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Review

Outcomes of non-reduction vs reduction pyeloplasty: a systematic review and meta-analysis

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Objective

To compare the surgical outcomes between non-reduction and reduction pyeloplasty in the management of pelvi-ureteric junction obstruction among patients such as postoperative functional outcomes, complication rate, and failure rate through a meta-analysis of comparative studies.

Patients and Methods

Electronic databases including PubMed, EMBASE, Scopus, and Cochrane Library, including the Cochrane Database of Systematic Reviews and the Cochrane Central Register of Controlled Trials were searched to identify published literature comparing reduction and non-reduction pyeloplasty in adult and paediatric patients. Data on anteroposterior pelvic diameter (APPD), differential renal function (DRF), and complications were extracted. Data synthesis and statistical analysis were done using ReviewManager. Random-effects model and standard mean difference (SMD) were used for calculation of all effect estimates with 95% confidence intervals (CIs) for extrapolation. This study was registered with the International Prospective Register of Systematic Reviews (PROSPERO:CRD42021288645).

Results

Five studies were selected for analysis, encompassing 177 renal units, of which 88 cases were reduction pyeloplasty and 89 cases were non-reduction pyeloplasty. Continuous variables were presented as SMDs with their 95% CIs. Our overall pooled effect estimates showed a statistically significant difference favouring reduction pyeloplasty in terms of postoperative APPD (SMD 1.77, 95% CI 0.43–3.10) and change in APPD (SMD 1.21, 95% CI 0.07–2.36). No statistically significant difference was observed for postoperative DRF (SMD 0.27, 95% CI −0.10 to 0.64) and change in DRF (SMD 0.68, 95% CI −0.39 to 1.74). Subgroup analyses revealed no statistically significant difference for all functional outcomes. Analysis of both groups revealed no significant difference in terms of postoperative complication rate (relative risk [RR] 0.91, 95% CI 0.38–2.16) and failure rate (RR 1.50, 95% CI 0.28–8.04).

Conclusion

The evidence suggests that non-reduction pyeloplasty results in comparable postoperative DRF and change in DRF. Although reduction pyeloplasty results in superior APPD and change in APPD compared to non-reduction pyeloplasty, these findings may be clinically negligible. Complication and failure rates between the two groups are comparable.

Keywords

Non-reduction pyeloplasty, reduction pyeloplasty, pelvi-ureteric junction obstruction, renal pelvis sparing, dismembered pyeloplasty

Introduction

A PUJ obstruction (PUJO) signifies obstruction to urinary outflow caused either by an intrinsic or extrinsic compression at the level of the PUJ causing a compelling disruption of urine transport which, when left untreated, leads to progressive renal damage and failure [1]. PUJO is one of the most common causes of obstructive uropathy leading to deterioration of renal function in children, affecting approximately one in 1250 live births [2]. The majority of cases are congenital in nature, such as an aperistaltic ureteric segment due to abnormal smooth muscle layer architecture, high insertion of the ureter into the renal pelvis impairing drainage of urine, and presence of an aberrant crossing accessory renal vessel compressing the PUJ. However, acquired diseases, both extrinsic (retroperitoneal masses, lymphadenopathy, or fibrosis) and intrinsic (impacted stone or ureteric tumours), can sometimes cause PUJO [3]. The paediatric population is more likely than adults to have PUJO. It is the most prevalent cause of antenatally identified pathological hydronephrosis, accounting for ~80% of all cases [4]. The severity of hydronephrosis varies greatly, as does its natural history, which can range from spontaneous remission to progressive loss of function over the first few years of life.

The diagnosis is made with a careful history coupled with imaging in which ultrasonography (US), magnetic resonance urography, and nuclear medicine studies are the most commonly used [5]. The presence of symptoms or infections, the appearance of the renal pelvis, as well as functional data, including a decreased split renal function or evidence of obstruction, are used for decision-making. Surgical management has evolved throughout the years, and several techniques have emerged, each with specific advantages and limitations, such as endopyelotomy, dismembered and non-dismembered open, laparoscopic, and robotic pyeloplasty [6].

Non-reduction (pelvis-sparing) pyeloplasty (NRP) is a surgical technique to address PUJO that aims to save the dilated renal pelvis while excising the narrowed or obstructed segment [7]. In contrast, reduction pyeloplasty (RP) involves excision of the redundant renal pelvis. Both of these techniques have been noted to improve urine flow, preserve renal function, and relieve symptoms of patients with PUJO.

This study aimed to determine the benefits of the reduction vs non-reduction techniques, contributing to the current surgical practice of pyeloplasty. This study will serve as an important tool in technique selection in the surgical management of PUJO.

Patients and Methods

Study Design

This meta-analysis compared the outcomes of RP vs NRP in the treatment of PUJO. The goal was to assess the efficacy, safety, and clinical outcomes associated with both surgical techniques. The review protocol was recorded in the International Prospective Register of Systematic Reviews (PROSPERO) registry (CRD42021288645) and conducted in line with Cochrane Collaboration guidelines [8], ensuring that reporting adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement [9].

