



Surgery

RELATION BETWEEN GUY'S STONE SCORE (GSS) WITH MINOR COMPLICATIONS ACCORDING TO CLAVIEN GRADING SCORE AND DURATION TIME OF PCNL PROCEDURE AT ADAM MALIK CENTRAL GENERAL HOSPITAL MEDAN

| | |
|---------------------------------|--|
| Boni Irawan | Surgery Resident of University of North Sumatra |
| Dhirajaya Dharma Khadar* | Urology Surgery Division of Faculty of Medicine University of North Sumatra – H. Adam Malik Medan Central General Hospital *Corresponding Author |
| Syah Mirsyah Warli | Urology Surgery Division of Faculty of Medicine University of North Sumatra – H. Adam Malik Medan Central General Hospital |

ABSTRACT**Introduction**

Percutaneous Nephrolithotomy (PCNL) is one of the minimally invasive in urology aimed at removing kidney stones using percutaneous access to reach the pelvicalices system. One of the simplest and applicative scoring systems as a predictor of PCNL procedures is Guy's Stone Score. The emergence of complications due to PCNL procedure is grouped into several categories as Clavien Grading Score and is significantly more frequent in patients with higher GSS scores. The purpose of this study was to investigate the relationship between Guy's Stone Score (GSS) with minor complications according to Clavien Grading Score and duration of operation on PCNL surgery procedure at RSUPH. Adam Malik Medan.

Methods This research is an analytical study with retrospective design. During the period of April to May 2018, 50 patients underwent the PCNL procedures, aged > 18 years, and with complete examination data were included in the study. Patients who have performed ESWL and endourology before PCNL procedures did not participate in the study. The variables in this study are numerical variables consisting of Guy's Stone Score (GSS), minor complications based on Clavien Grading Score and duration of operation. Data analysis was then conducted to assess the correlation between GSS with minor complications based on Clavien Grading Score and to assess GSS with duration of operation using Spearman Rho correlation test.

Results Of the 50 patients who underwent PCNL procedure, 27 (54%) of men were found, mean age 52.06 ± 9.69 years, ASA 1 group was mostly found in 44 (88%) patients, group GSS 4 was 23 (46%) patients, 37 (74%) patients had minor complications based on Clavien Grading Score, 46 (92%) of patients did not have postoperative fever with mean treatment duration of 7.16 ± 4.15 days. The average of Guy's Stone Score in this patient was 3.18 ± 0.91 , the mean duration of surgery in all patients was 167 ± 23.56 min, the mean preoperative and postoperative Hb rates were 11.84 ± 1.92 and $10,80 \pm 1.87$ gram/dl. Spearman Rho correlation test between GSS and duration of operation showed significant relationship ($r = 0,8$; $p < 0,001$). Spearman Rho correlation test to assess the relationship between GSS with minor complications according to Clavien Grading Score showed there was no significant relationship ($r = 0,6$, $p = 0,40$).

Conclusion From the 50 subjects who underwent PCNL surgery, 23 (46%) patients had GSS IV scores with a mean GSS score of $3.18 \pm 0,9$ and minor complications according to Clavien Grading Score of 37 (74%) patients with an average duration of surgery $167 \pm 23,56$ minutes. Hypothesis test in this study using Spearman Rho correlation test to see the relationship between GSS with long operation showed significant relationship ($p < 0,001$) with moderate correlation strength ($r = 0,6$).

KEYWORDS : PCNL, Guy's Stone Score, GSS, Clavien Grading Score**INTRODUCTION**

Percutaneous Nephrolithotomy (PCNL) is one of the minimally invasive actions in the field of urology that aimed at removing kidney stones using percutaneous access to reach the pelvicalices system. The European Association of Urology (EAU) considers PCNL the primary choice of surgery for large, multiple stones or inferior calix kidney stones. This procedure has been widely accepted as a procedure to remove kidney stones because they are relatively safe, effective, cheap, comfortable, and have low morbidity, especially when compared to open surgery (Nugroho D, et al, 2011, Purnomo B, Urology Basics 2011; Wein A. J et al., Campbell-Walsh Urology, 2016).

