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# Percutaneous Nephrolithotomy Versus Retrograde Intrarenal Surgery: A Systematic Review and Meta-analysis

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## Abstract

***Context:*** Recent advances in technology have led to the implementation of mini– and micro–percutaneous nephrolithotomy (PCNL) as well as retrograde intrarenal surgery (RIRS) in the management of kidney stones.
***Objective:*** To provide a systematic review and meta-analysis of studies comparing RIRS with PCNL techniques for the treatment of kidney stones.
***Evidence acquisition:*** A systematic literature review was performed in March 2014 using the PubMed, Scopus, and Web of Science databases to identify relevant studies. Article selection proceeded according to the search strategy based on Preferred Reporting Items for Systematic Reviews and Meta-analysis criteria. A subgroup analysis was performed comparing standard PCNL and minimally invasive percutaneous procedures (MIPPs) including mini-PCNL and micro-PCNL with RIRS, separately.
***Evidence synthesis:*** Two randomised and eight nonrandomised studies were analysed. PCNL techniques provided a significantly higher stone-free rate (weighted mean difference [WMD]: 2.19; 95% confidence interval [CI], 1.53–3.13; $p < 0.00001$) but also higher complication rates (odds ratio [OR]: 1.61; 95% CI, 1.11–2.35; $p < 0.01$) and a larger postoperative decrease in haemoglobin levels (WMD: 0.87; 95% CI, 0.51–1.22; $p < 0.00001$). In contrast, RIRS led to a shorter hospital stay (WMD: 1.28; 95% CI, 0.79–1.77; $p < 0.0001$). At subgroup analysis, RIRS provided a significantly higher stone-free rate than MIPPs (WMD: 1.70; 95% CI, 1.07–2.70; $p = 0.03$) but less than standard PCNL (OR: 4.32; 95% CI, 1.99–9.37; $p = 0.0002$). Hospital stay was shorter for RIRS compared with both MIPPs (WMD: 1.11; 95% CI, 0.39–1.83; $p = 0.003$) and standard PCNL (WMD: 1.84 d; 95% CI, 0.64–3.04; $p = 0.003$).
***Conclusions:*** PCNL is associated with higher stone-free rates at the expense of higher complication rates, blood loss, and admission times. Standard PCNL offers stone-free rates superior to those of RIRS, whereas RIRS provides higher stone free rates than MIPPs. Given the added morbidity and lower efficacy of MIPPs, RIRS should be considered standard therapy for stones <2 cm until appropriate randomised studies are performed. When flexible instruments are not available, standard PCNL should be considered due to the lower efficacy of MIPPs.
***Patient summary:*** We searched the literature for studies comparing new minimally invasive techniques for the treatment of kidney stones. The analysis of 10 available studies shows that treatment can be tailored to the patient by balancing the advantages and disadvantages of each technique.



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## 1. Introduction

Minimally invasive procedures have almost completely replaced open surgery in patients with kidney stones over the past two decades [1]. Percutaneous nephrolithotomy (PCNL) is now the standard of care for the treatment of large (>2 cm) stones [2]. However, its higher stone-free rates are counterbalanced by the risk of complications [3]. Recent advances in technology have led to a reduction in nephroscope diameter with the goal of minimising the surgical morbidity of PCNL. Thus *miniperc* and *microperc* have been implemented [4,5].

An alternative to the percutaneous approaches is provided by flexible ureteroscopy, also referred to as retrograde intrarenal surgery (RIRS). Originally proposed in the treatment of a lower pole stone resistant to shockwave lithotripsy (SWL) [6], studies have shown its utility in the management of larger renal stones throughout the entire pelvicalyceal system [1].

The 2013 European Association of Urology (EAU) guidelines recommend PCNL and RIRS as first-line treatment for lower pole stones when anatomic factors make SWL unfavourable [2]. The role of RIRS in the renal pelvis and remaining calyces, although technically feasible, is under investigation for stones >1.5 cm [1].

