

Value of preoperative stone scoring systems in predicting the results of percutaneous nephrolithotomy

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Introduction Guy's Stone Score and S.T.O.N.E. Nephrolithometry nomograms have been introduced for systematic and quantitative assessment of kidney stones.

The aim of this study was to reveal the value of two scorings systems, Guy and S.T.O.N.E, most frequently used for predicting postoperative stone-free status prior to Percutaneous Nephrolithotomy (PCNL), in the prediction of postoperative results of PCNL.

Material and methods We retrospectively examined patients who underwent PCNL. Preoperative abdominopelvic computerized tomography images of these patients were reviewed and scored according to the Guy and S.T.O.N.E. systems.

The relationship between the Guy and S.T.O.N.E. scores, and their postoperative stone-free status, complications based on Clavien system, operation time, fluoroscopy time and period of hospitalization was compared.

Results We identified a total of 102 patients who underwent PCNL between 2010 and 2014, having met the inclusion criteria.

The relationships between the total S.T.O.N.E score and Clavien score ($p < 0.001$); time of operation ($p = 0.012$) and stone-free status ($p < 0.001$); Guy stone score and Clavien score ($p < 0.001$); and period of hospitalization ($p < 0.001$) and time of operation ($p < 0.001$) were found to be statistically significant.

There was no statistically significant relationship between Guy score and stone-free status and no statistically significant relationship was found between fluoroscopy time and both stone scoring systems.

Conclusions Guy and S.T.O.N.E. scoring systems may be used as effective instruments particularly for predicting postoperative complications.

Key Words: complication ↔ computerized tomography ↔ percutaneous nephrolithotomy ↔ renal stone

INTRODUCTION

Percutaneous nephrolithotomy (PCNL) is a minimally-invasive treatment modality, considered by guidelines as primary care regarding treatment of >20 mm kidney stones, and as such, is now applied in a number of centers [1, 2].

However, there has been a remarkable increase in complication rates despite developments in surgical techniques and technology [3, 4].

The most frequent complications of PCNL include extravasation (7.2%), bleeding requiring a blood transfusion (11.2–17.5%) and fever (21–32.1%) [5].

Septicemia (0.3–4.7%), colon injury (0.2–4.8%), and pleural injury (0–3.1%) are rare complications [5]. Nephrectomy (0.4–1.1%) and patient's death (0.05%) are more serious and rarer complications after PCNL [6]. The complication rates increase due to the presence of accompanying diseases such as renal failure, diabetes mellitus, and obesity [5].

Computed tomography (CT) as the most frequently used imaging method in identifying pre-PCNL stones, plays a very important role in preoperative evaluations in terms of characterization of stones, renal caliceal anatomy and the identification

of anatomic proximity. In addition, it is possible to carry out systematic and quantitative evaluations with the help of *Guy* and S.T.O.N.E. stone scoring systems that are acquired based on preoperative CT findings [7, 8].

The *Guy* stone scoring system involves four grades (Grades 1, 2, 3, and 4) according to the caliceal localization of stones, the presence of single or multiple stones and renal anatomic structure [7].

The S.T.O.N.E. scoring system, on the other hand, is an acronym of the English initials the five parameters: stone size, tract length, obstruction, number of calyces retained, and stone density [8].

These nomograms allow the surgeon to form an opinion regarding the possible postoperative and preoperative complications, as well as the surgical success, and enable them to share these opinions with their patients [7, 8, 9].

Another potential advantage of using these nomograms is that they enable us to standardize operation results and compare them with other series. Until now, there has been a paucity of studies comparing such standardized nomograms with different series and also comparing the different nomograms with one another.

The purpose of this study was to reveal the value of two different scoring systems in predicting the postoperative results of PCNL.

MATERIAL AND METHODS

We retrospectively examined patients who underwent PCNL, between November 2010 and August 2014 at our hospital. Exclusion criteria included patients younger than 18 years old, a history of prior surgery on the ipsilateral kidney, nephrostomy tube or stent placement in the ipsilateral kidney prior to surgery, and patients with no CT images available preoperatively. Preoperative abdominopelvic computerized tomography images of the patients were reviewed and scored according to the *Guy* and S.T.O.N.E. scoring systems. S.T.O.N.E. scores were categorised as low complex, moderate complex and high complex.

Guy's score 1 (GS 1): a solitary stone in the mid and/or lower pole or in the renal pelvis with normal anatomy.

