Predictive analysis of factors associated with percutaneous stone surgery outcomes

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Introduction: *The aim of this study is to identify surgical, patient- and stone-related factors predictive of clinical success and complications after percutaneous nephrolithotomy (PCNL).*

Materials and methods: *We prospectively studied 100 consecutive PCNL procedures. Univariate and multiple regression models were used in order to identify which variables could act as independent predictors of PCNL outcomes. Success was defined as complete absence of fragments in a non-contrast CT. The Clavien-modified grading system was used to classify the complications.*

Results: *Univariate analysis showed that patients rendered stone-free had a significantly lower stone burden, shorter operating times, single stones and non-struvite composed calculi. Patient age, nephrostomy tract dilation with high pressure balloon and a stone composition different to struvite behaved as significant protective factors for complications. Logistic regression models revealed that the main independent prognostic factor for success was stone surface (OR = 0.997 per mm^2, p = 0.000), followed by multiple stones (OR = 0.203, p = 0.050). On the other hand, struvite composition (OR = 5.911, p = 0.028) was an independent predictor for the development of complications, whilst age (OR = 0.936, p = 0.012) and high pressure balloon dilation (OR = 0.041, p = 0.007) were rendered independent protective variables.*

Conclusions: *Stone burden and multiple calculi in the kidney affect the immediate stone-free rate, whilst Amplatz dilation, struvite stones and young patients lead to a higher incidence of postoperative complications. This information can be very useful for patient counseling, regarding percutaneous kidney stone management.*

Key Words: percutaneous nephrolithotomy, risk factors, treatment outcome, nephrolithiasis

Introduction

Percutaneous nephrolithotomy (PCNL) is nowadays considered the treatment of choice for kidney stones larger than 2 cm or when other less invasive treatments, like ureteroscopy (URS) or shock wave lithotripsy (SWL), have failed.[1,2]

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Since its first description in 1976,[3] the technique has evolved trying to improve its success, in terms of stone-free rate, as well as to lessen its morbidity. In fact, PCNL has clearly demonstrated less injury, shorter convalescence and reduced cost, when compared with open approaches, thus largely replacing open surgery for removal of large and complex kidney stones.[4]

Nevertheless, endourologists are still looking for their "Holy Grail": how to remove all the calculi whilst bringing about the minimum damage to the patient.

In this regard some technological improvements have been made: the miniaturization of the rigid endoscopes, the advent of the flexible nephroscopes and ureteroscopes with digital imaging, the use of nitinol

for stone fragment removal, and the new means of lithotripsy, like the Holmium laser.[5] Other refinements have been made in the position of the patient and the surgical approach, such as the change from prone to supine[6] and the description of the Galdakao-modified supine Valdivia position (GMSVP).[7] These changes have opened the door to the simultaneous use of flexible endoscopes in a retrograde way, avoiding the need for multiple tract procedures, thus minimizing its invasiveness, giving way to concept of endoscopic combined intrarenal surgery (ECIRS).[8-10]

Despite these advances, we consider that the final goal has not yet been reached. Moreover, there is still a huge variability in PCNL outcomes. These differences can be explained by the several definitions used for both success and complications in different papers.[11] More importantly, we all know from the experience that this variability also depends on some factors which have been previously identified by other authors as outcome predictors.[12-15]

The ideal situation would be to preoperatively identify those variables potentially associated with PCNL efficacy and safety. Thereby, we would have some predictive algorithms to determine the theoretical success rate of a given case[16] and, more importantly, to prevent some possible complications before they occur.[17,18]

The purpose of the present study is to identify those prognostic factors of clinical success and complications in our series of supine PCNL.

Materials and methods

Between October 2008 and October 2011 all 100 consecutive PCNL procedures performed at our department were initially included in this study, which was approved by the local ethics committee. Two patients with relevant missing data were excluded, so finally 98 cases were available for analysis. PCNL indications were kidney stones larger than 2 cm in diameter or SWL failures, with no specific exclusion criteria defined.

