



Factors Predicting Pleural Complication Following Upper Pole Access Percutaneous Nephrolithotomy

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Abstract

Background and objective: Percutaneous nephrolithotomy (PCNL) via upper-pole access can be achieved either supracostally and subcostally. The supracostal access is associated with a higher rate of pulmonary complication. We studied the factors, which predict the pulmonary complication following upper pole access PCNL and postoperative outcomes of patients with pulmonary complication.

Patients and methods: A total 325 patients were treated with percutaneous nephrolithotomy (PCNL) via the upper pole, of which 42 patients (group I) had pleural injury and 283 patients (group II) without pleural injury. Supracostal access was performed in 25 cases of group I and 99 cases of group II. Sex, age, BMI, side of stone, co-morbidity, stone size; operative time and hospital stay in the two groups were compared. Demographic data and surgical outcomes in patients with pleural injury were compared between patients treated conservatively and surgically.

Results: Sex, age, BMI, side of stone, co-morbidity, stone size and stone position were not significantly different of both groups. Pleural injury was in 25 cases in patients with supracostal access and 17 cases in subcostal access. The incidence of pleural injury was 13.6%, but only 3% needed intercostal drainage. Operative time was 97.73 ± 18.05 min and 86.00 ± 26.51 min of Group I and group II, respectively ($P < 0.01$). The duration of hospital stay was 8.54 ± 6.49 days and 5.13 ± 2.45 days of patients with and without pleural injury, respectively ($p < 0.01$). The incidence of postoperative fever, blood transfusion, analgesic usage was higher in patients with pleural injury. Patients with pleural injury, rate of blood transfusion was higher in patients treated with intercostal drainage.

Conclusion: Site of upper pole access is the factors predicting pleural complication following upper pole access PCNL. Patients with this complication have longer operative time, longer hospital stay and higher incidence of postoperative fever, blood transfusion, and analgesic usage.

Keywords

Pulmonary complication, Percutaneous nephrolithotomy

supracostal and subcostal is necessary in some patients with specific indications. The indications of upper pole access are staghorn calculi, large upper caliceal stone, renal stone associated with ureteropelvic junction pathology, calculi in morbidly obese patients and calculi in anomalous kidney such as horseshoe kidney [2,3]. Due to its invasiveness compared to extracorporeal shock wave lithotripsy, the overall complication rate following PCNL is 20.5%. Infection and bleeding complication are two most common complications follow by urinary leakage and hydrothorax [4].

The advantage of upper access is the good stone clearance due to this access can direct access to most of the intrarenal collecting system and upper ureter. Due to the anatomy of kidney related to pleura, upper pole access lead more incidence of pulmonary complication especially with supracostal approach [5-11]. The pleural complication following PCNL consisted of hydrothorax, hemothorax, pneumothorax or combination of these. Only few studies reported the factors of this complication following upper pole access.

We studied the incidence and compared the risk factors in patients following upper pole access PCNL who developed pulmonary complication. We also compared factors and operative outcomes in patients with pulmonary complication managed with and without intercostal drainage.

Patients and Methods

Patients

Three hundred twenty-five patients underwent upper pole PCNL by two surgeons (BL, PK) where retrospective studied, of which, 42 patients developed pleural complication (group I) and 283 patients without pleural complication (group II). The indication for upper pole access was 124 staghorn calculi, 124 multiple caliceal calculi in separate calix and 77 high location of the kidney. The inclusion criteria was patients who received upper pole access PCNL from July 2013 to June 2015. Patients with chest diseases such as COPD were excluded.

