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Original Article

Rearrangement of the Guy's stone score improves prediction of stone-free rate after percutaneous nephrolithotomy

Guy taş skorunun yeniden düzenlenmesi perkütan nefrolitotomi sonrası taşsızlık oranı öngörüsünü iyileştirmektedir

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ABSTRACT

Objective: We propose a modification of the original Guy´s Stone Score (GSS) to hold on 20 % of prognostic discrimination among groups which makes this score a more reliable resource for risk assessment in patients undergoing percutaneous nephrolithotomy (PCNL).

Material and methods: Historical cohort of 126 patients undergoing PCNL from December 2010 to November 2014 was included in the survey. Every patient was classified according to the original GSS. For the new classification of Guy Stone Score (GSS-M) all of the subgroups included in the scale were analyzed individually and then ranked from better to worst according to the postoperative stone- free rates (SFRs). This ranking led us to reclassify all the original subgroups, clustering them in three new categories according to their SFRs as subgroups of good, intermediate and poor prognosis, trying to achieve at least 20% of prognostic discrimination among the groups.

Results: Hundred and twenty-six PCNL procedures were evaluated, but only 124 were included for statistical analysis and classified based on SFR according to the GSS as follows: 76% for grade 1, 71% for grade 2, 55% for grade 3 and 20% for grade 4. The SFRs were also assessed for the GSS-M obtaining the following predictive values as 93%, 67% and 44% for the good, intermediate and poor prognostic groups, respectively. The prognostic difference among the GSS-M groups was always >20% ($p<0.05$).

Conclusion: The original GSS has limitations to predict SFR because of its poor discrimination power among prognostic groups. This rearrangement improves prediction of SFR and better discriminates risk groups in PCNL.

Keywords: Kidney stone; percutaneous nephrolithotomy; renal calculi; scoring method.

ÖZ

Amaç: Gruplar arasında %20 oranında prognostik ayrımını ve perkütan nefrolitotomi (PNL) yapılan hastalarda daha güvenilir bir risk değerlendirme kaynağı sağlamak üzere orijinal Guy Taş Skorunun (GTS) bir modifikasyonunu öneriyoruz.

Gereç ve yöntemler: Aralık 2010 ila Kasım 2014 arasında PNL yapılan 126 hastalık bir kohort çalışmaya alınmıştır. Her hasta, orijinal GTS'na göre sınıflandırılmış, bu ölçeğe dahil edilen alt grupların tümü yeni Guy Taş Skoru (GTS-M) sınıflandırılmasına alınmış, ayrı ayrı analiz edilmiş, daha sonra postoperatif sonucuna göre taşsızlık oranına göre daha iyiden daha kötüye göre derecelendirilmiştir. Bu derecelendirme gruplar arasında en azından %20 oranında prognostik ayrım sağlama amacıyla tüm orijinal GTS alt gruplarının üç yeni kategori içinde iyi, orta ve kötü prognoz olarak yeniden sınıflandırılmasına yol açmıştır.

Bulgular: Toplam 126 PNL işlemi değerlendirilmesine rağmen yalnızca 124'ü istatistiksel analize dahil edilmiş ve taşsızlık oranlarına göre sınıflandırılmıştır. Buna göre %76'sı 1., %71'i 2., %55'i, 3. ve %20'si, 4. derecede idi. Taşsızlık oranları GTS-M'e göre değerlendirilmiş ve %93, %67 ve %44'ü sırasıyla iyi, orta ve kötü prognoz gruplarına dahil edilmiştir. GTS-M grupları arasında prognostik farklılık her zaman %20'yi aşkın idi ($p<0,05$).

Sonuç: Prognostik gruplar arasında zayıf ayrım gücü nedeniyle orijinal GTS taşsızlık oranını sınırlı derecede öngörmektedir. Bu yeniden düzenleme taşsızlık oranını öngörmeyi iyileştirmekte ve PNL için risk grupları arasındaki ayrımı daha iyi yapmaktadır.

