Some Criteria to Attempt Second Side Safely in Planned Bilateral Simultaneous Percutaneous Nephrolithotomy

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OBJECTIVES To determine the validity of some criteria that could guide in the decision to cancel or proceed with the second side of planned bilateral simultaneous percutaneous nephrolithotomy (bsPCNL).

METHODS Patients with an indication for bilateral PCNL were enrolled in this study. The operation was stopped at the end of the initial side if operative time was >180 min, the hemoglobin level was <11 g/dL, the hemoglobin decrease was >3 g/dL, the systolic arterial pressure was <100 mm Hg, the arterial oxygen saturation was <95%, the arterial blood pH was <7.35, or the blood sodium was <128 mg/mL. The success and complication rates were compared in patients who underwent second side PCNL (group 1) and those for whom the procedure was stopped after the initial side (group 2).

RESULTS Of 42 planned bsPCNLs, 12 were stopped after the initial side, with the cause being prolonged operative time in 7, hemoglobin decrease in 6, systolic arterial pressure decrease in 2, arterial oxygen saturation decrease in 2, pH decrease in 1, and sodium decrease in 1. Differences in patient characteristics, stone burdens, and overall success and complication rates were insignificant. Transfusion, postoperative urinary infection, and prolonged urine drainage rates were similar, but the total hospitalization time was significantly longer in group 2. One hydrothorax and one renal pelvic perforation occurred in group 2. The need for transfusion correlated positively with the number of nephrostomy tracts in group 2 ($r = 0.895$, $P = .001$). No such correlation was found in group 1.

CONCLUSIONS Despite the best of intentions, about 30% of anticipated bsPCNL cases might be limited to single-sided PCNL, depending on the intraoperative events. Our criteria seem reasonable, because similar success and complication rates were obtained with bilateral, separate-session PCNL and bsPCNL. These criteria can be considered in the decision making to omit the advantages of a single session for safety. UROLOGY 72: 996–1000, 2008.

In the past 30 years, percutaneous nephrolithotomy (PCNL) has been proved to be a safe and effective treatment modality for regular and complex stone disease, including bilateral kidney stones.[1-11] If PCNL is indicated for both kidneys, surgery can be conducted in a single or separate sessions. Bilateral simultaneous (or synchronized) PCNL (bsPCNL) has certain advantages, including a single anesthesia session, single surgical stress, shorter hospitalization, less radiation exposure, less medication, shorter labor loss, and greater overall cost effectiveness.[6-10] In certain conditions, a planned bsPCNL can be stopped at the end of the first side, losing these advantages.[6,10,11] This decision is primarily made by the surgeon and anesthesiologist and usually depends on experience, operative measures, and the patient's condition. Published data on whether to stop at the end of the initial side or to pursue the second side are obscured. Most investigators have had their own criteria, but some points have been mentioned by all.[6,7,10,11] In this report, we present a prospective analysis of literature-derived decisive criteria to help in the decision to attempt or cancel the second side in terms of success, complications, and overall safety.

MATERIAL AND METHODS

This prospective study was performed in a university hospital settling from 2000 to 2005. During the study period, 87 patients were offered bilateral PCNL, and of these 87 patients, 42 (48.3%) were offered bsPCNL. The exclusion criteria for a simultaneous operation were age >50 years, American Society of Anesthesiologists class >1, hemoglobin (Hb) <12 g/dL,

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Submitted: November 27, 2007; accepted (with revisions): August 4, 2008

  0090-4295/08/$34.00 doi:10.1016/j.urology.2008.08.002

Table 1. Perioperative measures

Variable	Group 1		Group 2	
	Initial Side	Second Side	Initial Side	Second Side
Stone burden (mm^2)	457 ± 30	299 ± 19	487 ± 84	285 ± 24
Tracts (n)				
1	24	27	7	11
2	6	3	2	1
>2	0	0	3	0
Operative time (min)	110 ± 9	85 ± 8	165 ± 24	120 ± 11
Stone-free rate (%)	26/30 (86.7)	27/30 (90.0)	10/12 (83.3)	10/12 (83.3)
Hemoglobin decrease (g/dL)	1.5 ± 0.1	2.4 ± 0.2	1.8 ± 0.4	2.0 ± 0.2
Hospitalization (d)	3.6 ± 0.1		4.7 ± 0.3	3.1 ± 0.1

morbid obesity (body mass index >40 kg/m^2), stone size >1000 mm^2 on any side, and patient refusal. The stone burden was estimated using the millimeter-squared paper sheet method. The surgical plan was explained, and all patients provided informed consent indicating approval for both bsPCNL and bilateral separate-session PCNL. The kidney that was under more stress (in descending priority: obstruction, recurrent infection, more symptoms, greater stone bulk, more difficult side, and left kidney) underwent surgery first.