Methods

General anesthesia was administered; an open-ended 6F ureteral catheter was placed transurethrally into the ureter in the supine

Introduction

Percutaneous nephrolithotomy (PCNL) is the first line treatment of large renal and upper ureteral stone [1]. Upper pole access either

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Table 1: Demographic data of all patients (325 patients).

| Patient's profile | Pulmonary complications (n = 42) | No pulmonary complications (n = 283) | P-value |
|--|----------------------------------|--------------------------------------|---------|
| Sex | | | |
| Male, n (%) | 13 (30.95%) | 93 (32.86%) | 0.81 |
| Female, n (%) | 29 (69.05%) | 190 (67.14%) | |
| Age (years), mean ± SD | 56.83 ± 10.46 | 57.18 ± 10.75 | 0.84 |
| BMI (kg/m ²), mean ± SD | 23.91 ± 3.11 | 23.01 ± 3.71 | 0.14 |
| Comorbidity, n (%) | | | |
| Diabetes Mellitus | 9 (21.43%) | 34 (12.01%) | 0.09 |
| Hypertension | 18 (42.86%) | 109 (38.52%) | 0.59 |
| Dyslipidemia | 8 (19.05%) | 43 (15.19%) | 0.52 |
| ASA score, n (%) | | | |
| ASA I | 8 (19.05%) | 73 (25.80%) | 0.63 |
| ASA II | 30 (71.43%) | 187 (66.08%) | |
| ASA III | 4 (9.52%) | 23 (8.13%) | |
| ASA IV | 0 | 0 | |
| ASA V | 0 | 0 | |
| Preoperative creatinine clearance (mg/kg/min), mean ± SD | 58.97 ± 38.56 | 56.12 ± 29.00 | 0.57 |
| Previously ipsilateral renal surgery, n (%) | 5 (11.90%) | 59 (20.85%) | 0.17 |
| Laterality, n (%) | | | |
| Right | 25 (59.52%) | 147 (51.94%) | 0.36 |
| Left | 17 (40.48%) | 136 (48.06%) | |
| Stone character, n (%) | | | |
| Staghorn | 20 (47.62%) | 104 (36.75%) | 0.23 |
| Multiple | 16 (38.10%) | 108 (38.16%) | |
| Pelvic/Single calyceal | 6 (14.29%) | 71 (25.09%) | |
| Stone diameter (mm), mean ± SD | 47.09 ± 20.47 | 41.52 ± 19.10 | 0.08 |
| Degree of hydronephrosis, n (%) | | | |
| No | 8 (19.05%) | 50 (17.67%) | 0.43 |
| Mild | 17 (40.48%) | 83 (29.33%) | |
| Moderate | 11 (26.19%) | 90 (31.80%) | |
| Severe | 6 (14.29%) | 60 (21.20%) | |
| Approach, n (%) | | | |
| Supracostal | 25 (59.52%) | 99 (34.98%) | < 0.01 |
| Subcostal | 17 (40.48%) | 184 (65.02%) | |
| Operative time (minutes), mean ± SD | 97.73 ± 18.05 | 86.00 ± 26.51 | < 0.01 |

position. In prone position, the percutaneous access was performed by Bull eye technique under fluoroscopic guidance after injection of contrast medium via ureteral catheter supracostal access was performed in 25 cases (59.52%) and 99 cases (34.98%) of group I and II, respectively. All supracostal access was done between 11th and 12th ribs. The access was performed in the lower part of intercostal space. During full inspiration, needle was pushed through the diaphragm and retroperitoneum, whereas the needle was passed through renal parenchyma during full inspiration. Safety and working guide wires were inserted after the needle was in the collecting system. Access tract was dilated by telescopic metal dilator size from 8 F to 30 F, then a 30 Fr Amplatz sheath was inserted. A standard 26 F nephroscope was performed and ultrasonic with pneumatic lithotripsy was used for stone disintegration. For assessment of stone free, direct nephroscope and fluoroscopy was performed at the end of the procedure.

The 20 Fr nephrostomy tube was placed for 48 to 72 hours. If the operation met the criteria of tubeless PCNL (no significant bleeding, no significant extravasation, no distal obstruction and no secondary nephroscopy required), no postoperative nephrostomy tube was placed. Postoperative upright chest films were obtained in all cases in recovery room. For management of pulmonary complication, in patients who developed dyspnea, chest pain and oxygen desaturation with significant pleural effusion of chest film, 28 F chest tube was inserted as intercostal drainage via the 5th - 6th intercostal space in recovery room. Patients with minimal pleural effusion who did not

have any symptom or minimal symptom were treated conservatively. When retained stone was more than 4 mm, shock wave lithotripsy was used as the combination treatment. Failure was defined as a retained stone > 4 mm after shock wave lithotripsy or secondary nephroscopy.