Anahtar Kelimeler: Böbrek taşı; perkütan nefrolitotomi; böbrek taşları, skorlama yöntemi

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Introduction

The overall prevalence of urolithiasis in the world is 8.8%, and it is recognized as a more common disease in the male population (1.5:1).[1] Changes on its prevalence have been detected within the past two decades, observing an increase in its incidence in the U.S. population from 6.3% in 1994 to 10.3% in 2010.[1]

Current treatment options for kidney stones include retrograde intrarrenal surgery (RIRS), extracorporeal shock wave lithotripsy (ESWL), percutaneous nephrolithotomy[2,3] and open surgery. The employment of each option depends primarily on the size of the stone and its location. PCNL has become, since its introduction in 1976[4], the reference standard for the treatment of patients with stones larger than 2 cm, those who have failed ESWL and those with abnormal renal anatomy.[5]

Many nomograms have been developed for both the prediction of outcomes in PCNL and the classification of its complexity. The Guy's Stone Score (GSS) was developed by Thomas et al.[6] in 2011. This score categorizes patients according to the complexity of the stone and the pelvicaliceal anatomy based on plain radiography, ultrasonography, computed tomography (CT) and intravenous urography findings[6], as validated by a recent study.[7] There are four different categories for GSS in relation to the proposed SFR as category 1 (81%), 2 (72.4%), 3 (35%), and 4 (29%).[6]

In March 2013 the S.T.O.N.E nephrolithometric score was reported, based on 5 characteristics detected on preoperative non contrast-enhanced CT. These 5 features were abbreviated using the acronym "S.T.O.N.E." in relation to the Stone size, Tract length, Obstruction, Number of involved calices, and Essence or stone density . Each variable can be scored from 1 to 5 points, and then they are summarized and categorized in 3 risk groups (low: ≤5 points, moderate 6-8 points and high ≥8). Using this score the SFRs for low, moderate, and high-risk groups were 94-100, 83-92, and 27-64%, respectively.[8]

The most recently reported scoring system is the nephrolithometric nomogram on behalf of the Clinical Research Office of the Endourological Society[2], which includes patient related factors as well as intravenous pyelography findings, number of cases per year, prior treatments, stone burden and location, staghorn stones and overall number of stones. All of the factors listed are ranked between 0-100, with a total score obtained ranging between 0-350, with a probability of SFR from 30 to 90%, depending on the total sum obtained.[2]

Recently, Labadie et al.[9], evaluated and compared the three scores, finally concluding that all systems similarly predict the SFR, and a single and simple scoring system should be adopted to unify the reporting like the GSS. Bozkurt et al.[10] recently compared in a retrospective, single-center study the GSS and the CROES (Clinical Research Office of Endourological Society) nephrolithometric nomogram, concluding that both scorings systems equally predict the postoperative outcomes of PCNL, including SFRs, overall complications, blood loss and operative times. In another study our group demonstrated that GSS has major limitations for predicting SFR after PCNL, including its poor discrimination power among intermediate risk groups.[11] The objective of the present study is to evaluate a rearrangement of GSS to predict the SFR after percutaneous nephrolithotomy.

Material and methods

With approval of the local research committee and after obtaining patient informed consent we evaluated a cohort of 126 consecutive patients diagnosed as having kidney stones who underwent elective PCNL at our institution from December 2010 to November 2014, having complete medical record and sufficient radiological evaluations allowing a proper categorization according to the GSS. Patients who underwent bilateral procedures in the same surgical session or tubeless PCNL were excluded because of the scarce number of these procedures in order to avoid heterogeneity in our data and make them statistically more robust.

Initially an experienced urologist was asked to assign every case to one of the 4 categories of the GSS, based on noncontrast-enhanced CT and thereafter the calculation of SFR was made.

To formulate the new classification (GSS-M) system, all the subgroups included in the original scoring system[6] were analyzed individually, then ranked from better to worst prognosis according to the SFRs, and three main groups with good, intermediate and poor prognosis were obtained based on this ranked risk scoring system trying to achieve at least 20% of prognostic discrimination among the groups (Figure 1).

The stone-free status was defined as either lack of rest stones or presence of < 4 mm stones (not clinically significant) detected during postoperative radiological study, CT in case of radiolucent stones and plain x-ray of kidney, ureter and bladder (KUB) for the rest of the cases three weeks after the procedure, or no need for a secondary procedure for the clearance of the stones (ESWL, ureterorenoscopy or PCNL) within the six-week period following the PCNL. Any patient requiring surgical treatment for kidney stones 90 days after the previous procedure was considered as a new case. Secondarily, the degree of complications was assessed using the Clavien complication scale, regarding all the adverse events within the 30 days after the procedure.

Statistical analysis

To find a minimum of 20% difference between each group, with an α of 0.05% and a β of 80%, we needed to evaluate 91 cases.