According to the published data, the following conditions were determined as decisive criteria to stop the procedure at the end of the initial side: operative time >180 minutes, Hb <11 g/dL, Hb decrease >3 g/dL, pH <7.35, sodium <128 mg/mL, arterial oxygen saturation (SaO_2) decrease >5%, and systolic arterial blood pressure (SAP) <100 mm Hg. At the end of the initial side, the presence of ≥1 criteria prevented proceeding with the second side.

Patients received cephazolin 1 g for prophylaxis and underwent radial artery cannulation for invasive monitoring and blood sampling. Standard general anesthesia (induction by thiopental and fentanyl; muscle relaxation by vecuronium; endotracheal intubation; maintenance using isoflurane and nitrous oxide) was given. All patients were ventilated using the intermittent positive pressure ventilation mode and received intravenous saline at a dose of 10 mL/kg/h. The arterial blood pressure was monitored continuously. SaO_2, pH, Hb, and blood sodium were determined by arterial blood gas analysis and complete blood count at the end of the initial side. After bilateral catheterization of the ureters with the patient in the lithotomy position, the patient was placed in the prone position and prepared and draped for bsPCNL. Biplanar fluoroscopy and Amplatz dilators (Cook, Bloomington, IN) were used to create a 30F tract. A rigid nephroscope, graspers, and pneumatic lithotripter were used for stone extraction. Saline heated to 35°-36°C was used as irrigant. After visual and fluoroscopic control for residual fragments, antegrade nephrostography was performed to check for leakage. Blood samples and 3 consecutive SAP measurements were obtained during nephrostomy placement. The operative time was determined from cystoscopy to the nephrostomy dressing. The postoperative evaluation included plain abdominal radiography and antegrade nephrostography before nephrostomy tube removal. The stone size, number of punctures, operative time, success rate (excluding auxiliary procedures), and perioperative complications were recorded.

The data are presented as mean ± SEM. Statistical analysis was performed with nonparametric tests (χ^2 test for patient demographics, Mann-Whitney *U* test, Wilcoxon signed-rank test, and Spearman's test for collected data), and $P < .05$ was accepted as statistically significant.

RESULTS

Of the 42 planned bsPCNL operations, 30 (71.4%) were completed as scheduled (group 1). In 12 patients (28.6%), the second side operation was postponed because of 1, 2, or 3 criteria in 3, 8, and 1 patient, respectively (group 2). The second side operation was performed within a median of 4 weeks (range 3-9).

The mean patient age was 38.8 ± 1.6 years and 35.3 ± 2.2 years in groups 1 and 2, respectively ($P > .05$). In group 1, 15 patients were men and 15 were women, and in group 2, 7 were men and 5 were women ($P > .05$). The mean stone burden for the initial and second sides and the preoperative Hb levels were not significantly different between the 2 groups ($P > .05$). Data concerning the operative measures are listed in Table 1.

Eventually, 26 patients (86.7%) in group 1 and 10 patients (83.3%) in group 2 were rendered stone free bilaterally ($P > .05$). Residual stones were managed with extracorporeal shockwave lithotripsy in 9 and watchful waiting in 2 renal units.

The mean operative time for the initial and second sides was significantly greater in group 2 ($P = .04$ and $P = .006$, respectively) than in group 1, as was the total operative time ($P = .004$). In 7 patients, the surgeon did not proceed to the second side because of prolonged initial side surgery. Exceeding the operative time limit was the sole cause of not proceeding with the second side in 3 patients.