Statistical analysis with chi-square for categorical data and T-tests for continuous normal distributive variable was performed by using SPSS 16.0 version, and P < 0.05 was considered statistically significant.

Results

The mean age of group I and group II was 56.83 ± 10.46 and 57.18 ± 10.75 years, respectively. The mean BMI was 23.91 ± 3.11 in group I and 23.01 ± 3.71 of group II. The mean stone size by Plain KUB of group I was 47.09 ± 20.47 mm and of group II was 41.52 ± 19.10 mm. Patient profiles and position of the calculi are shown in [table 1](#). Demographic data of patients with pulmonary complication (Group1), who were treated with conservative and surgical treatment is shown in [table 2](#).

The average operative time was 97.73 ± 18.05 and 86.00 ± 26.51 min in group I and II, respectively. (P < 0.01) Twenty-five patients (59.52%) of group I, and 99 patients (34.98%) of group II were patients with supracostal access. Hospital stay was 8.54 ± 6.49 days and 5.13 ± 2.44 days of group I and II, respectively. (P < 0.01) Three (7.14%) cases group I and 26 (9.19%) cases in group II were tubeless. The incidence of pleural injury was 13.6% (42 of 325 patients),

Table 2: Demographic data of patients with pulmonary complications treated with conservative or surgical treatment (42 patients).

| Patient's profile | Conservative treatment (N = 32) | Surgical treatment (N = 10) | P-value |
|--|------------------------------------|--------------------------------|---------|
| Sex | | | |
| Male, n (%) | 11 (34.38%) | 2 (20.00%) | 0.39 |
| Female, n (%) | 21 (65.63%) | 8 (80.00%) | |
| Age (years), mean ± SD | 55.78 ± 11.04 | 60.2 ± 7.88 | 0.25 |
| BMI (kg/m ²), mean ± SD | 60.92 ± 10.66 | 59.05 ± 7.97 | 0.61 |
| Comorbidity, n (%) | | | |
| Diabetes Mellitus | 6 (18.75%) | 3 (30.00%) | 0.45 |
| Hypertension | 12 (37.50%) | 6 (60.00%) | 0.21 |
| Dyslipidemia | 5 (15.63%) | 3 (30.00%) | 0.31 |
| ASA score, n (%) | | | |
| ASA I | 8 (25.00%) | 0 | 0.07 |
| ASA II | 20 (62.50%) | 10 (100.00%) | |
| ASA III | 4 (12.50%) | 0 | |
| ASA IV | 0 | 0 | |
| ASA V | 0 | 0 | |
| Preoperative creatinine clearance (mg/kg/min), mean ± SD | 58.60 ± 31.33 | 60.16 ± 58.23 | 0.91 |
| Previously ipsilateral renal surgery, n (%) | 3 (9.38%) | 2 (20.00%) | 0.36 |
| Laterality, n (%) | | | |
| Right | 19 (59.38%) | 6 (60.00%) | 0.97 |
| Left | 13 (40.63%) | 4 (40.00%) | |
| Stone character, n (%) | | | |
| Staghorn | 16 (50.00%) | 4 (40.00%) | 0.16 |
| Multiple | 10 (31.25%) | 6 (60.00%) | |
| Pelvic/Single calyceal | 6 (18.75%) | 0 (0.00%) | |
| Stone diameter (mm), mean ± SD | 47.15 ± 21.70 | 46.9 ± 16.91 | 0.97 |
| Degree of hydronephrosis, n (%) | | | |
| No | 6 (18.75%) | 2 (20.00%) | 0.86 |
| Mild | 14 (43.75%) | 3 (30.00%) | |
| Moderate | 8 (25.00%) | 3 (30.00%) | |
| Severe | 4 (12.50%) | 2 (20.00%) | |
| Approach, n (%) | | | |
| Supracostal | 18 (56.25%) | 7 (70.00%) | 0.44 |
| Subcostal | 14 (43.75%) | 3 (30.00%) | |
| Operative time (minutes), mean ± SD | 97.19 ± 18.71 | 99.5 ± 16.57 | 0.73 |