We analyse those variables potentially related with both success and complications after percutaneous stone surgery, such as: age, sex, previous stone surgery or lithotripsy in the treated kidney, body mass index (BMI), stone surface, stone composition (calcium/uric acid/struvite), stone location (solitary/multiple/staghorn), duration of surgery, type of surgery (PCNL only or PCNL with simultaneous ureteroscopy), calyx of access (upper/middle/lower), calibre of the access (24 or 30F) and the dilation system used (Amplatz serial dilators or high pressure balloon).

Preoperative stone surface was calculated by non-contrast computed tomography (CT) scan or, less often, by intravenous urography, and expressed in square millimetres, according to EAU guidelines.[1] We define success as the complete absence of fragments in the routinely performed non-contrast CT in the third month after the procedure. Afterwards, the stone free status was primarily assessed by ultrasonography and plain x-ray films, at regular intervals. Complications are classified using the Clavien-modified grading system, in order to allow comparisons with other published series.

Surgical technique

Sterile urine was ensured before surgery in all cases. Even so, patients were preoperatively prepared with 1 g of intravenous amoxicillin clavulanate. Were the calculi staghorn (partial or complete) or if the patient had an indwelling catheter, an extra 240 mg of intravenous gentamicin was also administered. In case of preoperative positive urine cultures, an appropriate antibiotic treatment was scheduled before PCNL.

All the procedures were performed under general anaesthesia, by the same surgeons, in the Galdakao-modified supine Valdivia position (GMSVP). The puncture was done with a 16G needle, under fluoroscopic and ultrasound control, after retrograde injection of contrast through a 6F open-ended ureteral catheter. We use a 0.038" PTFE guidewire to obtain access to the pelvicaliceal system, trying to pass it through the ureter to the urethra. The chosen calyx of access was the one which, based on the preoperative imaging tests, theoretically allowed the best stone clearance with a single-tract percutaneous approach.

We either dilate the nephrostomy tract with Amplatz serial fascial dilators or high pressure balloon, to a 24F or 30F calibre, depending on the surgeon's preferences and system availability in our center. We start the endoscopy using a 21.5F rigid nephroscope and pneumatic lithotripsy, pulling out fragments with forceps or nitinol baskets. In certain stone locations of difficult access, we use flexible nephroscopy to reach and fragment the calculi with holmium laser, and extract them with 2.4F or 3F nitinol baskets. In some cases, we take advantage from the GMSVP to perform combined intrarenal surgery with a flexible ureteroscope and holmium laser. The systematic use of flexible endoscopes and the contribution of this position to the combined access have led to a minimal need for multiple tracts to treat even the most complex cases, but increased the operative time and the cost of the procedure.

Before finishing the procedure, we systematically review all the pelvicaliceal system with a flexible nephroscope through the percutaneous access to look for residual stone fragments. With this maneuver we have identified and extracted some residual calculi which

would have gone unnoticed with only an anterograde pyelography, thus improving our stone free rate.

In all cases a 12F to 20F nephrostomy tube and a 6F double J indwelling stent were routinely left. The first is removed the day after discharge, usually on the third postoperative day, if no complications appear. The latter is taken out, on an outpatient basis, between the 2nd and 4th postoperative week, depending on the department's appointment organization. We don't perform any imaging prior to the CT scan in the 3rd postoperative month, hence the decision of performing auxiliary interventions is mainly based on the endoscopic and fluoroscopic appearance at the end of the procedure. If a second look is required, it is scheduled in two weeks after PCNL, without taking out the tubes.

Data analysis

Counts were compared by the chi-square test. Continuous data were compared using the t test if the distribution of samples was normal or the Mann-Whitney U if the sample distribution was asymmetrical.

