Overview of Factors Affecting Total Blood Loss and Need for Blood Transfusion in a Series of Patient Undergoing Unilateral Percutaneous Nephrolithotomy

Abstract

**Purpose:** Although percutaneous nephrolithotomy (PNL) has been accepted as a standard method for the management of large renal stones, the incidence of renal hemorrhage is relatively high. This study investigated the variables that affect Haemoglobin (Hb) drop and blood transfusion need during PNL.

**Materials and Methods:** The medical records of 200 patients who underwent unilateral PCNL from January 2014 to October 2015 were recorded prospectively. Various clinical preoperative, perioperative and postoperative factors including age, sex, body mass index, diabetes mellitus, hypertension, preoperative creatinine level, previous renal surgery, renal anomalies, history of extracorporeal shock wave lithotripsy (SWL), stone size, stone site, stone complexity (GUY’s Stone Scoring System; SSS), degree of hydronephrosis, operative time, type of anesthesia, number of puncture, size of amplatz, method of stenting (double J or ureteric stent), intra operative complication (perforation and extravasation) were assessed. For statistical assessment, univariate and multivariate logistic regression analyses were used.

**Result:** The mean±SD of patient's age was 37.5±14.7 years, ranged from 5 to 75 years. The highest age group was 15-49 years i.e 71%. Male (62.5%) was more common than female (37.5%). Body Mass Index (BMI) was calculated for patients and the results were: under weight (4.5%), normal weight (31.5%), overweight (41.0%) and obese (23%). The overall blood transfusion rate was 14%. One patient (0.5%) underwent angioembolization after surgery. The average blood loss was 1.5±1g/dl. Multivariate stepwise regression analyses showed that the most important factors affecting the rate of blood transfusion were: the intraoperative complication (perforation and extravasation), stone complexity (GUY’s Stone Scoring System), operative time (>83 minute) and the most important factors affecting the total Haemoglobin drop were Stone complexity (GUY’s SSS) and preoperative creatinine level (≥1.4mg/dl). No correlation between (age, sex, BMI, diabetes mellitus, hypertension, previous renal surgery, SWL, degree of hydronephrosis, size of amplatz, and stenting method) and rate of blood transfusion was found.

**Conclusion:** Our results, showed that:

i. Stone complexity (GUY’s SSS, grade 3 and 4).
ii. Preoperative creatinine level (≥1.4mg/dl).
iii. Intra operative complication (perforation and extravasation).
iv. Duration of operation (>83 minute).

Were the most important factors associated with an increased risk of bleeding and transfusion during PNL in both univariate and multivariate analysis.

**Keywords:** PNL; Bleeding; Blood transfusion; Guys scoring system; Angioembolization; Complication

Abbreviations: BMI: Body Mass Index; GUY's SSS: GUY’s Stone Score System; S-ReSc scoring: Seoul National University Renal Stone Complexity; IRIS: Retrograde Intra Renalsurgery; SWL: Extracorporeal Shock Wave Lithotripsy; PNL: Percutaneous Nephrolithotomy

Introduction

Since the invention of percutaneous nephrolithotomy (PNL) as a novel strategy in the treatment of urinary stones, both indication and technique have continued to be developed.
[1,2]. Despite the possibility of high-quality imaging, technical improvements of lithotripsy devices, and anesthesia tailored for each patient, PNL is still a challenging procedure that requires an experienced and careful surgeon who is aware of the pitfalls [3]. About 50% of recurrent stone formers have just one lifetime recurrence. Highly recurrent disease is observed in slightly more than 10% of patients. Stone type and disease severity determine low or high risk of recurrence [4-6]. Currently, no standardized method is available to predict success rate after percutaneous Nephrolithotomy [7]. There is several scoring system which can predict success rate and complication like: Seoul National University Renal Stone Complexity Score (S-ReSC Scoring) [7], the GUY’S Stone Score (GSS) System [8], Table 1 the GUY’s stone score. Grading the complexity of percutaneous nephrolithotomy and S.T.O.N.E. Nephrolithometry Scoring System [9].

