Factors Affecting Transfusion During Percutaneous Nephrolithotomy: A Retrospective Study of 665 Cases

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Research Article

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Abstract

Purpose: To evaluate the aspects affecting transfusion following percutaneous nephrolithotomy (PCNL).

Background: From 2016 to 2019, 665 patients underwent PCNL for removal of renal calculi in our center. Complications, including hemorrhages, have been reported. Twenty-three patients (3.5%) have received a blood transfusion and twelve (1.9%) were treated by hyper-selective embolization. We focus on the influencing factors related to postoperative blood transfusion. The factors analyzed were (age, sex, hypertension, diabetes, serum creatinine level, preoperative hemoglobin, and use of anticoagulants or antiplatelet medications); renal and stone factors (previous surgery, abnormal anatomy, stone side, stone burden, stone type); and surgical features: (access number, the calyx of puncture and stone-free rate). These data were analyzed for the presence of bleeding.

Results: Among individual factors, preoperative hemoglobin level ($P<0.001$), and urinary infection ($P<0.001$) were significantly correlated with blood transfusion. Among renal and stone factors, only previous history of open surgery was significantly correlated with blood transfusion ($P<0.05$). Stone type or stone burden does not correlate with transfusion. There was also no statistically significant correlation between surgical features and bleeding, and a lower stone-free rate reported for transfusion group.

Conclusion: The obtained results demonstrated that PCNL is a safer surgery in a high volume center, but anemic conditions, infections and history of open surgery will significantly increase transfusion rate following PCNL.

Introduction

With the first description of the technique in 1976^[1], Percutaneous nephrolithotomy (PCNL) has been widespread for the treatment of renal calculi. It is the gold standard therapy for the treatment of 2 cm kidney stones^[2]. Although it is an effective and safe surgical method for upper urinary calculi, because of the not-low incidence of complications, the popularization level varies from place to place. Bleeding is one of the most serious complications following PCNL. The overall transfusion rate was reported from 0.8–17.5% in the previous literature^[3,4]. Moreover, 0.8% of patients need angioembolization to control intractable bleeding^[5].

Many studies have investigated the factors associated with bleeding after PCNL. As for different surgical methods in different centers and variable conditions of the patients, the factors associated with bleeding are not unified. The trend of transfusion rate through PCNL is reported lower^[4]. Factors affecting bleeding during PCNL are thought to be operating time, stone load, caseload, and sheath size and so on^[5]. In this study, we used a large database from 2016–2019. As for a high-volume center, we aimed to find the factors associated with transfusion after PCNL when unifying the sheath size and surgery methods.

Patients And Methods

A total of 665 patients who underwent PCNL performed in our department were included in this retrospective study. There were 232 female and 433 male cases with a mean age of 54.9 years (ranges from 17–80 years old).

Surgical Procedure

All percutaneous enters were performed under general anesthesia and in the prone position after retrograde ureteral catheterization. Access to the selected calyx was performed by Dr. G.J.M with ultrasound guidance by using an 18-gauge needle. Then a hard guide wire was inserted into the puncture needle. And the tract was dilatated with serial dilators from 8F to 20F sheath. An 18F nephroscope (Wolf) was used to insect the sheath and we used holmium laser to fragment stones with power ranges from 40 to 90 watts. Every case was demanded to place an internal ureteral stent on a suspect for the presence of mobile residual stones. A 14F nephrostomy tube was placed in the renal pelvis or the involved calyx for most patients.

All patients underwent urine routine and urinary bacterial culture examination before operation. Urinary tract infection was defined as the number of white blood cells in the urine was greater than 3.

When the bacterial culture is positive, antibiotics are used, and surgery will be performed after the bacteria is negative.

Plain radiography of the kidneys, ureters, and bladders was obtained on postoperative day 1 to day 3 according to the state of the patient. For X-ray-negative stones, we use CT scan for postoperative follow-up. The nephrostomy tube was removed when there were no stone residual nor clinically insignificant residual fragments (diameter less than 4 mm).

All patients were asked to take out the stent for outpatient service in one or two months after the surgery. If there were residual stones, they would have repeated PCNL, ureteroscopy, and shockwave lithotripsy (SWL). After that, all patients were evaluated with an ultrasound test or non-contrast CT scan after 3 to 6 months postoperatively. All patients accepted follow-ups at least for one year. During this period, they received follow-up calls or went to the clinic for regular check-ups.

PCNL was considered successful when the patient was stone-free or did not need any further intervention (clinically insignificant residual stone fragments).