The potential predictors for success and complications after PCNL (all variables included in Table 3 and 4, respectively) were selected following the step AIC procedure. For this purpose logistic regression models were performed. Odds ratios (ORs) and their 95% confidence intervals (95% CI) were derived from the coefficients. Diagnostic performance of these models was assessed by constructing receiver operating characteristic (ROC) curves and was evaluated by calculating the area under each ROC curve (AUC).

All statistical analyses were carried out in R using the packages RMS (for fitting logistic models), MASS (step AIC procedure) and pROC (for AUC and ROC curves). These packages are freely available at http://cran.r-project.org.

Results

A total of 98 patients were finally included for analysis in this study, whose demographics are depicted in detail in Table 1. The average patient age was 58 years (range 26-86), with a predominant female sex distribution (71% versus 29%) and a mean body mass index of 28.8 kg/m^2 (range 18.6-45.4). More than half the patients (59%) had previously undergone open stone surgery (21 cases) or SWL (37 cases). Concerning stone characteristics, we largely operated on staghorn calculi (55%) and high stone burdens, with a median stone surface of 471 mm^2 (range 71-1936). The lower calyx was chosen for access in 85% of the cases, whilst only in four was the approach was supracostal. Nephrostomy tract was mainly created with Amplatz serial dilators in 75% and high pressure balloon for the rest, to a 24Fr or 30Fr caliber, depending on the surgeon's preference. We took advantage of the simultaneous retrograde approach with flexible ureteroscopy to perform ECIRS in 22 cases, thus minimizing the need of multi-tract approaches. Median operating time was 105 minutes (range 38-320).

TABLE 1. **Patient demographics and characteristics (n = 98)**

Age, years	58 ± 14
BMI, Kg/m^2	28.8 ± 5.5
Sex female/male (%)	71/29
Side left/right (%)	60/40
Previous stone surgery or SWL, n (%)	58 (59)
Stone surface (mm^2)	471 (315, 944)
Location	
Single, n (%)	32 (33)
Multiple, n (%)	12 (12)
Staghorn, n (%)	54 (55)
Calyx of access	
Upper, n (%)	4 (4)
Middle, n (%)	11 (11)
Lower, n (%)	83 (85)
Dilation system	
Amplatz serial dilators, n (%)	73 (75)
High pressure balloon, n (%)	25 (25)
Access caliber	
24Fr, n (%)	39 (40)
30Fr, n (%)	59 (60)
Single tract surgery, n (%)	94 (96)
Simultaneous ureteroscopy, n (%)	22 (22)
Operating time, min	105 (80, 160)
Composition	
Calcium, n (%)	59 (60)
Uric acid, n (%)	20 (21)
Struvite, n (%)	16 (16)
Unknown, n (%)	3 (3)
Double J stent, n (%)	98 (100)
Percutaneous drainage, n (%)	98 (100)
Complications, n (%)	23 (23)
Success, n (%)	59 (60)

Results are expressed in mean ± SD or median [p25, p75]
BMI = body mass index

Fifty-nine patients were stone-free on the CT scan at 3 months, which means a success rate of 60% without considering auxiliary interventions after PCNL. Complications occurred in 23 patients, with the following Clavien-modified grading system distribution: grade I-II: 18 cases (1 peroneal neuropraxia, 9 hemorrhages needing transfusion, 8 postoperative fevers needing antibiotic treatment), grade III_a: 3 cases (persistent urinary leakages), grade IV_{a-b}: 2 cases (severe sepsis). No injuries to adjacent organs were observed.

Univariate analysis of potential prognostic factors associated with success and complications is shown in Tables 2 and 3, respectively. Regarding success, those patients rendered stone-free after PCNL had a significantly lower stone burden (p = 0.000), shorter operating times (p = 0.000) and single stones (p = 0.003) non-struvite composed (p = 0.040). Concerning complications, the patient age (p = 0.010), the nephrostomy tract dilation with high pressure balloon (p = 0.017) and a stone composition different to struvite (p = 0.046) behaved as significant protective factors.