Table 1: The GUY’s stone score. Grading the complexity of percutaneous nephrolithotomy [8].

| Grade | Stone Burden |
|-------|--------------|
| Grade 1 | -Solitary stone in mid/lower pole  
- Solitary stone in pelvis with simple anatomy |
| Grade 2 | -Solitary stone in upper pole  
- Multiple stone in patient with simple anatomy  
- Solitary stone in patient with abnormal anatomy |
| Grade 3 | -Multiple stones in patient with abnormal anatomy  
- Stones in calceal diverticulum  
- Partial staghorn calculus. |
| Grade 4 | -Staghorn calculus  
- Any stone in a patient with spina bifida or spinal injury |

PNL is a safe and efficient treatment option for larger stones and staghorn calculi. Nevertheless, surgeons have to face specific complications during and after the procedure [10]. Recent publications adopted the surgical Clavien classification as a comparable demonstration of complications [11,12]. Table 1 & 2 grading of Postoperative Complications of Percutaneous Nephrolithotomy According to the Modified Clavien Classification System. Acute hemorrhage is the most common significant complication of percutaneous access into the upper urinary tract collecting system. Percutaneous nephrostomy alone results in hemorrhage requiring transfusion in 0.5% to 4% of procedures [13]. With the addition of percutaneous nephrolithotomy, likely the percutaneous tract and increased intra renal manipulation, the incidence of hemorrhage to the point of transfusion rises to 6% to 20% [14].

Factors associated with hemorrhage during percutaneous surgery include patient characteristics, multiple access sites, supracostal access, increasing tract size, tract dilation with methods other than balloon dilation, prolonged operative time, and renal pelvic perforation, inexperience, preoperative anemia [15,16]. Blood transfusion was classified as a Clavien class II complication, radiological embolisation under local anaesthesia as IIIa and ICU admission or life-threatening complication as a class IV [17] Definition of blood transfusion should include the time and number of units of blood transfused. Only transfusion with indication related to surgical procedure should be reported. The cut-off level use to make decision to transfuse should be reported [18]. Aim of the study although percutaneous nephrolithotomy (PNL) has been accepted as a standard method for the management of large renal stones, the incidence of renal hemorrhage is relatively high. This study investigated the variables that affect Haemoglobin drop and blood transfusion during PNL.

Materials and Methods

Between (Feb/2014) to (Oct/2015) the demographic and procedural data of 200 patient (125 male and 75 female) who underwent PNL (106 right side, 94 left side), were maintained prospectively and analyzed regarding the factors which may have potential impact on haemoglobin drop and blood transfusion. Patients were divided depending on their ages in to those <15 years, 15-49 years and >50. Informed consent was obtained from patients before operation. The entire procedure was performed in the Urology department with the patient under general anaesthesia (171 patients) or spinal anesthesia (29 patient). The number and types of access depended on the size of treated stones (staghorn stone versus single stone) and localization (upper or lower pole). At the end of procedure, a clamped Foley catheter placed as a nephrostomy tube and opened after 8 hours. JJ stent placed for most of the subjects (159 patients) and removed after weeks. Ureteric stent left in place (41 patients) for those without JJ stent and removed after 24 to 48 hours. In this study, Hb checked preoperatively for all patients and repeated 24 hours following PNL. If necessary Hb checks were performed at more frequent intervals for specific cases. Urine output, haematuria, vital signs (pulse rate, blood pressure) routinely followed after operation. The urethral catheter was removed after 24-48 hours and nephrostomy tube was removed after 2-6 days. Stone burden and location classified based on GUY’s stone scoring system, it comprises 4 grades (Table 1).

Changes in haemoglobin concentration is defined at the difference between preoperative and 24 hour postoperative haemoglobin concentrations, and prior to discharge and patients receiving blood transfusion were identified. It was considered that a 1 unit blood transfusion increase the hemoglobin level by 1 gram/dl and hematocrit by 3%. Therefore drops in hemoglobin and hematocrit were calculated as following: (Preoperative Hb(Hct) - postoperative Hb(Hct)) – (number of unit transfused *1 gram/dl) /3% Hct. A proposed definition for blood transfusion; the total number of whole blood units transfused in the perioperative stay with the cut-off 10gram/dl. Postoperatively, patients with Hb < 10 g/dl were transfused. Patients with Hb > 10 g/dl but clinically showed symptoms of anaemia underwent further follow up, those who persist with anaemic symptom were transfused. Patient with intractable bleeding, haematuria or hemodynamic instability were candidates for angiographic intervention.