The advantage of the PCNL procedure is that the free stones rate larger than in ESWL, PCNL can be used for large-scale kidney stones (> 20 mm) therapy, it can be used on inferior calix stone which hard to treat with ESWL, and lower morbidity compared to open surgery in both systemic and preservation responses to postoperative renal function. (Nugroho D, et al, 2011). The weakness of PCNL is that it requires special skills and experience to perform its procedures. Currently open kidney stone surgery has been largely superseded by PCNL and ESWL procedures in both monotherapy and combination forms, due to greater open-operability morbidity than PCNL and ESWL. In general, PCNL techniques include four stages of the procedure, namely: percutaneous renal access, dilatation, fragmentation and stone extraction, and drainage. Although rare, but the process of puncture and dilatation are quite at risk for complications. (Kyriazis et al 2015, Nugroho D, et al, 2011).

The PCNL indication is 1. stone in the pelvicalices system that is not suited to ESWL 2. fails with ESWL management 3. stones with ureteric obstruction pelvic junction 4. Rocks on Calix diverticicles 5. Anatomical abnormalities (eg, horse horseshoe) Hohenfellner et al., Manual Endourology 2005; Nugroho D, et al., 2011). Contra absolute

indications are the presence of active urinary tract infection and coagulopathy. The relative indication is that transabdominal renal surgery performed previously may result in retinal rectal projection. (Hohenfellner et al, 2005 and Nugroho D, et al., 2011).

The success of PCNL in the management of large kidney stones began to shift open surgical procedures. Although minimally invasive, PCNL is a major surgery that has a risk of complications (Thomas et al 2002).

Tabel 1. Clavien Grading Score (Degimenci et al.)

| Grade | Definition | Classification |
|-------|---|---------------------------|
| I | Some postoperative complaints that do not require surgery, endoscopy and radiological intervention | Minor Complication |
| | Wound infections that occur during treatment | |
| | Therapeutic regimens may be given: antiemetics, antipyretics, diuretics, electrolytes and physiotherapy | |
| II | Pharmacologic is required in addition to grade I regimens | |
| | Tansfusion is required | |
| | It takes total parenteral nutrition | |
| III | Operation, endoscopy or radiological intervention is required | Major Complication |
| IIIa | Interventions are not under general anesthesia | |
| IIIb | Interventions are under general anesthesia | |

| | | |
|-----|---|---|
| IV | Y | Life-threatening complications, which requires ICU management |
| IVa | Y | Dysfunction of one organ (including dialysis) |
| IVb | Y | Dysfunction of more than one organ |
| V | Y | Dead |

Lojanapiwat et al, conducted the study and concluded that there was a significant relationship between Guy's Stone Score with minor complications based on Clavien Grading Score. Degimenci et al in his study stated that patient age, serum hydronephrosis, serum creatinine and Hb levels were significant parameters in the emergence of complications.

Rivera et al, in his study of 100 patients who underwent PCNL had an average length of surgery of 94.1 minutes, ranging from 41 to 210 minutes. Hosseini et al., In his study obtained an average length of PCNL 65 minute operation with an average acces time of 6.4 minutes (Hosseini, 2016). Rivera et al. also in another study comparing the length of PCNL surgery from unilateral and bilateral stones, which was obtained on unilateral stone average duration of operation 115.6 minutes and in patients with bilateral stone, the average duration of operation was 176.9 minutes.

Ingimarsson et al., Stated in his study the average length of surgery in patients undergoing PCNL procedure was 86 minutes with a range of 58 to 180 minutes. Thomas et al., In his study stated the average length of surgery in patients undergoing a 94 minute PCNL procedure ranging from 41 to 210 minutes. However, in the study there was no long-term grouping of operations based on GSS. Bansal et al in his study stated that duration of surgery over 120 minutes increased the risk of infection and SIRS (Bansal et al, 2017). Ramaraju et al also stated in his research that the duration of surgery had a significant effect on the occurrence of SIRS in patients post PCNL (Ramaraju, 2016).