All potentially predictive variables studied were subsequently included in logistic regression models for both success and complications, whose results are depicted in Table 4. The main independent prognostic factor for success after PCNL was the stone surface (OR = 0.997, per mm^2, p = 0.000), followed by its multiplicity in the kidney (OR = 0.203, p = 0.050). Furthermore, the analyses showed that a stone surface of 500 mm^2 could be a good cut off point in our population for predicting success after percutaneous surgery, with an approximate sensitivity and specificity of 72% and 73%, respectively. Struvite stone composition (OR = 5.911, p = 0.028) was an independent predictor for the development of complications, whilst age (OR = 0.936, p = 0.012) and high pressure balloon dilation (OR = 0.041, p = 0.007) were rendered independent protective variables.

Discussion

Many authors have investigated possible prognostic factors associated with PCNL outcomes. Their rationale is to preoperatively identify those cases at high risk for residual stones or complications in order to improve both results, whenever possible. Based on this knowledge, a mathematical algorithm could be formulated in order to preoperatively calculate the specific outcome of a PCNL case. Moreover, this predictive information could be helpful for both patients and surgeons in the decision-making process.

The list of factors analyzed in this paper was taken from previous researches, where they have independently proven their predictive ability.[12-16] We have finally identified five prognostic variables

TABLE 2. **Univariate analysis in relation to success after percutaneous nephrolithotomy**

	Stone-free (n = 59)	**Failure (n = 39)**	**p value**
Age, years	59 ± 14	57 ± 13	0.474
Previous stone surgery or SWL, n (%)	33 (56)	25 (64)	0.421
BMI, Kg/m^2	28.8 ± 6.0	28.9 ± 4.8	0.944
Stone surface (mm^2)	355 (279, 558)	841 (445, 1416)	0.000
Composition*			0.040
Calcium, n (%)	37 (66)	22 (57)	
Uric acid, n (%)	14 (25)	6 (15)	
Struvite, n (%)	5 (9)	11 (28)	
Stone location			0.003
Single, n (%)	27 (46)	5 (13)	
Multiple, n (%)	6 (10)	6 (15)	
Staghorn, n (%)	26 (44)	28 (72)	
Operating time, min	90 (66, 130)	155 (95, 190)	0.000
Simultaneous ureteroscopy	10 (17)	12 (31)	0.109

Results are expressed in mean ± SD or median [p25, p75]
BMI = body mass index
*stone composition was only available in 95 patients

TABLE 3. **Univariate analysis in relation to complications after percutaneous nephrolithotomy**

	Non-complicated (n = 75)	Complicated (n = 23)	p value
Age, years	60 ± 13	51 ± 14	0.010
Previous stone surgery or SWL, n (%)	45 (60)	13 (56)	0.767
BMI, Kg/m^2	29.2 ± 5.6	27.3 ± 4.9	0.120
Stone surface (mm^2)	472 (314, 886)	471 (315, 1150)	0.594
Composition*			0.046
Calcium, n (%)	47 (64)	12 (57)	
Uric acid, n (%)	18 (24)	2 (10)	
Struvite, n (%)	9 (12)	7 (33)	
Stone location			0.743
Single, n (%)	26 (35)	6 (26)	
Multiple, n (%)	9 (12)	3 (13)	
Staghorn, n (%)	40 (53)	14 (61)	
Operating time, min	105 (75, 155)	120 (80, 180)	0.394
Simultaneous ureteroscopy, n (%)	18 (24)	4 (17)	0.506
Multiple tract surgery, n (%)	2 (3)	2 (9)	0.201
Calyx of access			0.240
Lower, n (%)	63 (84)	20 (87)	
Middle, n (%)	10 (13)	1 (4)	
Upper, n (%)	2 (3)	2 (9)	
Access caliber 30Fr, n (%)	49 (65)	10 (43)	0.061
High pressure balloon dilation, n (%)	24 (22)	1 (4)	0.017