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Table 1. Patient demographic and clinical characteristics

	n=126
Sex	
Male (%)	43 (34.1)
Female (%)	83 (65.9)
Age (±SD) years	49.6 (±13.2)
BMI (±SD) kg/m²	28.5 (±5.5)
Comorbidity	
Heart disease (%)	2 (1.5)
CRF (%)	17(13.5)
DM (%)	19 (15.0)
Hypertension (%)	34 (26.9)
ASA	
1 (%)	19 (15)
2 (%)	80 (63.5)
3 (%)	27 (21.4)
Positive Urine Culture (%)	35 (27.8)
Laterality	
Right (%)	52 (41.2)
Left (%)	74 (58.8)
No. Guy Stone Score (%)	
1	42 (33.3)
2	32 (25.3)
3	27 (21.4)
4	25 (19.8)
No. Purposed score (%)	
Good prognosis	29 (23)
Regular prognosis	38 (38.09)
Poor prognosis	49 (38.8)

SD: standard deviation; BMI: body mass index; CRF: chronic renal failure; DM: diabetes mellitus; ASA: American Society of Anesthesiologists

Linear and logistic regression analyses were performed to assess the potential associations between the original GSS and the GSS-M. Besides, we correlated both scales according to SFRs, estimated blood loss (EBL), operative times (OT), length of hospital stay (LOS) and complications.

A univariate statistical analysis was performed using the Kruskal-Wallis test, calculating the relative risk (RR) and a 95% confidence interval. The Grade 1 was used as a reference to determine whether the GSS or GSS-M can predict residual stones. Statistical differences were considered as significant when $p \leq 0.05$. Statistical analyses were performed using the Statistical Package of Social Sciences version 19 (SPSS Inc.; Chicago, IL, USA).

Results

Of the overall 126 cases, only 124 were included in the study. One case was excluded because the patient had undergone tubeless PCNL, and the other case had missing radiological information. The mean age of the cohort was 49.6 years (±13.2), 65.9% were women and the global SFR after the first PCNL was 63.5%. Median OT was 90 minutes, EBL was 50 mL and LOS was 4 days. Subcostal access was performed in 96% of the cases.

Using the original GSS, the patients were classified in 4 grades, and SFRs were 76, 71, 55 and 20% for grades 1 to 4 respectively; and 93, 67 and 44% for the good, intermediate and poor prognostic groups, respectively based on our GSS-M scale scoring (Tables 1 and 2).

The relative risk (RR) for residual stones was calculated for all groups. For both scales Group 1 was determined as the reference group. The patients grouped in grades 2-4 of the GSS had RRs for residual stones of 1.06 (CI 0.8-1.3, p=NS), 1.3 (CI 0.9-2.0, p=NS) and 3.8 (CI 1.7-8.4, p=0.001) respectively. In the GSS-M group, the RRs were 3.5 for the moderate (CI 0.9-13.34, p=0.06) and 9.3 for the poor prognosis groups (CI 2.4-36.3, p=0.001).

Table 2. Results based on the original Guy's Stone score

Grades	1	2	3	4	p
Patients (%)	42 (33)	32 (25)	27 (21)	25 (20)	
EBL°	50 (10-400)	50 (5-400)	50 (10-800)	50 (5-600)	0.9*
OT°	72.5 (25-180)	85 (30-210)	90 (30-225)	90 (45-240)	0.6*
LOS°	4 (3-12)	4 (2-10)	4 (3-11)	4 (3-22)	0.5*
SFR (%)	32 (76)	23 (71)	15 (55)	5 (20)	0.00^
Complications					
Clavien ≤2 (%)	12 (28)	12 (37)	9 (35)	9 (36)	0.76^
Clavien >2 (%)	5 (13)	3 (10)	2 (8)	5 (10)	

*Kruskal Wallis Test; ^Chi-Square; °Median (range). EBL: estimated blood loss; OT: operative time; LOS: length of stay; SFR: stone- free rate