METHODS

This research is an analytical study with retrospective design. Samples were collected through secondary data that met the inclusion criteria of patients who underwent PCNL surgery aged > 18 years and had complete examination data during the period April to May 2018. Patients who had performed ESWL or endourologic actions before PCNL were excluded. Sampling is done by consecutive sampling. The minimum number of samples calculated by the formula:

$$n = \left(\frac{Z\alpha + Z\beta}{0,5 \ln \frac{1+r}{1-r}} \right)^2 + 3$$

$$= \left(\frac{1,96 + 0,842}{0,5 \ln \frac{1+0,5}{1-0,5}} \right)^2 + 3 = (5)^2 + 3 = 28$$

Information:

n = number of samples
 Zα = standard deviation α (standard error rate type I) = 5%, then Zα = 1.96
 Zβ = standard deviation β (standard error rate type II) = 20%, then Zβ = 0.842
 r = correlation coefficient value = 0.5

Based on the formula above eating the minimum sample size of this study is 28 people.

The collected data will be presented descriptively in the frequency distribution table. Data between GSS with minor complication and duration of operation were analyzed using Spearman Rho correlation test.

RESULTS

Sampel Characteristics

The mean age of the study subjects was 52.06 ± 9.69 years, with a minimum age of 25 years and a maximum age of 70 years. In the table shows that the number of patients who undergo PCNL surgery is 27 (54%) men and women as many as 23 (46%) subject. In patients it was found that the ASA 1 group was most prevalent in 44 (88%) patients and the GSS group of 4 (46%) patients. From 50 patients in this study,

found 37 (74%) patients had minor complications based on Clavien Grading Score. A total of 46 (92%) patients did not have postoperative fever with mean treatment duration of 7.16 ± 4.15 days. The average Guy's Stone Score in this patient was 3.18 ± 0.91. The average duration of surgery in all patients was 167 ± 23.56 minutes. The mean preoperative and postoperative Hb rates were 11.84 ± 1.92 and 10.80 ± 1.87 grams / dl respectively.

Table 2. Characteristics of Subjects

| Characteristics | Frequency (n) | Percentage (%) |
|--|-----------------------|----------------|
| Mean Age (Mean ± SD) (Min, Maks) | 52,06 ± 9,69 (25, 70) | |
| Gender | 23 | 46 |
| - Man | 27 | 54 |
| - Woman | | |
| ASA | | |
| ASA I | 44 | 88 |
| ASA II | 5 | 10 |
| ASA III | 1 | 2 |
| GSS Score | | |
| 1 | 3 | 6 |
| 2 | 8 | 16 |
| 3 | 16 | 32 |
| 4 | 23 | 46 |
| Clevien Grading Score | | |
| Major Complication (+) | 37 | 74 |
| Minor Complication (-) | 13 | 26 |
| Fever Post Operation | | |
| Fever (+) | 4 | 8 |
| Fever (-) | 46 | 92 |
| Mean of Guy's Stone Score (Mean ± SD) | 3,18 ± 0,91 | |
| Mean of Length of Stay (Day) (Mean ± SD) | 7,16 ± 4,15 | |
| Mean of Duration of Operation (Minutes) (Mean ± SD) | 167 ± 23,56 | |
| Mean of Pre Operative Hb (gr/dl) (Mean ± SD) | 11,84 ± 1,92 | |
| Mean of Post Operative Hb (gr/dl) (Mean ± SD) | 10,80 ± 1,87 | |

Results of Data Analysis

Spearman Rho correlation test between GSS and duration of operation showed significant relationship (r = 0,8; p <0,001). Spearman Rho correlation test to assess the relationship between GSS with minor complications according to Clavien Grading Score showed there was no significant relationship (r = 0.6, p = 0.40).