Patients And Groups

Factors were categorized into 3 groups with relevance to individual variables, renal and stone factors, surgical features. Individual variables consisted of sex, age, the presence of hypertension, diabetes mellitus, serum creatinine level, urinary infection, preoperative hemoglobin, and use of anticoagulants or antiplatelet medications. Renal and stone factors include previous surgery (open renal surgery, PCNL,

URSL, or SWL treatment), abnormal anatomy (horseshoe kidney, double ureteropelvic malformation, nephroptosis), stone side, stone burden, stone type, and degree of hydronephrosis. The kidney stone burden was estimated in terms of square area in millimeters by multiplying the length and the width measured on preoperative plain abdominal radiographs. Stone types were categorized as staghorn calculi (partial or complete) and non-staghorn stones. Hydronephrosis was graded as either nil/mild or moderate/severe using ultrasonographic criteria. Surgical features included the calyx of puncture, the number of access tracts. All factors were evaluated according to the presence and treatment of blood transfusion.

Statistical analysis

Chi-square, Fisher exact, Student tests were used for univariate analyses. Multivariate binary logistic regression was performed for further investigation if any parameter was significant with the univariate test. The univariate and multivariate logistic regression analyses were provided as OR, with 95% confidence intervals (CI). A P value of < 0.05 was considered significant. The data were analyzed with SPSS version 13.0.

Results

Severe bleeding which needed transfusion happened in 23 cases of 665 patients (3.5%). Twelve (1.9%) of them were treated by hyper-selective embolization. The average transfusion volume was 2.83 U RBC (ranges from 1U to 6U). For transfusion group, Their average hemoglobin amount before surgery was 114.6 g/l (63–138 g/l), the average hemoglobin amount at the first blood transfusion was 61.7g/l (35–96 g/l), and the average Hb loss was 52.9g/l. The distribution of cases with or without severe bleeding according to individual variables, renal and stone factors, and surgical features are shown in Tables 1, 2, and 3, respectively.

Individual variables

The mean age was 54.9 years old (range from 17 to 80 years old). There was no significant correlation between sex, age, the presence of hypertension, diabetes mellitus, preoperative serum creatinine and severe bleeding. However, preoperative hemoglobin has a strong correlation with severe bleeding. ($P < 0.001$). Urinary infection increased the risk of bleeding in our study. ($P < 0.001$).

Antiplatelet drugs were stopped for one week before the operation for all patients, and for warfarin intake patients, they were stopped 3 days before the operation and heparin was used for bridging treatment. We found the use of anticoagulants or antiplatelet medications has no significant correlation with transfusion following PCNL.

According to the logistic regression model, transfusion during PCNL was existing 9 times and 16 times with anemic conditions and infection, respectively (Table 4).

No significant difference was noted in transfusion with factors as the position of the stone, stone size, stone type. Among the factors of previous surgeries, only a history of open renal surgery was significantly correlated with severe bleeding. In our cases, the degree of hydronephrosis also did not correlate with severe bleeding following PCNL ($P > 0.01$).

In this study, 76 patients had received more than one access in the surgery. There was no significant correlation between the number of access with severe bleeding nor the calyx of entry. The total stone-free rate was 79.4% (528/665). For transfusion group, their stone-free rate was 60.9% (14/23), which tended to be lower. ($P < 0.05$)

Discussion

PCNL for renal calculi was first described by Fernstrom and Johansson in 1976 ^[1]. The complications of PCNL include fever, infection, bleeding necessitating transfusion, and bleeding for super-selective angioembolization (SAE).

In this retrospective study, we studied and reported 665 patients receiving PCNL in our center from 2016 to 2019. The risk of hemorrhagic complications requiring blood transfusion is associated with low preoperative hemoglobin levels, preoperative infection and history of open surgery of treated kidney. The OR value found was 9.3, 15.6, 3.2 respectively.

Yamaguchi ^[5] and Christian ^[6] found that a larger tract size will increase the risk of hemorrhage during PCNL. The transfusion rate varied from of 1.1–12% when the tract size turned from 18F to 30F. In our study, we used a 20F sheath and 18F nephroscope to remove the calculi. It was defined as a medium size of sheath ^[5]. The transfusion rate in our study was 3.5%. In another three studies include more than 500 cases ^[7–9], the authors used the fixed tract size, 30F, 30F, 26-30F, respectively, and the transfusion rate was 10.8%, 0.8%, 12.3%, thus bleeding may have increased rate with the surgery performed at different centers than the size of the tract. Here we look back into six studies (Table 5) ^[5, 7, 8, 9, 10, 11] which include more than 500 cases and analyze our data with them.