Guy's score 2 (GS 2): a solitary stone in the upper pole; multiple stones in a patient with simple anatomy; or a solitary stone in a patient with abnormal anatomy.

Guy's score 3 (GS 3): multiple stones in a patient with abnormal anatomy or in a calyceal diverticulum or partial staghorn calculus (defined as a stone evolving the renal pelvis and at least 2 calices).

Guy's score 4 (GS 4): a complete staghorn calculus (all calices and the pelvis occupied by stones) or any stone in a patient with spina bifida or a spinal injury. The S.T.O.N.E. score can vary from a minimum of 5 to a maximum of 13. A score of 5–6 denotes a low complex stone, 7–8 is regarded moderate complex and a score of 9–13 indicates a high complex stone [7, 8].

The demographic characteristics, presence of residual stones, operation time, period of hospitalization, fluoroscopy time and complications were recorded from patient files.

PCNL Technique

As described in the literature [9], briefly, access was obtained under C-arm fluoroscopy using an 18 gauge needle with the patient in the prone position. The tract was dilated with amplatz dilators. Fragmentation of the stone burden was accomplished using a pneumatic (Vibrolith®, Elmed, Ankara, Turkey) or ultrasonic (Swiss Lithoclast®, EMS Electro Medical System, Nyon, Switzerland) lithotripter. A 14 F nephrostomy tube was placed inside the renal pelvis or the involved calyx at conclusion in the majority of cases. Operative time was recorded from the beginning of cystoscopy for ureteral catheter insertion until the end of nephrostomy placement. Postoperative stone-free rates were determined at hospital discharge by kidney – ureter – bladder (KUB) radiogram. In our study stone-free status is defined as the absence of residual stones or stone fragments in a KUB radiogram.

The relationships between *Guy* and S.T.O.N.E. scores of patients, and their postoperative stone-free status, complications based on Clavien system, operation time, fluoroscopy time and period of hospitalization were compared by using the Chi square test.

RESULTS

A total of 102 patients underwent PCNL, of which 63 were men (61.8%) and 39 were women (39.2%). The average age of the patients was 48.9 ± 11.6 years. The mean operative time was 128 ± 42 min., the mean fluoroscopy time was 5.6 ± 1.4 min. and the average hospital stay was 3.8 ± 1.2 day. Once postoperative complications were categorized in accordance with the modified Clavien classification, 82 patients were considered as Clavien 0 (normal postoperative trajectory without any unexpected deviation) (80.4%), 13 patients Clavien I (fever, pain management with nonsteroid anti-inflammatory drugs) (12.7%), 6 patients Clavien II (fever treated with antibiotics, bleeding requiring blood transfusion) (5.9%) and

1 patient Clavien IIIa (renal pelvic perforation managed by ureteric stenting without general anaesthesia) (1%).

The operative variables of patients are demonstrated in Table 1.

According to the KUB taken on the 1st postoperative day, 91 patients were found to be residual stone-free (89.2%) and 11 patients (10.8%) had residual stones. The mean total S.T.O.N.E. score was 6.62 ± 1.62 . According to the Guy score, 75.5% of the patients were GS 1, 21.6% GS 2 and 2.9% GS 3. In our study, 10% of GS 1, 4% of GS 2 and 66% of GS 3 patients had residual stone (Table 2). According to the S.T.O.N.E. score categories; 3% of S.T.O.N.E. score 5-6 patients (low complex), 16% of S.T.O.N.E. score 7-8 patients (moderate complex), and 29% of S.T.O.N.E. score 9-13 patients (high complex) had residual stone (Table 3).

Table 1. Operative variables

Male (n=63)	61.8%
Female (n=39)	39.2%
Mean age	48.9 ± 11.6
Right	56.9%
Left	43.1%
Mean operative time	128 ± 42 min.
Mean fluoroscopy time	5.6 ± 1.4 min.
Average hospital stay	3.8 ± 1.2 days
Clavien 0	80.4%
I	12.7%
II	5.9%
IIIa	1%
Stone-free rate	89.2%
Residual stone rate	10.8%
Mean S.T.O.N.E. score	6.62 ± 1.62

Table 2. Residual stone rate for Guy's score

Guy's score	Residual stone
Grade 1 (n=77)	8 (10%)
Grade 2 (n=22)	1 (4%)
Grade 3 (n=3)	2 (66%)
Grade 4 (n=0)	–

Table 3. Residual stone rate for S.T.O.N.E. score

S.T.O.N.E. score	Residual stone
5-6 (n=61) (low complex)	2 (3%)
7-8 (n=24) (moderate complex)	4 (16%)
9-13 (n=17) (high complex)	5 (29%)

There was a positive correlation between total S.T.O.N.E. score and Clavien score ($p < 0.001$), time of operation (0.012) and stone-free status ($p < 0.001$). This correlation was found to be statistically significant. There was a positive correlation between Guy's stone score and Clavien score ($p < 0.001$), period of hospitalization ($p < 0.001$) and the time of operation ($p < 0.001$). This correlation was found to be statistically significant.

