof, as well as the different distribution of the data according to the experience of surgeons are detailed in Tables 3 and 4.

Another concern is the isolation of germs in urine culture samples and the different prophylaxis used in the process. 259 patients (77.3%) underwent urine culture before surgery, detecting positivity thereof in 25 (22.7%) cases. The most frequently isolated germ was *Escherichia coli* (15 cases, 60%), followed by *Enterococcus faecalis* (2 cases, 8%), *Proteus* sp. (2 cases, 8%), *Candida* sp. (2 cases, 8%), *Pseudomonas* sp. (1 case, 4%), *Salmonella* sp. (1 case, 4%), and *Staphylococcus saprophyticus* (1 case, 4%). The data describing the preferred patterns of antibiotic prophylaxis are expressed in Table 5.

### Intraoperative results

The mean operative time was 113.3 ± 46.4 min, being lower for the group with previous experience (106.6 ± 38.2 min vs. 124.9 ± 56.2 min; p < 0.002). In all the cases of this study, both the puncture and the development of the nephrostomy path were performed by the urologist.

To do it we used fluoroscopy in 89.9% of the cases and ultrasound in 10.1%. In most patients a single path was made (97%) and it was multiple only in 3%. The creation of the nephrostomy tract was performed using high-pressure balloon catheter in 235 patients (70.1%), Amplatz type progressive dilators in 60 (17.9%), and Alken type metal telescopic dilators in 40 (11.9%). In 243 cases (72.5%) it was prolonged up to a 30 Fr gauge. The proportion of patients who achieved a maximum dilation 28, 26, 24 and 20 Fr. gauge was 5.1, 6, 14.6, and 1.8%, respectively.

For lithiasic fragmentation, we used pneumatic energy in 258 patients (77%), laser in 33 (9.6%), and ultrasound in 22 (6.6%). In 22 cases (6.6%) we did not use any energy. In most patients (83.9%) a nephrostomy catheter was left located at the end of the intervention. In 54 (16.1%), a procedure without intubation (tubeless) was carried out. In most cases (92.2%), a ureteral or double J catheter was left. All these data are presented in detail in Table 6.
Table 6 Descriptive characteristics of the intervention.

<table>
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<td>Medium calyx</td>
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<td>Type of guide wire</td>
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<td>Ultrasound</td>
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<td>2</td>
<td>10</td>
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<tr>
<td>Type of dilation</td>
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<td>Balloon</td>
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</table>

Postoperative results

The overall postoperative stay was 4.8 ± 3.8 days, with no differences between the 2 experience groups. Overall, in 85 patients (25.4%) there were complications. Although there were no differences in the complication rate according to the defined experience groups, the least experienced group suffered higher grade complications according to the Clavien–Dindo classification (p < 0.001).

The mean decrease in hemoglobin was 2.4 ± 1.5 g/dl, the transfusion rate being 5.4% (8.1% in the least experienced group and 3.8% for the most experienced group), and the average transfused units were 2.6 ± 2 (3.1 ± 2.6 vs. 2.0 ± 0 for the least expert group and for the expert group, respectively). These differences have no statistical significance. One patient had an arteriovenous fistula that required embolization. 28 cases (8.4%) had postoperative fever > 38 C and 3 (0.9%) severe sepsis, which in a patient led to death from this cause. The rest of complications are listed in Table 7.

The absolute success rate, assessed as total absence of lithiasic fragments was 69.6% (71.8 vs. 68.2%), with no differences between groups. In 102 patients (30.4%), residual lithiasis was recorded, 60 patients (17.9%) requiring complementary treatment. This treatment involved second PNL in 21 cases (6.3%) and ESWL in 36 (10.7%). Therefore, the relative rate of success including salvage therapy was 83%. There are a great number of residual lithiasis in the least experienced group, but overall no differences are detected between the probability of residual lithiasis, the type of treatment thereof, and the overall success rate of the procedure (Table 7).

Discussion

Despite the advantages of the position described by Valdivia et al. in the PNL still today it only represents 20% of the approaches in European practice. A further sub-analysis of the CROES study, focused on the results and differential backup between both positions in supine and prone, showed a better success rate for the prone position (77 vs. 70.2%), although the bleeding and fever rate were lower for the supine position. The comparative studies between these positions conducted to date are not numerous, but they have demonstrated equivalence between both in terms of success rates and complications. Some authors have pointed out the clear convenience of the supine position for the PNL in obese patients, to avoid anesthetic complications and even to prevent supracostal punctures.

The multicenter study conducted from the AEU aim of this article is to provide greater understanding of the results and complications of the PLN in supine, while providing data on many relevant technical aspects that draw the profile of how the PLN is done at this time in a representative sample of Spanish hospitals; although not all the groups using this position participated in it. Furthermore, by including 37% of cases belonging to groups that are starting in the technique, this work helps to know certain aspects of the learning curve of the procedure. The weakness of the work lies in its non-comparative nature with the prone decubitus position, obviously a minority today in our health care environment.

In this study, unlike different trends recorded in other European field studies, all the approaches were performed by the urologist. Preferentially we used fluoroscopic control and a single tract was mostly also conducted created with balloon dilation. Lithiasic fragmentation took place predominantly with pneumatic energy. In a high percentage of patients, nephrostomy was left. Only 16% of the procedures were performed without intubation. An incipient tendency to use combined approaches is also appreciated, which were performed in 11.7% of the interventions.

The overall rate of complete success, defined by the total absence of lithiasic fragments checked by imaging, which has been achieved in this cohort of patients (69.6%) is somewhat lower than those reported in both prone and supine. We cannot justify this result by the fact that a significant number of cases were performed by urologists in learning curve, since there was no difference between the success rates achieved by each group. These differences are possibly due to the fact that in our study the lithiasic load treated was larger and that more than 40% of the lithiasis were complex, if we consider the percentage of branched lithiasis and multiple lithiasis that affected several calyces. We believe that these factors may affect
the incidence of residual lithiasis.\textsuperscript{18} On the other hand, the multi-institutional nature of this study also involves a record very close to the reality of everyday practice, which may not be present in other studies conducted in specific units of this type of pathology.

Although the operative time was greater in the least experienced group, if we assess the success rate of the inexperienced group, as well as the number of residual lithiasises and their size, we see that the results that expert urologists obtain in that position are readily reproducible by the least experienced urologists. These data suggest that the learning curve of the PLN in supine is similar and no higher than that of the PNL in prone, which estimates the acquisition of competence at around 45–60 interventions.\textsuperscript{19,20}

We should do a different reading of the complications that occurred during this study. The overall complication rate was lower than that in other studies,\textsuperscript{22} but significantly greater than 15\% described by the CROES.\textsuperscript{4} This difference is mainly due to a higher rate of minor complications in our study (68.2 vs. 55\%). Furthermore, although there was no difference in the overall rate of complications between the experience groups, there was when comparing the grade of complication. In the expert group, the Clavien grade 1 complication rate accounted for 87\% of the total compared to 35.5\% in the inexperienced group and in this one the greatest complications occurred in the scale, including grade 5 in one case. The transfusion rate in our study was 5.2\%, lower than those previously reported\textsuperscript{21,22} and similar to that of the CROES (5.7\%).\textsuperscript{4} A larger number of cases are obviously needed to carry out logistic regression studies to better determine such differences.

Conclusion

The supine LPN achieves excellent results in the resolution of complex lithiasis with a low rate of major complications, so it seems equivalent in effectiveness and safety to the PLN in the prone position, according to the data available in the literature. In addition, its rapid learning curve makes it possible for these results to be achieved in a short time.

Conflict of interest

The authors declare that they have no conflict of interest.

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