The main drawbacks of retrograde access include the requirement of flexible scopes, limited visualisation, reduced size of fragment removal, and the need for flexible lithotrites and baskets [7]. Cost is a major deterrent to RIRS, particularly in developing countries [8]. However, percutaneous approaches have traditionally provided enhanced capacity for stone removal, given the use of large-sheath diameters. This paradigm has recently changed with the progressive miniaturisation of devices for percutaneous access. PCNL techniques offer significant economic advantages due to the decreased reliance on disposable instrumentation.

The aim of this study was to perform a meta-analysis of available studies comparing RIRS with percutaneous surgery (including standard PCNL, miniperc, and microperc) in the management of kidney stones.

## 2. Evidence acquisition

### 2.1. Literature search and article selection

A systematic literature review was performed in March 2014 using PubMed, Scopus, and Web of Science databases to identify relevant studies. Searches were restricted to publications in English and in the adult population. Separate searches were done with the following search terms: *percutaneous nephrolithotomy, retrograde intrarenal surgery, percutaneous lithotripsy, RIRS, miniPCNL, microperc-utaneous nephrolithtomy*, and *flexible ureteroscopy*.

Article selection proceeded according to the search strategy based on Preferred Reporting Items for Systematic Reviews and Meta-analysis criteria (www.prismastatement. org) (Fig. 1). Only studies comparing PCNL and RIRS were included for further screening. Cited references from the selected articles retrieved in the search were also assessed for significant papers. Conference abstracts were not included because they were not deemed to be methodologically appropriate. Two independent reviewers completed this process, and all disagreements were resolved by their consensus.

### 2.2. Assessment of study quality

The level of evidence (LE) was rated for each included study according to the criteria provided by the Oxford Centre for Evidence-based Medicine [9]. The methodological quality of the studies was assessed using the Newcastle-Ottawa Scale (NOS) for nonrandomised controlled trials (RCTs) [10] and the Jadad scale for RCTs [11]. Two reviewers reviewed the full texts of the included studies. Preoperative demographic characteristics as well as perioperative and postoperative outcomes between the two procedures were compared.

### 2.3. Statistical analysis

A meta-analysis was performed to assess the overall outcomes of PCNL compared with RIRS. A subgroup analysis was performed considering standard PCNL (sheath size ≥24F) only versus RIRS and minimally invasive percutaneous procedures (MIPPs; ie, mini- and microperc) only versus RIRS.

In one study a combination of mini and standard PCNL was used, and this study was included in the overall analysis but not in the subgroup analysis [12]. Of 10 studies, 2 were multi-institutional [12,13].

Extracted data for the analysis included operative time, estimated blood loss, length of hospital stay, need for auxiliary procedures, and postoperative complication rate. Odds ratio (OR) was used for binary variables, and mean difference or standardised mean difference was used for the continuous parameters. For studies presenting continuous data as means and range, standard deviations were calculated using the methodology described by Hozo and associates [14]. Pooled estimates were calculated with the fixed-effect model (Mantel-Haenszel method) if no significant heterogeneity was detected; otherwise, the random-effect model (DerSimonian-Laird method) was used. The pooled effects were determined by the $z$ test, and $p < 0.05$ was considered statistically significant. The Cochrane chi-square test and inconsistency ($I^2$) were used to evaluate the heterogeneity among studies. Data analysis was performed with Review Manager software (RevMan v.5.1, Cochrane Collaboration, Oxford, UK).

## 3. Evidence synthesis

### 3.1. Study characteristics

Ten studies were selected for the analysis including 727 PCNL cases (61.55%) and 454 RIRS cases (38.44%) (Table 1). There were no differences between PCNL and RIRS study populations in terms of mean age (44.8 vs 45.07 yr, respectively) and body mass index (24 kg/m$^2$ vs 24.1 kg/m$^2$, respectively).