Results and Discussion

The mean±SD of patients age was 37.5±14.7 years, ranged from 5 to 75 years. The highest age group was 15-49 years i.e 71%. Male (62.5%) was more common than female (37.5%). Body Mass Index (BMI) was calculated for patients and the results were: under weight (4.5%), normal weight (31.5%), over weight
(41.0%) and obese (23%). Table 2 demonstrates some preoperative characteristics of the studied population. The most common stone size was 20-30 mm (42%). According to the GUY's Stone Scoring system. The highest incidence of stone complexity was grade 1 and 2 in 35% and 47.5% respectively. The average operation time was 83 minutes. The duration was less than average in 60% of patients. One puncture was used in most of patients 85.5%. 

| Preoperative Findings                        | Number | Percent |
|----------------------------------------------|--------|---------|
| Diabetes mellitus                           | 23     | 11.5    |
| Hypertension                                | 39     | 19.5    |
| Serum creatinine (>)1.4                     | 4      | 2.0     |
| Previous renal surgery                      | 73     | 36.5    |
| Stone location                              |        |         |
| -Pelvic                                      | 53     | 26.5    |
| -Upper pole                                  | 38     | 19.0    |
| -Lower                                       | 14     | 7.0     |
| -Mid                                         | 26     | 13.0    |
| -Staghorn                                    | 2      | 1.0     |
| -Partial                                     |        |         |
| Previous SWL                                 | 75     | 37.5    |
| Previous renal surgery                       | 73     | 36.5    |
| Renal anomaly                                | 19     | 9.5     |

Table 3: Factors Affecting Hb drop assessed by univariate analyses.

| Parameters                  | Hb Drop (g/dL) Mean±SD | P Value |
|-----------------------------|------------------------|---------|
| Age Group                   |                        |         |
| - <15                       | 1.07±0.48              | 0.312   |
| - 15-49                     | 1.50±1.00              |         |
| -≥50                        | 1.45±1.10              |         |
| Sex                         |                        |         |
| - Male                      | 1.50±0.99              | 0.439   |
| - Female                    | 1.38±1.02              |         |
| BMI                         |                        |         |
| - Under Weight              | 1.71±0.52              | 0.001   |
| - Normal                    | 1.45±0.94              |         |
| - Over wt                   | 1.17±0.81              |         |
| - Obese                     | 1.92±1.26              |         |
| Diabetes Mellitus           |                        |         |
| - (-ve)                     | 1.40±0.97              | 0.024   |
| - (+ve)                     | 1.90±1.15              |         |
### Table of Factors Affecting Total Blood Loss and Need for Blood Transfusion

| Factor                                      | (-ve)  | (+ve)  | p-value |
|---------------------------------------------|--------|--------|---------|
| **Hypertension**                            | 1.39±0.95 | 1.74±1.16 | 0.046   |
| Preoperative creatinine level (≥ 1.4 mg/dl)  | 1.43±0.97 | 2.95±1.55 | 0.003   |
| Previous renal surgery (Pyelolithotomy & PNL) | 1.44±1.07 | 1.48±0.86 | 0.777   |
| Renal Anomalies                             | 1.38±0.96 | 2.20±1.05 | 0.001   |
| Previous SWL                                | 1.37±0.94 | 1.61±1.07 | 0.103   |
| Stone size                                  | 1.03±0.88 | 1.44±0.86 | 0.001   |
| Stone complexity (GUY’s Stone scoring system) | 1.31±0.97 | 1.85±0.50 | 0.017   |
| Degree of Hydronephrosis                     | 0.88±0.65 | 1.30±1.05 | 0.142   |
| Type of Anesthesia                          | 1.46±0.99 | 1.42±1.05 | 0.816   |
| Duration by Minute                          | 1.29±0.91 | 1.71±1.08 | 0.003   |
Review of Factors Affecting Total Blood Loss and Need for Blood Transfusion in a Series of Patient Undergoing Unilateral Percutaneous Nephrolithotomy

Table 4: Outcomes of multivariate binary logistic regression analysis: factors affecting Hb drop.

| Factors                                      | P value | Odds Ratio | 95% CI Lower | 95% CI Higher |
|----------------------------------------------|---------|------------|--------------|--------------|
| Stone complexity (GUY’s SSS)                |         |            |              |              |
| 1.0                                          | 0.039   | 1.22       | 0.57         | 2.91         |
| 2.0                                          | 1.54    | 1.02       | 4.89         |              |
| 3.0                                          | 2.01    | 1.97       | 5.86         |              |
| 4.0                                          |         |            |              |              |
| Preoperative creatinine rise (≥1.4 mg/dl)    |         |            |              |              |
| Absent (Reference)                          | 0.042   | 1          |              |              |
| Present                                     | 1.96    | 1.03       | 5.32         |              |

Blood transfusion, Overall blood transfusion rate was 14% (n=28 patients). Table 5 demonstrate the factors affecting blood transfusion in univariate analysis. Table 6 shows Outcome of multivariate logistic regression analysis for blood transfusion. Blood loss frequently occurs from the nephrostomy tract itself, but can also be secondary to parenchymal lacerations incurred during tract dilation or stone breakup, or lesions of the vascular system arising from pseudo aneurysms or arteriovenous fistulae [19]. Fortunately, in most cases bleeding can be controlled with conservative measures, such as clamping the nephrostomy, hydration, and haemostatic medications [20].

