

Residual Fragments After Percutaneous Nephrolithotomy: Cost Comparison of Immediate Second Look Flexible Nephroscopy Versus Expectant Management

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Abbreviations and Acronyms

CT = computerized tomography

ER = emergency room

PCN = percutaneous nephrostomy tube placement

PCNL = percutaneous nephrostolithotomy

RF = residual fragment

SLFN = second look flexible nephroscopy

SWL = shock wave lithotripsy

URS = ureteroscopy

Submitted for publication April 1, 2009.

Study received institutional review board approval.

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† Financial interest and/or other relationship with Cook Urological, Boston Scientific, Altus Medical and Percutaneous Systems.

For another article on a related topic see page 357.

Purpose: We performed a cost comparison of immediate second look flexible nephroscopy vs expectant management for post-percutaneous nephrostolithotomy residual fragments.

Materials and Methods: We used a decision analysis model to compare the cost of managing residual fragments by second look flexible nephroscopy vs observation. Outcomes of residual fragments after percutaneous nephrostolithotomy were determined from institutional experience and published shock wave lithotripsy series. Cost data were obtained from billing records. One-way sensitivity analysis was done to evaluate incurred costs of second look flexible nephroscopy while varying the likelihood of a stone event, the probability of surgery and the cost of surgical intervention. Two-way sensitivity analysis was done to assess the model across a range of scenarios.

Results: Based on data in the literature and our institutional experience 40% of patients with residual fragments 4 mm or less had a stone event, of whom 57% required surgical intervention. Based on these estimates the average cost of expectant management for a residual fragment 4 mm or less vs greater than 4 was \$1,743 vs \$4,674. The average incremental cost of second look flexible nephroscopy at our institution was \$2,475. Two-way sensitivity analysis showed that varying assumptions dramatically altered conclusions about the cost benefit of second look flexible nephroscopy.

Conclusions: Our model suggests that second look flexible nephroscopy is not cost advantageous in all patients with post-percutaneous nephrostolithotomy residual fragments. Cost benefit analysis is significantly impacted by the likelihood of a stone related event, the need for surgical intervention and surgical costs. Compared to an observational strategy second look flexible nephroscopy incurs lower costs for greater than 4 mm but not for 4 mm or less residual fragments.

Key Words: kidney; kidney calculi; nephrostomy, percutaneous; cost-benefit analysis; decision support techniques

PERCUTANEOUS nephrostolithotomy is effective for large or complex renal calculi¹ with the goal of achieving a stone-free state. Despite our best effort to remove all stone fragments as

many as 70% of patients with large calculi requiring intracorporeal lithotripsy are left with RFs after initial PCNL.² SLFN is advocated to retrieve RFs and ensure a stone-free state.

However, SLFN for small RFs is not uniformly done because these stones are not considered to pose a significant risk of future problems. Thus, SLFN is not considered cost advantageous compared to an observational approach.

In our practice we have routinely performed SLFN to retrieve RFs of any size identified on postoperative CT after PCNL. To our knowledge the cost benefit of this surgical practice remains to be established and we have not discriminated based on RF size. For study purposes we analyzed published outcomes of 4 mm or less RFs after SWL and combined these data with our institutional outcomes for small RFs after PCNL to estimate the likelihood of a future stone related event or need for surgical intervention. We applied these estimates to a decision analysis model to evaluate the potential cost advantage of SLFN vs expectant management for small RFs.

MATERIALS AND METHODS

RF Natural History After PCNL

After receiving institutional review board approval we reviewed the medical records of 728 patients who underwent PCNL at our medical center between April 1999 and January 2007. Of this group 527 patients had 6 months or greater of documented radiographic followup, of whom 42 (8%) with 1 to 12 mm RFs on postoperative CT were observed instead of undergoing SLFN. Indications for observation were physician and/or patient preference, and medical conditions or complications precluding repeat nephroscopy. The natural history of these RFs, including symptomatic stone events and the need for surgical intervention, were reported previously.³

Likelihood of Stone Related Event With RFs 4 mm or Less

We reviewed the literature to identify studies of the natural history of stone RFs after SWL, PCNL or URS. To be included in analysis eligible studies had to specify whether the RF was symptomatic and whether surgical intervention or conservative management was done. We also excluded series of asymptomatic untreated stones due to the confounding impact of treatment (vs none) and lead time bias. Using such criteria we identified 5 studies in

the SWL literature^{4–8} but none in the URS and PCNL literature that appropriately recorded RF outcome. Outcomes from our PCNL series, including only patients with RFs 4 mm or less,³ were then incorporated into this pooled analysis (table 1). Weighted averages were used to calculate mean and median followup, and the proportion of patients with symptomatic events and requiring secondary procedures.

Cost Assumptions

Cost data on surgical procedures were obtained from our institutional billing department. Total direct cost reflects the sum of individual costs generated at each department involved in patient care without including profit margins that are typically incorporated into charges. Cost centers included operating room overhead or supplies, day surgery, recovery room, laboratory, professional fees and anesthesia. Professional fees were obtained from 2007 Medicare reimbursement rates in Texas. We assumed that certain procedures were done on an outpatient basis, including URS with or without stent placement and with or without stone fragmentation, SWL with or without stent placement, PCN and cystoscopy with stent placement. We assumed 2-day hospitalization after PCNL. Daily hospital costs included room and board, antibiotics, laboratory studies, analgesics and fluids. Our SLFN technique was previously described.² Costs of this procedure were derived from the mean of 179 consecutive cases done between September 2005 and May 2007 at a large metropolitan hospital. Loss of wage was calculated as \$13.76 per hour, which is the median wage in Texas.⁹ Table 2 lists the cost variables used.

Decision Analysis Model

A decision analysis model using TreeAge Pro™ 2004 with linear success rate assumptions was constructed to compare the cost of observing RFs vs immediate SLFN. When determining the cost of RF treatment, we assumed that asymptomatic patients incurred no additional cost during the observation period. In patients with RFs who became symptomatic treatment consisted of a conservative approach and continued observation or surgical intervention according to the likelihood of requiring surgery vs successful spontaneous stone passage derived from our literature search. Cost assumptions for conservative treatment included an ER visit and nonenhanced helical CT as well as loss of wage during the evaluation and treatment period. Cost assumptions for surgical treatment included the cost of individual procedures, an ER visit with nonenhanced

Table 1. Outcome in patients with RFs 4 mm or less

References	Primary Treatment	No. Pts	Mean or Median Followup (mos)	No. Symptomatic RF/Total No. (%)	No. Symptomatic + Surgery (%)
EI-Nahas et al ⁵	SWL	154	31	75/154 (49)	52 (69)
Osman et al ⁸	SWL	173	59	37/173 (21)	15 (40)*
Khaitan et al ⁶	SWL	75	15	44/75 (59)	23 (52)
Candau et al ⁴	SWL	83	41	31/83 (37)	18 (58)
Stroom et al ⁷	SWL	160	23	69/160 (43)	41 (59)
Raman et al ³	PCNL	33	41	12/33 (36)	5 (42)
Overall	—	678	34	(40)	(57)

* Extrapolated from data.

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