but only 3% (10 cases) needed intercostal drainage. Patients with pleural complication, higher rate of postoperative blood transfusion was in patients with surgical treatment compared to patients with conservative treatment (50.0% : 18.7%). No patient in this study who required blood transfusion need intervention embolization. The demographic data and surgical outcome between patients with and without pulmonary complication (Table 1 and Table 2) and between patients with pulmonary complication, who were treated with conservative and surgical treatment (Table 3 and Table 4) were compared. Multivariate analysis of factors increasing pulmonary complication was shown in table 5.

Discussion

CROES global study reported large series of complication following PCNL, bleeding and infection are most common complication. Pleural injury is most common adjacent organ injury following this procedure. The definition of pleural complication is significant pleural effusion of chest film with symptom of dyspnea, chest pain and oxygen desaturation. The incidence of pleural complication depends on site of renal access. The chance of injury is increase when the access site is higher. The incidence is higher in supracostal access (3-15% above the 12th rib and 10-100% above the 11th rib). The incidence is only < 5% in subcostal access [4].

The clinical symptoms of significant pleural injury are oxygen desaturation. Difficult breathing and decreased breath sound on physical examination. Pleural injury usually noticed when patients returned from prone position to supine position and begin to have spontaneous breathing. Some patients have the sign of increase peak respiratory pressure during operation under general anesthesia. The injury occurs during the step of renal access and tract dilatation. The accumulation of fluid in pleura occurs during step of nephroscope and stone disintegration. This problem can be hydrothorax, hemothorax, pneumothorax or combination [5-11].

Supracostal access is proven for the factor of pleural complication. Sharma, et al. reported the factors predicting pleural complication following percutaneous nephrolithotomy in 332 patients. The incidence of pleural complication was 3% (10 patients). The incidence was 4.2% in supracostal and 2% in subcostal access. Low BMI, mean age < 27-years and supracostal access are factors in predicting pleural complication [7]. The explanation of obesity can protect pleural complication by longer distance between upper pole and diaphragm, and posterolateral perirenal fat at level of renal hilum [7,12,13].

The younger patients are prone to have a pleural complication. This can be explained by the lower BMI and trend to aggressive treatment in younger patients [7,14]. Sharma reported the pleural

Table 3: Operative outcome of all patients.

| Patient's profile | Pulmonary complications (n = 42) | No pulmonary complications (n = 283) | P-value |
|--|----------------------------------|--------------------------------------|---------|
| Postoperative morphine usage (mg), mean ± SD | 4.19 ± 5.20 | 1.88 ± 2.82 | < 0.01 |
| Postoperative fever, n (%) | 26 (61.90%) | 119 (42.05%) | 0.01 |
| Postoperative blood transfusion, n (%) | 10 (23.81%) | 22 (7.77%) | 0.01 |
| Hospital stay (days), mean ± SD | 8.54 ± 6.49 | 5.13 ± 2.45 | < 0.01 |
| Tubeless PCNL, n (%) | 3 (7.14%) | 26 (9.19%) | 0.65 |
| Success rate, n (%) | 28 (66.67%) | 206 (72.79%) | 0.41 |

Table 4: Operative outcome of patients with pulmonary complication.

| Patient's profile | Conservative treatment (N = 32) | Surgical treatment (N = 10) | P-value |
|--|---------------------------------|-----------------------------|---------|
| Postoperative morphine usage (mg), mean ± SD | 5.05 ± 5.77 | 2.0 ± 2.32 | 0.16 |
| Postoperative fever, n (%) | 21 (65.63%) | 6 (60.00%) | 0.75 |
| Postoperative blood transfusion, n (%) | 6 (18.75%) | 5 (50.00%) | 0.05 |
| Hospital stay (days), mean ± SD | 9.75 ± 8.16 | 5.87 ± 3.22 | 0.21 |
| Tubeless PCNL, n (%) | 2 (6.25%) | 1 (10.00%) | 0.69 |
| Success rate, n (%) | 20 (62.50%) | 8 (80.00%) | 0.31 |