Blood transfusion was reported in 27 studies. Twenty-one (77.8%) of the studies did not report the criteria for blood transfusion. Three (11.1%) of the studies reported a cutoff Hb level of 9 gm/dl, while one study used a cutoff level of 10g/dl. Five studies reported estimated blood loss without explanation of calculation [18]. Table 7 demonstrate comparison of transfusion rate with other published series. Excessive bleeding during...
PNL managed by some maneuvers, like placement of a larger nephrostomy tube, nephrostomy tube clamping, hydration, balloon tamponade and haemostatic medication. The bleeding is mainly venous in origin and most of our intraoperative bleeding was controlled conservatively. In our study, only 1 (0.5%) patient needed angiographic embolization of the bleeding renal artery. Table 8 demonstrate comparison of Embolisation rate with other published series [21-23].

Table 5: Factors affecting blood transfusion requirement assessed by univariate analysis.

| Parameters                        | Transfusion (-ve) | Transfusion (+ve) | P value |
|-----------------------------------|-------------------|-------------------|---------|
| Age Group                         |                   |                   |         |
| - <15                             | 14 (100)          | 0 (0)             | 0.278   |
| - 15-49                           | 120 (84.5)        | 22 (15.5)         |         |
| - ≥50                             | 37 (84.1)         | 7 (15.9)          |         |
| Sex                               |                   |                   |         |
| - Male                            | 105 (84)          | 20 (16)           | 0.437   |
| - Female                          | 66 (88)           | 9 (12)            |         |
| BMI                               |                   |                   |         |
| - Under weight                    | 7 (77.8)          | 2 (22.2)          | 0.727   |
| - Normal                          | 52 (82.5)         | 11 (17.5)         |         |
| - Over wt                         | 72 (87.8)         | 10 (12.2)         |         |
| - Obese                           | 40 (87.0%)        | 6 (12.0)          |         |
| Diabetes Mellitus                 |                   |                   |         |
| - (-ve)                           | 153 (86.4)        | 24 (13.6)         | 0.295   |
| - (+ve)                           | 18 (78.3)         | 5 (21.7)          |         |
| Hypertension                      |                   |                   |         |
| - (-ve)                           | 137 (85.1)        | 24 (14.9)         | 0.74    |
| - (+ve)                           | 34 (87.2)         | 5 (12.8)          |         |
| Preoperative Creatinine Level (≥1.4) |                |                   |         |
| - (-ve)                           | 169 (86.2)        | 27 (13.8)         | 0.042   |
| - (+ve)                           | 2 (50.0)          | 2 (50.0)          |         |
| Previous Renal Surgery            |                   |                   |         |
| - (-ve)                           | 112 (88.2)        | 15 (11.8)         | 0.154   |
| - (+ve)                           | 59 (80.8)         | 14 (19.2)         |         |
| Renal Anomalies   | (-ve) | 159 (87.8) | 22 (12.2) | 0.004 |
|-------------------|-------|------------|-----------|-------|
|                   | (+ve) | 12 (63.2)  | 7 (36.8)  |       |
| Stone Complexity (GUY’s System) |       |            |           |       |
| - 1.00            |       | 65 (92.9)  | 5 (7.1)   | 0.001 |
| - 2.00            |       | 83 (89.2)  | 10 (10.8) |       |
| - 3.00            |       | 10 (83.3)  | 2 (16.7)  |       |
| - 4.00            |       | 13 (52.0)  | 12 (48.0) |       |
| Stone Size        |       |            |           | 0.01  |
| - < 20mm          |       | 38 (90.5)  | 4 (9.5)   |       |
| - 20 -30mm        |       | 77 (91.7)  | 7 (8.3)   |       |
| - > 30mm          |       | 56 (75.7)  | 18 (24.3) |       |
| Previous SWL      |       |            |           | 0.108 |
| - (-ve)           |       | 103 (82.4) | 22 (17.6) |       |
| - (+ve)           |       | 68 (90.7)  | 7 (9.3)   |       |
| Degree of Hydronephrosis |       |            |           | 0.107 |
| - No              |       | 8 (80.0)   | 2 (20.0)  |       |
| - Mild            |       | 53 (89.8)  | 6 (10.2)  |       |
| - Moderate        |       | 78 (88.6)  | 10 (11.4) |       |
| - Severe          |       | 32 (74.4)  | 11 (25.6) |       |
| Duration by Minutes |      |            |           | 0.001 |
| - < 83            |       | 114 (95.0) | 6 (5.0)   |       |
| - > 83            |       | 57 (71.3)  | 23 (28.8) |       |
| Number of punctures |      |            |           | 0.038 |
| - 1               |       | 150 (87.7) | 21 (12.3) |       |
| - 2               |       | 19 (76.0)  | 6 (24.0)  |       |
| - 3               |       | 2 (50.0)   | 2 (50.0)  |       |
| Size of Amplatze  |       |            |           | 0.487 |
| - Mini            |       | 4 (100.0)  | 0 (0)     |       |
| - 20 – 24Fr       |       | 34 (81.0)  | 8 (19.0)  |       |
| - 26 – 30 Fr      |       | 133 (86.4) | 21 (13.6) |       |