The criteria for not proceeding to the second side was a Hb decrease >3 g/dL in 4 patients and Hb <11 g/dL in 2 additional patients. A Hb decrease was the sole cause of stopping the procedure in 1 patient. Of these 6 patients, 3 had had 3 and 2 had had 2 nephrostomy tracts in initial side. Also, 4 of these patients (33.3%) required a median of 2 U (range 2-4) of red blood cells. None of them needed a transfusion at the second side operation. The need for a transfusion correlated positively with the number of nephrostomy tracts in group 2 ($r = 0.895$, $P = .001$). In group 1, 3 patients (10.0%) required a median

Table 2. Overall complications

Complication	Group 1	Group 2	*P* Value
Transfusion (n)	3 (10)	4 (33.3)	<.05
Total RBC transfused (U)	7	10	<.05
UTI (n)	4 (13.3)	4 (33.3)	<.05
Stenting for drainage (n)	6 (20)	4 (33.3)	<.05
Hydrothorax (n)	—	1 (8.3)	<.05
Renal pelvis perforation (n)	—	1 (8.3)	<.05

RBC = red blood cell; UTI = urinary tract infection.
Data in parentheses are percentages.

of 2 U (range 2-3) of red blood cells at the second side operation.

A pH level of <7.35 (together with a SaO_2 decrease) was the reason for stopping the procedure in 1 patient only, who had ventilatory difficulty.

One patient had blood sodium level of <128 mg/mL accompanied by a Hb decrease intraoperatively. He received a rapid intravenous colloid solution of 2.2 L intraoperatively and a red blood cell transfusion postoperatively.

A SAP of <100 mm Hg was the cause of stopping the procedure in 2 patients. This was accompanied by a Hb decrease in 1. A SaO_2 decrease of >5% was the reason in 2 patients.

In group 1, the mean stone burden and operative time for the initial side were significantly greater than for the second side ($P = .001$ for both). The operative time correlated positively with the stone burden for both the initial and second sides ($r = 0.74$, $P = .001$ and $r = 0.79$, $P = .001$, respectively). The mean Hb decrease was significantly greater with the second side operation compared with the initial side ($P = .001$). In group 1, the mean Hb decrease did not correlate with the operative time for the initial side; however, the total Hb decrease correlated positively with the total operative time ($r = 0.49$, $P = .006$).

In group 2, the mean stone burden of the initial side was significantly greater than that of the second side ($P = .002$). However, the differences in operative time and Hb decrease were not significant ($P > .05$).

The mean hospitalization time for group 1 was significantly lower than that after the initial side operation for group 2 ($P = .001$).

The complications are listed in Table 2. Urinary infection was treated with proper antibiotics. All kidney units with prolonged urine drainage underwent double-J stenting. The cases complicated by hydrothorax and renal pelvic perforation were treated with chest tube drainage and double-J stenting, respectively.

COMMENT

The decision of whether to cancel or pursue the second side procedure in planned bsPCNL is one that the surgeon and anesthesiologist should decide together. They both must be satisfied with the results of the initial side in terms of the complications and patient condition. Personal experience can guide in this phase, but support from published data is insufficient. Most studies were designed to inform on what problems occurred, not on how to foresee and prevent them. However, some logical inferences from the published data can help with how to proceed.

First, the blood loss should be tolerable, and the red blood cell volume should be sufficient to withstand additional bleeding. We derived 2 criteria from the published data to restrict bleeding-related complications: a Hb decrease of >3 g/dL and/or Hb level of <11 g/dL should prevent proceeding with the second side operation. Dushinski and Lingeman[6] reported on 48 bsPCNLs with an average Hb decrease of 2.6 g/dL, and Davidoff and Bellman[12] revealed that a Hb decrease of >3 g/dL necessitated transfusion. A Hb level of <11 g/dL was considered to be critical for percutaneous renal processes, because the transfusion rate of renal biopsy patients was greater if they had a prebiopsy Hb level of 11 ± 2 g/dL.[13] Stoller et al.[14] stated that patients undergoing PCNL with preoperative Hb level of >12, <12, and <11 g/dL had an operation-related transfusion rate of 14%, 45%, and 83%, respectively. They also established that in 111 patients undergoing PCNL, the total Hb decrease was 3.1 g/dL, and that a decrease of 2.8 g/dL should be estimated in uncomplicated 1-stage PCNL. Nadler et al.[15] performed bsPCNL in patients with preoperative hematocrit levels of 30.4%-39.8%, and only 1 patient required transfusion, with an average hematocrit drop of 11.7%. The data published after the onset of our study were also supportive.[16] A positive correlation between the total Hb decrease and the total operative time in group 1 and no transfusions with the second side operation in group 2 revealed that bleeding from the first side contributes further to a Hb decrease during the second side operation. Because early Hb test results are not stable, ongoing bleeding from the initial side might be more serious than expected if the second side is undertaken. Our criteria restricted proceeding with untolerable blood loss; therefore, the eventual transfusion rates of the 2 groups were not significantly different.