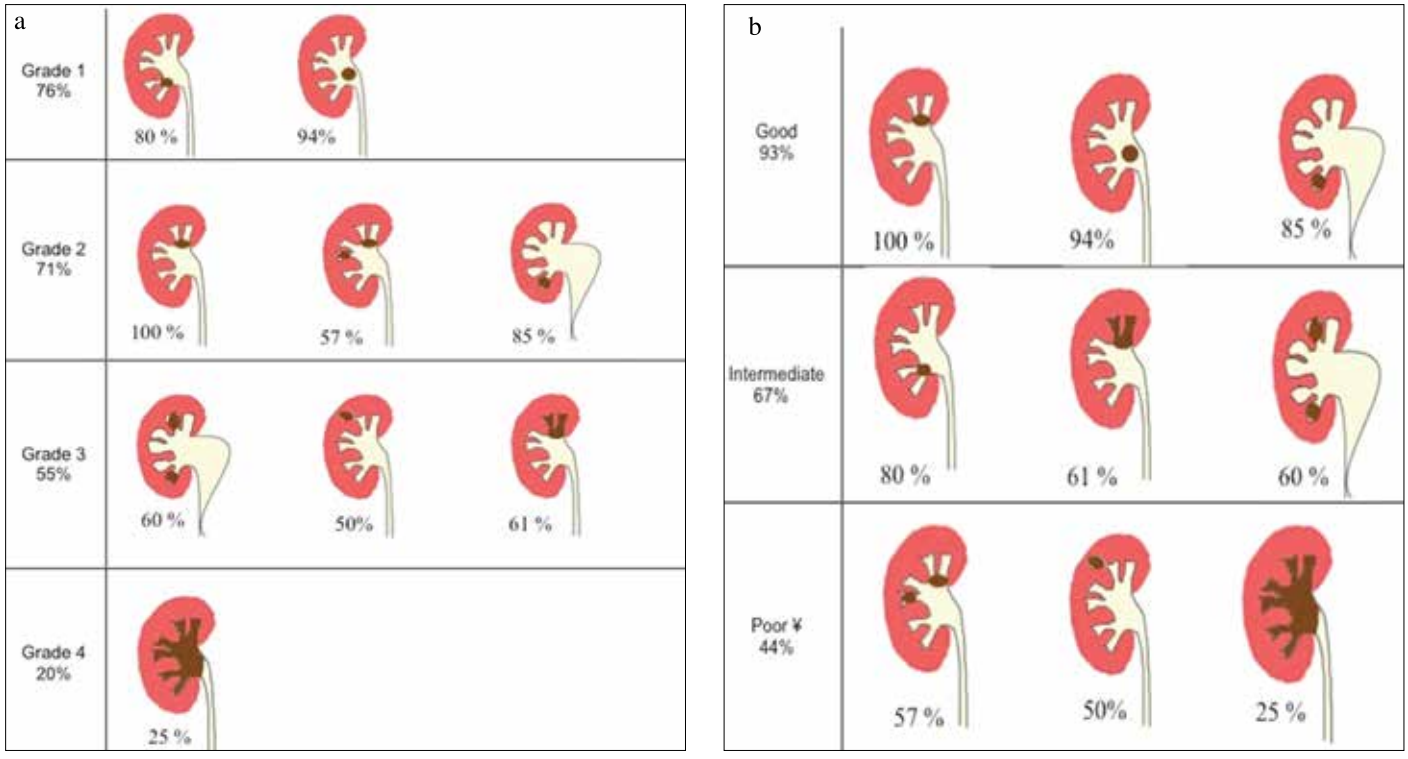

Figure 1. a, b. Figure 1. a, b. (a) Original Guy's Stone Score[6]
Grade 1: a solitary stone in the mid/lower pole or in the renal pelvis with normal anatomy.
Grade 2: a solitary stone in the upper pole; multiple stones in a patient with simple anatomy; or a solitary stone in a patient with abnormal anatomy.
Grade 3: multiple stones in a patient with abnormal anatomy or in a calyceal diverticulum or partial staghorn calculus.
Grade 4: a staghorn calculus or any stone in a patient with spina bifida or a spinal injury.
(b) Rearrangement of the subgroups originally proposed on GSS, and clustering into three major groups (GSS-M)
*To make the new classification every subgroup was assigned an Arabic number, and for each specific model a decimal (eg 1.1 corresponds to grade 1 of the scale of Guy Stone and the first specific model (a solitary Stone in lower/middle pole with simple anatomy); we evaluated independently each specific subgroup and their predicted SFR, and we ranked them from the better to the worst, and finally we grouped them into 3 major groups: good, intermediate and poor according to the SFR prognosis.
¥ Original Guy's classification includes stones in patients with spina bifida as Guy's IV, we didn't have these kind of patients but we think they should be included in the poor prognosis group

Table 3. Results based on the rearrangement proposed to the Guy's Stone Score (GSS-M)