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### Table 6: Outcomes of multivariate binary logistic regression analysis: factors affecting blood transfusion requirement.

| Factors                                | P value | Odds Ratio | 95% CI | Lower | Higher |
|----------------------------------------|---------|------------|--------|-------|--------|
| Complication                           |         |            |        |       |        |
| Absent (reference)                     | 0.001   | 1          |        | 1.44  | 7.14   |
| Present                                |         | 4.04       | 1.17   | 0.15  | 2.71   |
| Stone Complexity (GUY’s scoring system)|         |            |        |       |        |
| 1 (reference)                          |         | 1          |        |       |        |
| 2                                      | 0.004   | 1.17       | 0.15   | 2.71  |        |
| 3                                      |         | 1.20       | 0.372  | 3.89  |        |
| 4                                      |         | 2.80       | 1.07   | 4.33  |        |
| Duration of Anesthesia                 |         |            |        |       |        |
| < 83 minutes (reference)               | 0.001   | 1          |        | 1.39  | 3.63   |
| > 83 minutes                           |         | 2.01       | 1.39   | 3.63  |        |

### Table 7: Comparison of transfusion rates with other published series.

| Series                  | N  | Transfusion Rate % |
|-------------------------|----|--------------------|
| Keoghane et al. 2012    | 547| 3.8                |
| Unsal et al. 2012       | 868| 9.5                |
| de la Rosette et al. 2011| 5803| 5.7               |
| Tolga et al. 2011       | 649| 10.8               |
| Stoller et al. 1994     | 127| 23                 |
| Jones et al. 1990       | 1000| 29                |
| Lee et al. 1987         | 582| 12                 |
| Current study           | 200| 14                 |
Table 8. Demonstrate comparison of Embolization rate with other published series.

| Series                              | N   | Embolization Rate % |
|-------------------------------------|-----|---------------------|
| Keoghane et al. 2012. [21]          | 547 | 0.9                 |
| Martin et al. 2000 [21]             | 808 | 1                   |
| Kessaris et al. 1995 [21]           | 2200| 0.8                 |
| Jones et al. 1990 [21]              | 1000| 0.6                 |
| Mousavi-Bahar et al. [22]           |     | 0.15                |
| Current Study                       | 200 | 0.5                 |

Conclusion

i. Stone complexity (GUY’s SSS., grade 3 and 4).
ii. Preoperative creatinine level (≥1.4mg/dl).
iii. Intra operative complication (perforation and extravasation).
iv. Duration of operation (>83 minute).

Were the most important factors associated with an increased risk of bleeding and transfusion during PNL in both univariate and multivariate analysis. Study demonstrates several statistically significant Cutoff value such as, (Operating time > 83 minute, preoperative creatinine level ≥ 1.4mg/dl) correlated well with Hb drop and transfusion rates.