Search Strategy

The investigators, with the help of a board-certified librarian, utilised electronic databases to identify published medical literature comparing surgical outcomes of NRP vs RP. The searches were not restricted by language and included the following databases: PubMed (December 2023), EMBASE (December 2023), Scopus (up to December 2023), and Cochrane Library, including the Cochrane Database of Systematic Reviews and the Cochrane Central Register of Controlled Trials (December 2023).

The search covered all publications from inception to the present. Grey literature, such as conference abstracts and unpublished studies, were to be included if relevant. Unpublished and ongoing trials were also explored through Clinicaltrial.gov and Proquest (Database of dissertation and Thesis [November 2023]).

The researchers used both Pubmed Medical Subject Heading (MeSH) terms and free text in all fields including title, abstracts, keywords (preliminary terms: ("pyeloplasties"[All Fields] OR "pyeloplasty"[All Fields]) AND ("reduction"[All Fields] OR "reductions"[All Fields] OR (("pelvi"[All Fields] OR "pelvis"[MeSH Terms] OR "pelvis"[All Fields]) AND ("spare"[All Fields] OR "spared"[All Fields] OR "spares"[All Fields] OR "sparing"[All Fields]))).

The references from studies that met our inclusion criteria and review articles or textbooks of related topics were also searched for potentially relevant titles. Experts in the field of specialty were asked to identify additional relevant studies and to obtain any unpublished data potentially not included in the initial search.

Study Selection

Human clinical comparative studies on adult and paediatric patients, including randomised or quasi-randomised controlled studies, cohorts (prospective or retrospective), and case controls, were included in the eligibility criteria. Open, laparoscopic or robot-assisted procedures with comparative outcomes between the pyeloplasty approaches and clearly defined outcome and intervention in the published article were included. Patients who underwent re-do pyeloplasty or those who had poorly functioning kidneys were excluded.

All stages of the review were performed independently by two reviewers knowledgeable in the principles of critical appraisal.

The selection process included:

1. Title and abstract screening: without prior consideration of the study results, two of three physician reviewers, at least one of two specialised in paediatric urology, independently evaluated the citations and abstracts. The reviewers identified article titles relevant to the topics.
2. Full-text screening: the full texts of the selected studies were retrieved and reviewed independently by the same reviewers for eligibility based on the inclusion and exclusion criteria.

3. Disagreements: any disagreements between two reviewers were resolved through consensus with reconciliation by a senior reviewer who also served as the methodologist.

Data Extraction, Data Synthesis and Data Classification

Data extraction was done by one reviewer and counter-checked by another, and the former tabulated the necessary data for each study. Adjusted point estimates or raw data to extrapolate relative risk (RR) or odds ratio was the preferred parameter if available in the publication. If the same cohort with multiple publications was encountered, only the most recent and most comprehensive data were included.

A summary table was constructed to describe the details of the studies included for both meta-analysis and systematic review, specifically the author(s), year of publication, study design, participants, intervention, comparison, outcome, and other relevant information.

When selective outcome reporting was present or if discrepancies were noted between the final study report and the previously published study protocol, the study authors were contacted for additional information or reassess the trial registration for additional outcome data. If the study reported no estimated effect measurement and raw data for the calculation of point estimates, authors were e-mailed for the request of vital data for deriving the effect estimate.

The postoperative complication rate and failure rate were the binary outcomes assessed in this meta-analysis, reported as RRs along with their corresponding 95% CIs. If a study reported multiple follow-up values, the authors used the values from the longest follow-up interval. Mean and SD were calculated from each intervention group for the continuous outcome comparison on anteroposterior pelvic diameter (APPD) and differential renal function (DRF). For the parameters in the change in APPD and DRF, the authors derived the standard mean difference (SMD) from the pre- and postoperative values whereas the SD was calculated using the ReviewManager (RevMan; The Cochrane Collaboration, London, UK) 5.4 calculator. The SMD and its 95% CIs were calculated to estimate the treatment effect between the groups. To address the varied methodologies in the studies, effect estimates were standardised using the SMD or RR with corresponding 95% CI. The pooled effect estimates were then calculated using the inverse variance method with a random-effects model to determine the average treatment effect [8,10,11]. RevMan 5.4 software was used for data synthesis and statistical analysis.

Risk of Bias and Heterogeneity Assessment

The risk of bias was evaluated using the Cochrane Risk of Bias tool for randomised controlled trials [8]. For assessment of inter-study heterogeneity, the chi-square test was used, and I^2 for heterogeneity and variability estimates, respectively [8]. Furthermore, we conducted subgroup analyses to investigate possible factors contributing to the heterogeneity observed in the included studies.

Results

The search strategy identified 7047 potentially relevant articles, of which 2735 were duplicates and 4140 articles were deemed irrelevant based on the title and abstract screening process. Among the 172 full-text articles that were reviewed, 167 were excluded due to reasons depicted in the PRISMA figure (Fig. 1). Five studies (one non-randomised retrospective cohort and four randomised prospective cohort) were included in the final analysis.