Groups	Good	Intermediate	Poor	p
Patients (%)	29 (23)	48 (38)	49 (39)	
EBL°	60 (5-400)	50 (5-800)	50 (5-600)	0.1*
OT°	90 (25-180)	77.5 (30-225)	90 (30-240)	0.7*
LOS°	4 (2-12)	4 (3-11)	4 (3-22)	0.2*
SFR (%)	27 (93)	34 (67)	19 (44)	<0.00^
Complications				
Clavien ≤2 (%)	8 (27)	16 (33.3)	18 (36.7)	0.9^
Clavien >2 (%)	6 (20.6)	2 (4.1)	7 (14.2)	

*Kruskal Wallis Test; ^Chi-Square; °Median (range). EBL: estimated blood loss; OT: operative time; LOS: length of stay; SFR: stone- free rate

The overall complications rate was 45%, and Clavien score ≤2 (33%) and >2 (12%) complications were stratified in the GSS and GSS-M as reported in Tables 2 and 3. There were 45 patients with residual stones, 37 required secondary procedures including ESWL (n=6), RIRS (n=6), and a second PCNL (n=23) through the same tract, pyelolithotomy (n=1), ureterolithotomy (n=1) and surveillance only (n=8).

Discussion

Currently, none of the existent scoring systems for the prediction of success after PCNL is used routinely, mainly, because of their overall complexity. The ideal nephrolithometry index should be easy to perform and should have a good discrimination power, capable of arrange patients in major risk groups according to their

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prognosis. The urge to predict the SFR after PCNL has made several authors to create and evaluate various scales. The GSS which was the first scale reported, and described by Thomas et al. is the easiest, and perhaps the most used of them all.[6] Thomas et al.originally evaluated SFRs in 100 patients undergoing PCNL, and reported predictive values of GSS for SFRs as follows: Grade 1-81%, Grade 2-72.4%, grade 3-35% and grade 4-29%. Later Vicentini et al.[12], reported the SFRs using the GSS as follows: 95%, 79.5%, 59.5% and 40.7% for Grades 1-4, respectively. These results contradicted those obtained by Mandal et al.[13], who found SFRs of 68%, 74%, 56% and 0% for each of the grades. As reported in those studies, the GSS properly discriminates the two endpoints, and create 2 extremes of success, as extremely good (Grades 1 and 2), and extremely bad (Grades 3 and 4), with a minimum difference among the two grades obtained in both extremes. Therefore we propose that a novel classification of GSS into three major groups could represent a more useful grading.

With the intention to improve the discrimination among the GSS groups, we calculated the SFR for each of the subgroups originally included in this classification, and then clustered them into 3 groups. This rearrangement not only simplifies the GSS scale but increases the discrimination power for each of the new groups obtained. The patients with multiple stones in a simple anatomy kidney, stones in a calyceal diverticulum, staghorn calculus which can be independent predictors of the need either for multiple PCNL procedures or secondary procedures such as ESWL or RIRS to achieve the stone-free status are included in the poor prognostic group. Unfortunately no patients with spina bifida or spinal injury were admitted for PCNL procedures in our center, thus we were not able to cluster this subgroup into one of the major groups obtained.

The purpose of these classifications is to simplify GSS, hence making this scale a more accurate tool, improving its acceptance and reproducibility. Our rearrangement of the GSS is based on a more homogeneous initial evaluation, as all our patients were categorized using a CT scan, opposite to the initial description by Thomas et al.[6].

In GSS-M complications occurred more frequently in the intermediate and poor prognosis groups, in relation to grades 3 and 4 of the original GSS, thus we propose that patients with the included features should be assessed thoroughly to reduce the likelihood of complications.

The major limitations depicted in the present study are its retrospective design, the routine use of kidney, ureter and bladder (KUB) X-Ray study as a tool for the postoperative assessment of the stone- free status, even though the routine use of computed tomography for the postoperatively assessment of PCNL has been widely discussed[14-16], and the omitted evaluation of other stone factors such as density, which has been suggested as a predictor of success in patients undergoing PCNL.[17,18]

Another limitation is that the original Guy's classification includes stones in patients with spina bifida as Guy IV, we didn't have these kinds of patients but we think they should be included in the poor prognosis group. GSS-M needs to be evaluated in further prospective studies to achieve an optimal validation, however the results indicate a clear statistical trend to better discrimination power among groups and their respective residual stone risks categorized in low, intermediate and high risk groups.

In conclusion, although further validation is needed, the arrangement of the GSS proposed in the current study improves prediction of SFR and better discriminates risk groups in PCNL ameliorating the poor discrimination power noticed in the original GSS.

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