Second, the operative time for first side surgery should be short enough to attempt the second side. Dushinski and Lingeman[6] reported a mean operative time of 269 minutes (range 40-435) for bsPCNL, and cessation of the procedure in 3 patients because of prolonged, complicated first-side operations, although they did not mention any time limit. Maheshwari et al.[7] reported on 24 patients undergoing bsPCNL with an average operative time of 122 minutes (range 70-200). They stated that "the second side was attempted only if first side was accomplished safely and satisfactorily in a reasonable time"; however, again, a time limit was not given. In a report dated later than the onset of our study, Silverstein et al.[10] reported a mean of 166 minutes (range 127-207) for bsPCNL and 155 minutes (range 80-450) for separate-session PCNL. We used an operative time of 180 minutes as the time limit for first side operation, because these reports revealed that the estimated time for bsPCNL is covered by this limit. In our study, a positive correlation between the total Hb decrease and the total operative time and the similarity of overall complication rates revealed that 180 minutes for the initial side is a reasonable limit to prevent time-related complications.

Intraoperative hyponatremia is considered the result of fluid absorption during endoscopy.[17,18] Hyponatremia during PCNL is debatable in both preceding and later studies. Some investigators have reported a decrease in serum sodium[17,19] and others found no significant alterations.[20,21] We detected hyponatremia in only 1 patient, together with a Hb decrease of >3 g/dL. This patient had received rapid administration of plasma expanders. We were unable to demonstrate a clear advantage in determining the serum sodium levels at the end of the initial side. Additionally, a reliable test is time consuming and rapid testing with the blood gas analyzer can lead to uncertain results (personal communication, P. N. Rao, EULIS 2003, Istanbul, Turkey).

A decrease in SAP can be an indicator of bleeding during PCNL; however, no data could be found before recruitment for our study. In later reports, Atici et al.[19] revealed decrease in postoperative SAP compared with intraoperative values. In contrast, Koroglu et al.[22] and Mohta et al.[23] did not find any significant alterations. However, the assessment of the adequacy of intraoperative fluid resuscitation integrates some clinical variables, including pH, blood pressure, and arterial oxygenation.[24] We believe that hypotension necessitating preventive measures despite adequate hydration and stable anesthesia during the first side could indicate a troublesome second side operation, if undertaken.

The pH and SaO_2 levels that necessitated correction (pH <7.35 and SaO_2 decrease >5%) can result from pulmonary complications or deteriorated airway patency in otherwise uncomplicated PCNL. Obviously, both situations restrict proceeding with the second side operation. No data were available for the initiation of our study; however, later, Atici et al.[19] reported no significant alterations in either arterial oxygen pressure or SaO_2 during uncomplicated PCNL. Mohta et al.[23] revealed a significant decrease in pH (from 7.45 preoperatively to 7.39 postoperatively) but no alterations in arterial oxygen pressure or arterial oxyhemoglobin saturation. Gehring et al.[20] proposed arterial oxyhemoglobin saturation <92% as an indication of postoperative intensive care but did not give any information regarding SaO_2. In our study, a pH decrease (together with a SaO_2 decrease) occurred in 1 patient only, and resulted from ventilatory difficulty that urged the anesthetist to revert the patient to the supine position. No hypoxemic sequelae occurred in that patient.

The number of nephrostomy tracts used for the initial side might have contributed further, but it was (unfortunately) not one of our prospective criteria. When evaluated retrospectively, our data were not sufficient to propose a "safe" number of nephrostomy tracts for initial side; however, because all patients with a Hb decrease of >3 g/dL or who needed transfusion had had multiple nephrostomy tracts, our findings support the published data indicating a relationship between the transfusion rate and the number of nephrostomy tracts.[11,14,25-27]

CONCLUSIONS

We obtained similar success and complication rates for bsPCNL and separate-session PCNL by using some objective criteria at the end of the initial side to determine whether to proceed with the second side. We propose the operative time and Hb as reliable criteria, the blood pressure as a reasonable measure, the SaO_2 and pH as informative measure but requiring invasive tests, and the serum sodium as an unnecessary measure in the decision to proceed with the second side. If these criteria are considered during planned bsPCNL, the advantages of a single session can be either taken safely or sacrificed for safety. Despite the best intentions, about 30% of anticipated bsPCNL cases should expect to be limited to single-side PCNL, depending on the intraoperative events.

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