Access number was thought to be associated with bleeding during PCNL. Nevertheless, different study had different results. It may be related to the proportions of multiple tracts of stone removal operations. Arkman and his colleagues ^[7] found that multiple access surgery increases the risk of bleeding by 2.7 times following PCNL ($P < 0.001$). In that study, the percent of multiple tract accesses was 22.7%. In another study, Soucy and his colleagues ^[8] found that there was no statistically significant difference in transfusion rates (0.7–1.2% $P = 0.24$) in patients who were treated with a single tract or among those needing multiple tracts. In their study, the percent of multiple tract accesses was 16%. In our study, the percent of multiple accesses was 11.5%. There are relatively few patients with multi-channel puncture in our group. Only 74 patients received 2 channels and 2 patients had 3 channels, which would cause data bias. This is one of the limitations of our research.

Renal pelvic perforation is associated with bleeding in our study. The history of open surgery will increase the risk of severe bleeding by 3 times. Patients with a open surgery history may have a different kidney anatomy, and this may increase the risk of bleeding at the puncture site. This result is consistent with Christian's ^[6] work. In these six studies, only Arkman^[7] demonstrated that bleeding had no relation with previous surgery history following PCNL.

Our study found that preoperative hemoglobin levels were associated with transfusion, consistent with the study reported by Akman's ^[7]. Among our bleeding patients, there were 13 patients having preoperative anemia (average Hb was 114.6 g/l), accounting for 56.5% with hemoglobin ranges from 63 g/l to 127g/l. In the non-transfusion group, the preoperatively anaemic rate was 10%. The average Hb loss was 52.9g/l in the transfusion group. Among them, six patients had received a two-stage operation during one hospital stay. For them, hemoglobin before the second operation was 94g/L. Average blood loss was 28.2g/l. For a second-stage PCNL operation patient, if there is anemia before the operation, he will have a higher transfusion rate during PCNL.

Yamaguchi ^[5], Akman ^[7], and Srivastava^[9] found that the stone load (size) was associated with bleeding during PCNL. Operation time was also associated with bleeding in Yamaguchi ^[5] and Akman's ^[7] study. Large stones often mean more puncture tracts and longer operation time. In our study, for staghorn calculi, transfusion was 0.066 compared to non-staghorn ones. Tract establishments were all performed by Dr. G.J.M in this study. He used an 18-gauge needle to access to the selected calyx with the aid of ultrasound guidance. The tract was dilatated with serial dilators from 8F to 20F sheath. The overall process was completed within 5 minutes. With the update of laser technology and stronger lithotripsy efficiency, the operation time can be greatly shortened than before. The operation time is not included in our study, which is a limitation of this study.

The caseload is also associated with bleeding during PCNL. In the CROES study, Opondo ^[12] and his colleagues found that a high volume center (> 120 cases per year) usually has higher stone-free rates and lower complication rates. In studies reported previously, the transfusion rate was 5.24% vs 3.4 % (P < 0.001) according to low volume center and high volume center.

A positive preoperative urine culture will increase bleeding complications following PCNL in both intraoperative and postoperative hematuria ^[13]. Despite antibiotic treatment before surgery, urine infection will increase the risk of severe bleeding in PCNL by 16 times. We had found that when infectious stones were seen when access was made into the kidney, indwelling nephrostomy immediately for drainage and stop the surgery is the best measure. Slightly increased operation time and water pressure will increase the risk of bleeding in PCNL.

We used plain abdominal radiography of the kidneys, ureters, and bladder (KUB) or ultrasound for a postoperative image. This test may result in false negative results for stones. But we use postoperative ultrasound or CT to correct this bias. All patients have received a follow-up for at least one year. The total stone-free rate was 79.4% (528/665). For the transfusion group, the SFR was 60.9% (14/23), and in the

non-transfusion group—the SFR was 80.1%(514/642) ($P = 0.031$). The group of no transfusion was 2.5 times more likely to get rid of the stones than those who suffered serious bleeding in PCNL.

In our study, the blood transfusion rate found was 3.5%. In previously reported literature of more than 500 cases, the blood transfusion rate ranges from 0.8–12.3% [5, 7, 8, 9, 10, 11], So our results were correlated with previous reports. Our center had a low transfusion rate as compared to the reported cases by others. The reason may be attributed to the use of medium tract passage, ultrasound-guided puncture to save time, relatively few puncture tracts and application of high-power laser to fragment stones. In a retrospective study, 305 patients who underwent percutaneous nephrolithotomy, reported a blood transfusion rate of 0%. Their experience is worth learning: Careful patient selection, accurate positioning, and use of the best available instruments with well-trained urologists are necessary to avoid the complications associated with PCNL [14].