Table 3. Spearman Correlation Analysis Results between Guy's Stone Score and Duration of Operation of PCNL

| | Lama Operasi PCNL |
|--------------------------|-------------------|
| Guy's Stone Score | r = 0,8 |
| | p = 0,000 |
| | n = 50 |

Based on the results of analysis by using Spearman correlation test in the above table to see Spearman correlation between Guy's Stone Score with long operation concluded that there is a significant relationship between GSS with PCNL duration of operation seen from p value <0,05 (p = 0,000) with strength good correlation (r = 0.8).

Table 4. Relation Between Guy's Stone Score and Minor Complication Based on Clavien Grading Score Using Spearman Correlation Test

| GSS | Major Complication (+) | Minor Complication (-) | % Minor Complication Rate | r = 0,60 p = 0,40 |
|-----|------------------------|------------------------|---------------------------|----------------------|
| 1 | 2 | 1 | 66,7% | |
| 2 | 3 | 5 | 37,5% | |
| 3 | 14 | 2 | 87,5% | |
| 4 | 18 | 5 | 78,3% | |

Based on the table above it was found that of 50 patients who underwent PCNL surgery, found 37 (74%) patients had minor

complications. Of these 37 patients, 18 (78.3%) patients were in the GSS group 4 with a minor complication rate of 78.3%. While the number of patients who did not experience minor complications were 13 (26%) patients. Based on the results of analysis by using Spearman correlation test known that there is no relationship between GSS with the number of minor complications based on Clavien Grading Score in patients undergoing PCNL surgery. This can be seen from the value $p > 0.05$ ($p = 0.40$) with the correlation power syang contained in the table above.

DISCUSSION

In this study it was found that the mean age of patients who underwent PCNL surgery was 52.06 ± 9.69 years with the smallest age of 25 years and the largest 70 years. As in Kumar et al. (2017) conducted in India, it was found that the mean age of the sufferer was 40.8 ± 8.72 . The study by Yang et al. (2016) obtained mean age is 51.07 ± 12.08 year. This is assumed because the age is a productive age which has a high mobility and activity that is at risk of trauma.

Patients who underwent PCNL surgery on the basis of sex were 27 (54%) patients and women as many as 23 (46%) patients. Research data by Yang et al. (2016) showed similar results in which men (67.1%) were more likely to have PCNL surgery than women with a male-to-female ratio of 2.027 (Kumar et al., 2017). So is the study by Bansal et al. (2017) found that patients who undergo most PCNL surgery in men 59.1%.

In this patient based on ASA, most are ASA I as many as 44 (88%) patients. This is in contrast to research conducted by Palacios (2018) in Mexico which states that ASA 2 is the largest group (63.5%). Based on Guy's Stone Score it was found that most patients in the GSS 4 group accounted for 23 (46%) patients with a mean Guy's Stone Score 3.18 ± 0.91 . This is in contrast to research conducted by Mandal et al. (2012) which states that most patients with PCNL surgery in the GSS 2 group of 98 people. Similarly, research conducted by Palacios (2018) in Mexico which states that most are GSS 1 42 (33.3%) patients. GSS can be used as an effective parameter in predicting perioperative complications and postoperative PCNL procedures (Kumsar, 2015).

In this study it was found that of 50 patients who underwent PCNL surgery, found 37 (74%) patients had minor complications. Of these 37 patients, 18 (78.3%) patients were in the GSS group 4. The results of this study were similar to those conducted by Lojanapiwat et al. (2016) states that the GSS group 4 is the largest group with minor complications based on Clavien Grading Score. However, unlike research conducted by Palacios (2018) in Mexico which states that patients who undergo PCNL surgery who experienced minor complications based on Clavien Grading Score most in the GSS 2 group as much as 37%. Clavien Grading Score is used as a standard evaluation of complications to determine the effectiveness and efficacy of such operating costs (Taken, 2015).