Results are expressed in mean ± SD or median [p25, p75]; BMI = body mass index
*stone composition was only available in 95 patients

TABLE 4. **Predictors of success and complications after percutaneous nephrolithotomy selected by the multiple logistic regression models**

	Odds ratio	95% CI	p value
Success predictive model			
Stone surface (mm^2)	0.997	0.995-0.990	0.000
Stone location			
Single	Ref.		
Multiple	0.203	0.041-0.999	0.0050
Staghorn	0.386	0.108-1.447	0.161
Previous stone surgery or SWL	0.386	0.128-1.165	0.092
Complication predictive model			
Age, years	0.936	0.889-0.985	0.012
Composition			
Calcium	Ref.		
Uric acid	0.672	0.119-3.788	0.653
Struvite	5.911	1.213-28.80	0.028
High pressure balloon dilation	0.041	0.004-0.414	0.007

95% CI = 95% confidence intervals for the odds ratio; Ref, Category of reference; The variables included in both regression models were obtained from all the variables listed in Tables 2 and 3, respectively, using the step AIC procedure

associated with outcomes. Stone burden was the factor which best predicted success after PCNL, followed by its location in the kidney. On the other hand, Amplatz dilation had the highest risk of complications, followed by struvite stones and younger patients.

Stone size influences both the indication of active removal and the procedure selection in kidney stone management. In general, larger stones > 20 mm should be primarily treated by PCNL.[1] Not many authors have specifically assessed the effect of the stone burden on PCNL outcomes, yet most of them confirm that stone size is the most consistent predictor of immediate clearance.[16,19-21] In our study we have found that stone surface is the main prognostic factor for success, with no influence in the incidence of complications. Our results show that each rise of 1 cm^2 has a 30 percent increased risk of residual stones and that 500 mm^2 could be a good threshold value for predicting a stone-free status.

Stone surface was a better predictor of success than its location in the kidney. Nevertheless, we have analyzed the relationship between stone configuration and success after percutaneous surgery. We coincide with some authors who have reported that multiple stones have a negative impact on the clearance rate.[14-16,19] In our study, caliceal or pelvic single stones have the highest stone-free rate, whereas multiple stones have a 5-fold risk of residual fragments. Percutaneous surgery of multiple or staghorn calculi is a demanding procedure, where some fragments can be easily passed by. Moreover, these stones are sometimes allocated in calices with narrow infundibulum or have large branches, which make their removal more complex. Hence, it is difficult to render these cases stone free through a single nephrostomy tract, even though the use of flexible endoscopes can improve the results. In our series, we have performed 96% single tract surgeries, a systematic final endoscopic review with a flexible nephroscope, and taken advantage of the GMSVP to carry out a simultaneous intrarenal flexible ureteroscopy in 22% of the cases.

Even though stone prior surgery or lithotripsy in the treated kidney has not shown its significance in both the univariate and multivariate analysis, it has been included in the success predictive model to improve its discrimination. Our results have determined that patients with prior surgery or SWL have 2.6-fold risk of failure after PCNL, whereas they have no influence in the complication rate. This negative impact in the stone-free rate could be explained by both the anatomical distortion of the collecting system after open surgery, and a higher probability of multiple scattered fragments after SWL or surgery which can easily go unnoticed or, sometimes cannot be reached and extracted with a single percutaneous approach.[22] However, the scar tissue left around the kidney after an open approach has, in our opinion, a beneficial effect, fixating and limiting the kidney movements, thus making the puncture and the dilation maneuvers easier. Yuruk and colleagues have specifically assessed the effect of previous SWL in percutaneous surgery outcomes, and found that it altered neither the stone clearance nor the incidence of complications.[23] The impact of open renal surgery on PCNL was investigated by many authors with different results. Most of them have reported that a history of open nephrolithotomy does not adversely affect the efficacy and morbidity of the percutaneous approach, even though sometimes auxiliary procedures are needed.[24-30] On the other hand, there are some series describing a higher failure and complication rate in patients with previous open surgery.[31,32] Contrarily, Shahrour et al demonstrated that SWL treatment before percutaneous surgery increased stone clearance rates.[21] Furthermore, the influence of both SWL and open renal surgery on subsequent PCNL was evaluated by Resorlu and associates, who found no impact in either the success or complications rate in both groups.[33]