Table 5: Multivariate analysis of factors increasing pulmonary complication.

| Parameters | Odds ratio | 95% CI | p-value |
|--|------------|---------------|---------|
| Supracostal approach (subcostal approach = reference) | 2.774 | 1.336 - 5.762 | 0.006* |
| Operative time | 1.013 | 1.001 - 1.026 | 0.049 |

complications was more common in patients younger than 27-years-old [7]. Palnizkya reports the mean age of patients who have pleural complication was 43 ± 22-years where are patients without complication was 55 ± 15-years-old [14]. But in CROES study there was no different in pleural complication between the age groups, which was 1.8% in patients > 70-years and 1.4% in patients 18-70 years old [15].

PCNL on left kidney was reported to have more incidence of pleural complication. This can be explained by the position of right kidney is lower than left kidney due to the liver. Palnizkya, et al. reported the incidence of pleural complication in right and left kidney was 0% and 13.7%, respectively [14]. In contrast, other studies reported more incidence of pleural complication in right sided PCNL. The incidence of pleural injury was 4% of right sided PCNL where 1.8% of Left sided PCNL [7,13,16,17]. Hopper, et al. reported the anatomic relationship between kidney and pleural and lung during PCNL. In normal anatomy, the left kidney is crossed by 11th and 12th rib, while right kidney is crossed by only 12th rib. During full expiration, in the supracostal access, the pleura traversed on the right in 29% and on the left in 14%. This finding may explain the higher increase of pleural complication in right sided PCNL [16].

The diagnosis of pleural complication based on clinical symptom and post-operative chest films. The clinical symptoms consist of dyspnea, tachypnea with low oxygen saturation. Chest films should be performed in all cases follow upper pole access. The abnormality of postoperative chest film depends on volume of the effusion [18,19]. The amounts of 500 ml of effusion revealed the obliteration of hemidiaphragm by chest films. The sensitivity of intraoperative chest fluoroscopy, immediate post chest film and chest CT scan to detect pleural fund was 1%, 8% and 38%, respectively. Even false-negative rate of intraoperative fluoroscopy was 59.6% and chest film was 48.4%, but most of these were clinically insignificant [20]. Chest X-ray is the common test to detect post-PCNL pleural injury, this should be done in all patients who received upper pole access [12]. The treatment of pleural complication depended on clinical symptom and amount of pleural effusion. Patients with no symptom and minimal amount of effusion can be managed by conservative treatment or thoracentesis. Intercostal drainage is for patients with symptoms and large amount of effusion.

The previous series of pleural complication, which need surgical intervention is 0-23% [2,3,5,8,10,20]. Our previous study the incidence of pleural complication was 15.3% in supracostal rib 12th access, only 5% with significant pulmonary complication needed intercostal drainage [2]. This recent study showed the incidence of pleural injury needed intercostal drainage was 3%. All pleural injuries

in this study were hydrothorax. Patients with pleural injury had longer operative time. This complication affects the duration of hospital stay. The result of this study is different from the previous reports, which demonstrated that low BMI, laterality and younger patients are not the factors of pleural complication following upper pole access.

The total incidence of pleural complication in this study is quite high, this may be the technique of renal access by fluoroscopic guidance compare with ultrasonic guidance. Some patients with pelvic stone in this study need supracostal access due to the high location of kidney. Seventeen cases of patients with subcostal access also developed pleural complication from its high location of renal unit, but most of them were managed by conservative treatment.

Demographic data in patients with pulmonary complication who treated with intercostal drainage was not different from conservatively treated patients, only blood transfusion of surgical outcome was higher in patients with intercostal drainage. The limitation of this study is its retrospective study that has imbalance of the amount of each group, which may bias the outcome of the study.

Conclusion

Pleural complication is more common in supracostal access PCNL. Operative time is longer in patients with this complication. Patients with pleural complication have a longer hospital stay and higher incidence of postoperative fever, blood transfusion, and analgesic usage. Rate of blood transfusion is higher in patients treated with intercostal drainage.

Conflict of Interest

None.

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