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References

1. Alken P, Hutschenreiter G, Gunther R, Marberger M (1981) Percutaneous stone manipulation. J Urol 125(4):463-466.
2. Türk C, Knoll P, Petrlik A, K Sarica, A Skolarikos, et al. (2014) Guidelines on urolithiasis. Arnhem, the Netherlands: European Association of Urology.
3. Manuel R, Patrick K, Maurice S (2011) European Association of Urology supplements, pp. 433-439.
4. Pearle MS, Pak YC (1996) Renal calculi: A practical approach to medical evaluation and management. International Yearbook of Nephrology. New York, Oxford University Press, USA, pp. 69-80.
5. Cussenot O, Desgrandchamps F, Ollier P, Teillac P, Le Duc A (1992) Anatomical bases of percutaneous surgery for calculi in horseshoe kidney. Surg Radiol Anat 14(3):209-213.
6. Ginalske JM, Portmann L, Jaeger P (1990) Does medullary sponge kidney cause nephrolithiasis?. AJR Am J Roentgenol115(2):299-302.
7. Jeong CW, Jung JW, Cha WH, Lee BK, Lee S, et al. (2013) Seoul National University Renal Stone Complexity Score for Predicting Stone Free Rate after Percutaneous Nephrolithotomy. PLoS One 8(6): e65808.
8. Thomas K, Smith NC, Hegarty N, Glass JM (2011) The Guy’s stone score—grading the complexity of percutaneous nephrolithotomy procedures. Urology 78(2):277-281.
9. Okhunov Z, Friedlander JL, George AK, Duty BD, Moreira DM, et al. (2013) S.T.O.N.E. nephrolithometry novel surgical classification for kidney calculi. Urology 81(6):1154-1160.
10. Michel MS, Trojan L, Rassweiler JJ (2007) Complications in percutaneous nephrolithotomy. Eur Urol 51(4):899-906.
11. De la Rosette J, Assimos D, Desai M, Gutierrez J, Lingeman J, et al. (2011) The Clinical Research Office of the Endourological Society percutaneous nephrolithotomy global study: indications, complications, and outcomes in 5803 patients. J Endourol 25(1):11-17.
12. Wenz F, Mamousakis C, Rioja J, Michel MS, de la Rosette J, et al. (2009) Two contemporary series of percutaneous tract dilation for percutaneous nephrolithotomy. J Endourol 23(10):1655-1661.
13. Kavoussi LR (2012) Campbell-Walsh Urology: (10th edn), Alan J Wein (Ed).
14. Preminger GM, Assimos DG, Lingeman JE, Nakada SY, Pearle MS, et al. (2005) Chapter 1: AUA guideline on management of staghorn calculi: diagnosis and treatment recommendations. J Urol 173(6):1991-2000.
15. Netto, Ikonomidis J, Ikari O, Claro JA (2005) Comparative study of percutaneous access for staghorn calculi. Urology 65:659-662.
16. Rastinehad AR, Andonian S, Smith AD, Siegel DN (2009) Management of Hemorrhagic Complications Associated with Percutaneous Nephrolithotomy. J Endourol 23(10):1763-1767.
17. Keoghane SR, Cetti RJ, Rogers AE, Walmsley BH (2013) Blood transfusion, embolisation and nephrectomy after percutaneous nephrolithotomy (PCNL). BJU Int 111(4):628-632.
18. Opondo D, Gravas S, Joyce A, Pearle M, Matsuda T, et al. (2014) Standardization of Patient Outcomes Reporting in Percutaneous Nephrolithotomy. J Endourol 28(7):767-774.
19. Michel MS, Trojan L, Rassweiler JJ (2007) Complications in percutaneous nephrolithotomy. Eur Urol 51(4):899-906.
20. Unsal A, Resorha B, Atmaca AF, Diri A, Goktug HN, et al. (2012) Prediction of Morbidity and Mortality after Percutaneous Nephrolithotomy by using the Charlson Comorbidity Index. Urology 79(1):55-60.
21. Keoghane SR, Cetti RJ, Rogers AE, Walmsley BH (2013) Blood transfusion, embolisation and nephrectomy after percutaneous nephrolithotomy (PCNL). BJU Int 111(4):628-632.
22. Unsal A, Resorha B, Atmaca AF, Diri A, Goktug HN, et al. (2012) Prediction of Morbidity and Mortality after Percutaneous Nephrolithotomy By Using the Charlson Comorbidity Index. Urology 79(1):55-60.
23. Tolga Akman, Murnat Binbay, Erhan Sari et al: Factors Affecting Bleeding During Percutaneous Nephrolithotomy: Single Surgeon Experience. J Endolog 25(2):327-333.

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