In this patient based on postoperative fever at most is no post operative fever as much as 46 (92%) patients and 4 (8%) have a fever. This is in line with research conducted by Bansal (2017) in India which states that patients with PCNL post surgery who had a fever of 16.5%. Similarly, research by Yang et al. (2015) stated the same that 20 (12.2%) patients had PCNL postoperative fever. Yang et al. (2017) states postoperative PCNL fever occurs if the body temperature is more than 38°C and hospitalized. Bansal (2017) cites fever after PCNL action does not always appear but has a low incidence of severe sepsis and multi-organ failure that can be life-threatening.

Mandal (2012) also mentioned postoperative fever PCNL is the second most frequent complication after blood transfusion and reported incidence for fever after PCNL surgery ranged from the lowest of 2.8% to 27.6%. This is due to differences in patient populations such as urinary tract infections, infectious lesions, urinoma, perinephric abscess, urosepsis, renal insufficiency, infection stones, duration of operation (<90 min), irrigation fluid amount, side effects of blood transfusion and policy on antibiotic use Mandal, 2012). Singh et al. (2015) also adds that postoperative fevers often appear after PCNL surgery, but the progression of sepsis is rare and difficult to determine who is at risk of experiencing it. To minimize the condition it is advisable to perform urine culture and treat urinary tract infections during preoperative based on culture results (Singh et al., 2015).

The mean duration of treatment of patients undergoing PCNL surgery was 7.16 ± 4.15 days. This is in line with research conducted by Kumar

(2018) that the length of treatment of these patients is 3.77 ± 0.94 days. A similar feature was also found in the study by Singh et al. (2015) which states that the mean duration of care is 4.74 ± 8.53 days. Yang et al. (2017) states that patients will recover and return from hospital on the sixth day after surgery.

The average duration of surgery in this study was 167 ± 23.56 minutes. This is similar to that of Yang et al. (2017) stated that the average operation duration was 133.66 ± 53.35 minutes. However, the average length of this operation is different from the research conducted by Kumar (2018) that is 75.51 ± 27.42 minutes. Likewise in the study by Mandal (2012) states the average length of operation is 80 minutes with a range of 45-180 minutes. Sharma (2015) says that the longer the operation has implications for the increasing amount of irrigation fluids and the high risk of sepsis. The risk of infection is related to the amount of fluid irrigation and the duration of surgery. Song (2015) also argues that the duration of surgery also reflects the surgeon's ability to perform PCNL actions, and also includes the time needed to reposition the patient after urinary catheter insertion and stone demolition process.

The mean preoperative and post operative Hb rates in this study were 11.84 ± 1.92 and 10.80 ± 1.87 . This is in line with research conducted by Said et al. (2016) which states that there is a decrease in Hb level of 1.5 ± 1 g / dl between before and after PCNL surgery. Mandal (2012) mentions this due to intraoperative blood loss and low preoperative Hb levels.

Spearman correlation test result in this research to see the relationship between GSS with PCNL operation duration concluded there is significant relation seen from $p = 0.000$ ($p < 0.05$) with good correlation strength ($r = 0.8$). This significant relationship is also similar to that of Kumar (2017) with $p < 0.001$. Research by Ruix, et al. (2016) also states that there is a significant relationship with the value of $p < 0.001$. This is because PCNL operations allow multiple access in the urinary tract and clear the stone (Song, 2015).

Based on the results of analysis using Spearman correlation test to see the relationship between GSS with minor complication rate based on Clavien Grading Score obtained p value = 0.40 ($p > 0.05$) is in the GSS group 4 with the number of minor complications 78.3% so it is concluded that there was no significant association between GSS and minor complications based on Clavien Grading Score in patients undergoing PCNL surgery. This is similar to a study by Kumar (2018) which shows no association between GSS with minor complications with $p = 0.054$ ($p > 0.05$). Similar results were also obtained in a study by Palacios (2018) which states there is no association between GSS with minor complications seen from $p = 0.76$ ($p > 0.05$).