There was no statistically significant relationship between Guy score and stone-free status and no statistically significant relationship between fluoroscopy time and both stone scoring systems.

DISCUSSION

Today, as in many other surgeries, a certain number of nomograms have found a place in predicting complications and surgical success after PCNL

In this study, we used the Guy and S.T.O.N.E. scoring systems based on preoperative CT findings. We compared the rates of these nomograms to predict stone-free status and postoperative complications.

In this study, 89.2% of patients were stone-free postoperatively. Even though there are numerous factors affecting whether the patient is stone-free after PCNL, the literature suggests rates between 78% and 100% [10, 11]. This study has produced comparable rates.

Although we found no statistically significant relationship between the Guy stone score and the stone-free status, there was a significant relationship between the S.T.O.N.E. scoring system and the stone-free status.

In two different studies conducting external validation of the Guy scoring system, Mandal and Ingirmasson evaluated this scoring system as an efficient instrument in predicting the stone-free status [12, 13].

In their series involving 278 PCNL cases, Mandal et al. observed that the stone-free rates decreased as 100%, 74%, 56%, and 0% according to the GS 1, 2, 3, 4 scores respectively [12].

On the other hand, in their series involving 147 PCNL cases, Vicentini et al., defined ≤ 4 mm fragments as stone-free, based on the result of CT performed on the 1st postoperative day. In doing so, they determined the stone-free in patients with GS1 at the rate of 95.2%, 79.5% in GS 2, 59.5% in GS 3 and 40.7% in GS 4, and found a significant relationship between the rates of the stone-free and the Guy scores [14].

We think that the absence of a significant relationship between the Guy's scoring and the stone-free status in this study, when compared to the aforementioned studies, could be associated with the limited

number of patients in groups GS 2 and 3 and the absence of patients in the group GS 4.

In their study identifying the S.T.O.N.E. nephrolithometry scores of 117 diseases, Okhunov et al., determined the total rate of the stone-free as 80%. The relationship between the rates of the stone-free and the stone scores was determined to be significant [15].

According to the results of a recent study published by Labadie et al., it was reported that the Guy and S.T.O.N.E. scores and the CROES nomogram could be used as an efficient instrument in predicting the stone-free status after PCNL [16].

Despite high success rates, PCNL may produce complications such as bleeding, adjacent organ injuries, and serious infections [17].

These complications, that frequently used to be separated into minor and major complications, could now be identified in a more standardized way according to the modified Clavien system [18, 19, 20].

The Modified Clavien system is also commonly used in evaluating the postoperative complications of other urological surgeries such as radical prostatectomy, laparoscopic nephrectomy, laparoscopic pyeloplasty, laparoscopic or open partial nephrectomy and transurethral resection of prostate (TUR-P) [21–25].

In their series of 4230 diseases classifying PCNL complications according to the Clavien system,

de la Rosette et al., determined 4.2% Clavien I, 4.8% Clavien II, 2.2% IIIa, 0.9% IIIb, 0.3% IVa, 0.1% IVb, and <0.1% Clavien V complications [20].

In this study, however, the complications are reported as Clavien I in 12.7%, Clavien II in 5.9%, and Clavien IIIa in 1%.

Compared to the aforementioned study, the fact that we did not encounter Clavien IIIb or higher complications in this study could be associated with the relatively limited number of patients in our study, and furthermore, may result from our patient selection criteria, by which we excluded patients with a nephrostomy, double J stent (DJS) or a history of surgery on the same kidney.

CONCLUSIONS

The present study investigated the effectiveness of S.T.O.N.E. and Guy scoring systems in predicting perioperative and postoperative complications and other operative parameters. Scoring systems can provide a more accurate prediction of success rates and possible complications of PCNL. Further large-scale research would be necessary to clarify the results of this study.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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