The final predictive model of success has not included the stone composition or the operating time despite their significance on univariate analysis. This exclusion can be statistically explained by the strength of the stone size as prognostic factor, with which the previously mentioned variables powerfully correlate.[34-36]

One of the mainstays to reduce surgical complications is the preoperative identification of those factors which are prone to their advent. Our study has proven that Amplatz dilation and struvite stones have a higher risk of complication, whilst age is a protective factor.

One of the main steps in percutaneous stone surgery is the choice of the nephrostomy tract dilation system and its caliber. This decision may influence perioperative bleeding and the need for transfusion, which was the most frequent complication in our series. The use of high pressure balloons for tract dilation has emerged as the most important independent protective factor in our study, when compared with the use of the Amplatz fascial set, which has a 24-fold risk of complication. Nevertheless, this result must be regarded with caution, because the study has not been specifically designed to assess the difference between these dilation system options. In fact, the choice of the tract dilation technique was not randomized, but based on the surgeon's preferences and the availability of both systems. From a technical standpoint, there is a theoretical higher risk of tissue damage when using fascial dilators, because this technique is based on exerting sequential shearing

forces to the tissue instead of the one-step radial eccentric pressure of the balloon method. In this regard, some papers have demonstrated that balloon dilation cause less blood loss than the Amplatz technique, thus bringing about a lower complication rate.[37,38] Conversely, other papers favor Amplatz fascial dilation.[39,40] Moreover, several investigators have not found differences between either dilation systems in terms of complications or renal trauma.[41-45] In summary, to date the choice of the safest dilation technique is still a controversial topic under debate.

In our center, the dilation system used has determined the tract size, since all those dilated with balloon were to a 30Fr caliber whereas all those with the Amplatz set were to 24Fr. Despite this important confounding bias, we have not found the tract size as an independent prognostic factor for complications. The effect of the small caliber tract PCNL (Miniperc) on complications has been evaluated by some authors. The great majority agree that the larger a percutaneous access is, the more the risk of parenchymal injury and bleeding.[46-48] Contrarily, a protective effect could also be attributed to large tract calibers, taking into account that they could drop the intrarenal pelvic pressure during the surgery, thus minimizing the risk of pyelovenous backflow and postoperative fever or infection.[49,50] Li and co-workers have not found significant advantages, in terms of surgical trauma and associated invasiveness, between 14FR-18Fr mini-PCNL and standard 30Fr PCNL, although the hemoglobin loss and transfusion rate was higher in the 30Fr group.[51]

Struvite stones complicated calcium stones by a factor of six, bringing about primarily urinary tract infections or sepsis, which were the second most common complications in our cases. Even though the infective nature of this stone composition would seem to be an important factor for these complications, supporting data are limited. Moreover, some authors have not found stone composition to be a prognostic factor for post-PCNL fever, arguing that bacteria could colonize any stone.[52-54] Nevertheless, Gonen and others have reported that positive stone cultures significantly predict infective complications after percutaneous surgery.[52,55-57]

Consequently, it is strongly recommended to send for microbiological evaluation some fragmented stones and a pelvic urine sample, in order to have specific sensitivity tests in case of postoperative infection. Apart from the prophylactic use of antibiotics, in case of struvite infective stones, we think that it is also worth scheduling the treatment in two or more PCNL sessions rather than lengthen it in only one. Finally, in cases with purulent fluid in the pelvicaliceal system, we advise finishing the procedure as soon as possible, draining the kidney with a nephrostomy tube and using wide-spectrum antibiotics to perform a delayed PCNL in a few days.