CONCLUSION

Clinicians can apply Guy's Stone Score (GSS) and Clavien Grading Score as a benchmark in PCNL procedures and reduce the incidence of life-threatening complications. In addition, GSS can be used to predict the optimization of the length of operation so as to reduce the burden on the hospital.

References

- Abdelhafez M.F, B. Amend, J. Bedke, S. Cruck, U. Nagele, A. Stenzi, D. Schilling, 2012. Minimally Invasive Percutaneous Nephrolithotomy : A Comparative Study of Management of Small and Large Renal Stones, *Journal Urology*, 81 (2), 241 – 245.
- Aminsharifi A. A. Eslahi, A.R. Safarpour, S. Mehrabi, 2014, Stone Scattering During Percutaneous Nephrolithotomy : Role of Renal Anatomical Characteristics, *Urolithiasis*, 42, 435 – 439.
- Bansal et al., 2017. Predictive Factors for Fever and Sepsis Following Percutaneous Nephrolithotomy: A Review of 580 Patients. *Urology Anals* 9(3), 230-233.
- Binbay M, T.Akman, F. Ozgor, O. Yazici, E. Sari, A. Erbin, C. Kezer, O. Sarilar, Y. Berberoglu, A.Y. Muslimanoglu, 2011. Does Pelviciceal System Anatomy Affect Success of Percutaneous Nephrolithotomy?, *Journal Urology*, 78(4), 733 – 737.
- Hohenfellner R, Stolzenburg J.U, 2005, *Manual Endourology*, 1st ed, Springer, Heidelberg.
- Kamphuis G.M, J. Baard, M Westendarp, J.J. de la Rosette, 2015, Lesson Learned from the CROES Percutaneous Nephrolithotomy Global Study, *World Journal Urology*, 33, 223 – 233.
- Karami H, M.M. Mazloomfard, A. Golshan, T. Rahjoo, B. Javanmard, 2010, Does Age Affect Outcomes of Percutaneous Nephrolithotomy ?, *Journal Urology*, 7(1), 17 – 21.
- Khorrami M, M. Hadi, M.M. Sichani, K. Nourimahdavi, M. Yazdani, F. Alizadeh, M.H Izadpanahi, F. Tadayyon, 2014, Percutaneous Nephrolithotomy Success Rate and Complications in Patients with Previous Open Stone Surgery, *Urology Journal*, 11(03), 1557 – 1562.
- Kumar et al., 2017. STONE Score Versus Guy's Stone Score – Prospective Comparative Evaluation for Success Rate and Complication in Percutaneous Nephrolithotomy. *Urology Annals* 10(1), 76-81.
- Kyriazis I, V. Panagopoulos, P. Kallidonis, M.Ozsoy, M. Vasilas, E. Liatsikos, 2014, Complications in Percutaneous Nephrolithotomy, *World Journal Urology*, 33, 1069 – 1077.