In our study we have attempted to analyze PCNL surgery in high-volume center and previous case studies. Although it is a retrospective study, the obtained results demonstrated that PCNL is a safer surgery for an experienced surgeon. For a high-volume urolithiasis center, anemic conditions, infection before the surgery, and the history of open kidney surgery will significantly increase the risk of hemorrhagic complications following PCNL. The operation time was not included in our study as well as the time taken to achieve access into the desired calyx. This is a limitation of the study. In addition, for the follow-up of stones, we use KUB instead of CT. This may bring about a bias of high postoperative success rate. Although we use one year for follow-up after surgery, there will definitely be data bias, but overall, our study might have a ground-breaking interest for the readers about PCNL surgery significance factors affecting bleeding during PCNL.

Declarations

- Ethics approval and consent to participate

All experimental protocols were approved by Shanghai Xu-Hui Central Hospital ethics committee. The ethics board approval number is SOP-IEC-013-02.0-AF03. All human subjects provided written informed consent with guarantees of confidential. All methods were carried out in accordance with relevant guidelines and regulations.

- Consent for publication

All of the writers agreed for publication of the manuscript.

- Availability of data and materials

The data was open and if you need we will share. Please communicate with Dr Hong Zhao, E-mail.: drzhaohong1986@gmail.com

- Competing interests

We declare that we have no financial and personal relationships with other people or organizations that can inappropriately influence our work, there is no professional or other personal interest of any nature or kind in any product, service and/or company that could be construed as influencing the position presented in, or the review of, the manuscript entitled

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There is no funding for this study.

- Authors' contributions

Hong Zhao: protocol, writing

Jun-Sheng Li data collection

Li Li: management

Hang Wang: editing

Yi Miao: project development (corresponding author)

Jian-Ming Guo: project development (corresponding author)

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References

1. Fernström I, Johansson B. Percutaneous pyelolithotomy. A new extraction technique. Scand J Urol Nephrol 1976;10: 257–259
2. Miernik Arkadiusz, Schoenthaler Martin, Wilhelm Konrad, et al. Combined semirigid and flexible ureterorenoscopy via a large ureteral access sheath for kidney stones > 2 cm: a bicentric prospective assessment.[J]. World J Urol, 2014, 32: 697–702.
3. Michel MS, Trojan L, Rassweiler JJ. Complications in percutaneous nephrolithotomy. Eur Urol 2007;51:899–906
4. de la Rosette Jean, Assimos Dean, Desai Mahesh et al. The Clinical Research Office of the Endourological Society Percutaneous Nephrolithotomy Global Study: indications, complications, and outcomes in 5803 patients.[J]. J Endourol, 2011, 25: 11–7.
5. Yamaguchi Akito, Skolarikos Andreas, Buchholz Niels-Peter Noor et al. Operating times and bleeding complications in percutaneous nephrolithotomy: a comparison of tract dilation methods in 5,537

- patients in the Clinical Research Office of the Endourological Society Percutaneous Nephrolithotomy Global Study.[J].J Endourol, 2011, 25: 933–9.
6. Seitz Christian, Desai Mahesh, Häcker Axel et al. Incidence, prevention, and management of complications following percutaneous nephrolitholapaxy.[J].Eur Urol, 2012, 61: 146 – 58.
 7. Akman Tolga, Binbay Murat, Sari Erhan et al. Factors affecting bleeding during percutaneous nephrolithotomy: single surgeon experience.[J].J Endourol, 2011, 25: 327–33.
 8. Soucy F, Ko R, Duvdevani M et al. Percutaneous nephrolithotomy for staghorn calculi: a single center's experience over 15 years. J Endourol 2009;23:1669–73.
 9. Srivastava A, Singh KJ, Suri A et al. Vascular complications after percutaneous nephrolithotomy: Are there any predictive factors? Urology 2005;66:38–40.
 10. Armitage James N, Irving Stuart O, Burgess Neil A et al. Percutaneous nephrolithotomy in the United kingdom: results of a prospective data registry.[J].Eur Urol, 2012, 61: 1188–93.
 11. Desai M, De Lisa A, Turna B, et al., CROES PCNL Study Group. The clinical research office of the endourological society percutaneous nephrolithotomy global study: staghorn versus nonstaghorn stones. J Endourol 2011;25:1263–8.
 12. Opondo Dedan, Tefekli Ahmet, Esen Tarik et al. Impact of case volumes on the outcomes of percutaneous nephrolithotomy.[J].Eur Urol, 2012, 62: 1181–7.
 13. El-Nahas Ahmed R, Eraky Ibrahim, Shokeir Ahmed A et al. Factors affecting stone-free rate and complications of percutaneous nephrolithotomy for treatment of staghorn stone.[J].Urology, 2012, 79: 1236–41.
 14. Michel Maurice Stephan, Trojan Lutz, Rassweiler Jens Jochen, Complications in percutaneous nephrolithotomy.[J].Eur Urol, 2007, 51: 899–906; discussion 906.

Tables

Due to technical limitations, tables 1 to 5 are only available as a download in the Supplemental Files section.

Supplementary Files

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