Concerning the relationship between age and PCNL outcomes, Anagnostou and co-workers demonstrated that PCNL can be safely performed even on the elderly whenever surgical experience and anaesthesiological assessment is given.[58] Sahin and colleagues also proved its safety and effectiveness in patients over 60, even dealing with more solitary kidneys and complex stones.[59] Likewise, Karami and associates concluded that PCNL can be safe and yield a high stone-free rate even in patients over 65.[60] On the other hand, elderly patients are assumed to be high risk because of their associated morbidities, which make them more likely to succumb to perioperative complications.[61] In these cases, performing prone PCNL is sometimes a challenge to both the patient and the anesthesiologist, thus making the supine position strongly recommended.[62]

We did not find any association with success, but found that younger patients have a higher risk of complications than the older ones. This result may be considered circumstantial or due to the more frequent incidence of infective and complex stone cases in our younger patient cohort. This find does not agree with previous papers assessing differences in urinary stone disease between young and geriatric patients.[58,63] Nonetheless, we coincide with Stoller and co-workers in the higher incidence of uric acid stones found in the elderly.[64]

One of the main limitations of this study is the small number of cases included. However, we have identified some interesting prognostic factors for endourologists planning percutaneous stone surgery. Moreover, the discriminative ability of both predictive models (AUC for success = 0.83 and AUC for complications = 0.83) was excellent. Nevertheless, we emphasize the need of multicenter studies with more enrolled cases to develop more accurate predictive models.

On the other hand, this research has some potential advantages. Firstly, all operation and patient details, as well as all clinical preoperative or postoperative variables were routinely recorded prospectively in our computerized database, and these have been analyzed prospectively. Secondly, it is well known that the more surgeons performing a technique, the more variable the results are. In our series, all the cases were performed by the same team, with similar experience in PCNL, thus avoiding this surgeon-effect bias. Furthermore, we have used the most sensitive imaging test to identify residual stones along with the most stringent definition for success, thus implying a high consistency to our

results.[65] We have chosen this strict definition of success following other authors who have demonstrated that a substantial number of clinically insignificant residual fragments (CIRFs) are at higher risk of needing additional interventions or having symptoms in the follow up.[66-68] This can partially explain our suboptimal stone clearance rate (60%) when compared with the literature, not forgetting that this is an early PCNL series where the learning curve is still running and that we have performed a 96% of single-tract surgeries in a high stone surface series where 55% of the calculi were staghorn.[69-72]

The learning curve effect also accounts for why we have decided to routinely leave a nephrostomy tube and a double J stent after finishing the procedure. We strongly believe that with more experience, there are patients who would benefit from a tubeless surgery. Moreover, we consider that our length of double J stenting should be shortened to lower the incidence of urinary tract symptoms and discomfort.

Nonetheless, our complication rate (23%) was similar to other published series. We have used the Clavien modified grading system to classify them, thus avoiding the huge variability and the subjectivity in the definitions found in the literature.[17,18,73-76]

Conclusions

The present study has identified five factors which could independently influence percutaneous stone surgery outcomes. This information can be very useful for patient counseling, regarding percutaneous kidney stone management. Stone burden and multiple calculi in the kidney affect the immediate stone-free rate, whilst Amplatz dilation, struvite stones and young patients lead to a higher incidence of postoperative complications.

Nevertheless, bearing in mind the small number of our series, findings might be regarded with caution. Further studies, with more cases recruited, will help to confirm our data or identify the presence of other potential independent risk factors for PCNL outcomes.

Finally, we think that a consensus on the definitions of both success and complications after PCNL is mandatory, to standardize results and to allow comparisons between groups. □

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