11. Lojanapiwat B., 2013. The Ideal Puncture Approach for PCNL: Fluoroscopy, Ultrasound or Endoscopy?. *Indian Journal of Urology* 29(3), 208-213.
12. Mandal S, A. Goel, R. Kathpalia, S. Sankhwar, V. Singh, R.J. Sinha, B.P Singh, D. Dalela, 2012. Prospective Evaluation of Complications Using the Modified Clavien Grading System and of Success Rate of Percutaneous Nephrolithotomy Using Guy's Stone Score: a Single-Center Experience, *Indian Journal of Urology*, 28(4): 392-398.
13. McAninch J.W, Lue T.F, 2013, Smith & Tanangho's General Urology, 18th ed, McGraw Hill, New York.
14. Nerli R.B, S. Devaraju, M.B Hiremath, 2014, Training in Percutaneous Nephrolithotomy: A Structured Apprenticeship Program, *Journal of the Scientific Society*, 41(1), 26 – 31.
15. Noureldin Y.A, M.A Elkoushy, S. Andonian, 2015, Which is Better? Guys Versus S.T.O.N.E Nephrolithometry Scoring System in Predicting Stone Free Status Post Percutaneous Nephrolithotomy, *World Journal Urology*, 33(5), 1821 – 1825.
16. Nugroho D, P. Birowo, N. Rasyid, 2011, Percutaneous Nephrolithotomy sebagai Terapi Batu Ginjal, *Majalah Kedokteran Indonesia*, 61(3), 130 – 138.
17. Ortiz C.T, A.I. Martinez, A.J Morton, H.V Reyes, S.C. Feixas, J.F. Novo, E.F. Miranda, 2014, Obesity in Percutaneous Nephrolithotomy. Is Body Mass Index Really Important?, *Journal Urology*, 84(3), 538 – 543.
18. Palacios et al., 2018. Rearrangement of the Guy's Stone Score in Improves Prediction of Stone-Free Rate After Percutaneous Nephrolithotomy. *Turkey Journal Urology*, 44(1), 36-41
19. Prakash G, R.J. Sinha, A. Jhanwar, A. Bansal, V. Singh, 2017, Outcome of Percutaneous Nephrolithotomy in Anomalous Kidney : Is It Different?, *Urology Annals*, 9(1), 23 – 26.
20. Purnomo B.B, 2011, Dasar-Dasar Urology, Edisi Ketiga, Sagung Seto, Jakarta.
21. Rui X et al., 2016. Comparison of Safety and Efficacy of Laparoscopic Pyelolithotomy Versus Percutaneous Nephrolithotomy in Patients with Large Renal Pelvic Stones: A Meta-Analysis. *Journal of Investigating Medicine*, 64, 1134-1142.
22. Said et al., 2016. Percutaneous Nephrolithotomy; Alarming Variables for Postoperative Bleeding. *Arab Journal of Urology* 15, 24-29.
23. Singh et al., 2015. Comparative Evaluation of Upper Versus Lower Calyceal Approach in Percutaneous Nephrolithotomy for Managing Complex Renal Calculi. *Urology Annals*, 7(1), 31-35.
24. Sofer M, I. Druckman, A. Blachar, J. Ben-Chaim, H. Matzkin, G. Aviram, 2012. Non-contrast Computed Tomography After Percutaneous Nephrolithotomy : Finding and Clinical Significance, *Journal Urology*, 79(5), 1004 – 1010.
25. Song et al., 2015. Evaluating the Learning Curve for Percutaneous Nephrolithotomy under Total Ultrasound Guidance. United Kingdom.
26. Takene et al., 2015. Comparison of Percutaneous Nephrolithotomy Complications According to the Modified Clavien Classification During and After the Learning Curve. *Eastern Journal of Medicine* 20, 94-100.
27. Thomas K, N.C. Smith, 2011, The Guy's Stone Score – Grading the Complexity of Percutaneous Nephrolithotomy Procedures, *Journal Urology*.
28. Thomas K, N.C. Smith, N. Hegarty, J.M. Glasee, 2011, How Accurate is the :Guy's Stone Score: for Predicting the Stone Free Rates after Percutaneous Nephrolithotomy?, *Indian Journal of Urology*, 27 (4), 568 - 569.
29. Wein A.J, Kavoussi L.R, Partin A.W, Peters C.A, 2016, *Campbel-Walsh Urology*, 11th ed, Elsevier, Philadelphia.
30. Williams N.S, Bulstrode C.J.K, O'Connell P.R, 2008, *Bailey & Love's Short Practice of Surgery*, 25th ed, Hodder Arnold, London.
31. Yang et al., 2017. The Evaluation of Risk Factors for Postoperative Infectious Complication After Percutaneous Nephrolithotomy. *Biomed Research Internasional*.