Table 1 depicts the study characteristics of the five included studies. The included studies encompassed a total of 168 renal units, with 85 undergoing NRP and 83 undergoing RP. All of the studies involved paediatric or adolescent patients and none of them described adult patients. Four studies [2,12–14] described open Anderson–Hynes pyeloplasty, both RP and NRP, while one study [7] described laparoscopic NRP and open RP. Preoperative parameters such as age, baseline APPD, DRF, and GFR were similar between the two groups in all included studies as depicted in Table 2. Only one study documented postoperative complications and failure rate as outcomes [14].

Study Quality Assessment (Risk of Bias)

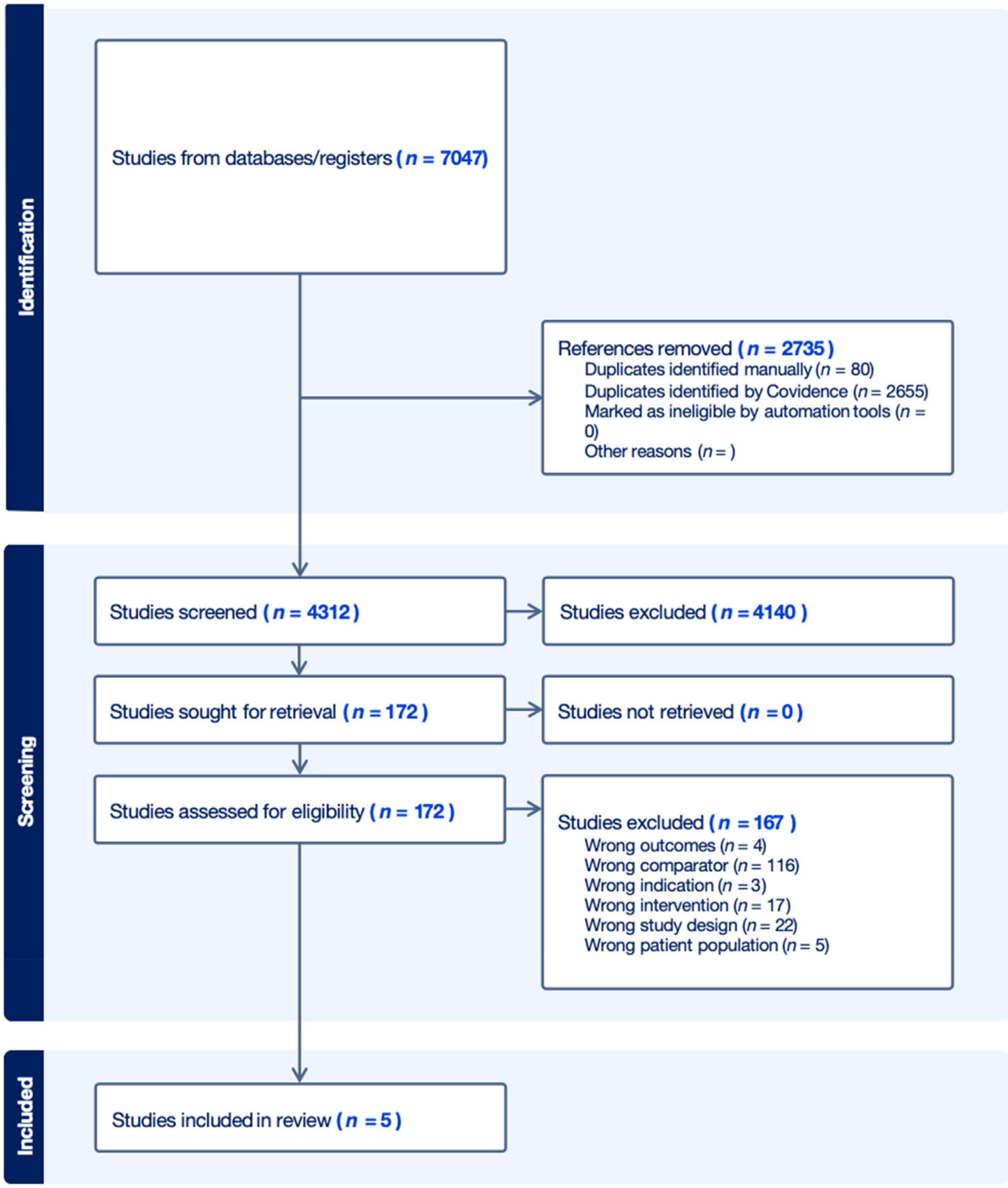
Risk of bias assessment using the Cochrane Risk of Bias 2 (ROB 2) tool showed that two of the included studies were at high risk of bias due to lack of randomisation process and incomplete and/or missing data (Fig. 2). Three studies were assessed as having some concern for risk of bias, two of which were due to concerns from measure of the outcome and one due to selection of the reported result concerns.

Outcomes Effect Estimates

Postoperative APPD

Postoperative APPD after RP and NRP were evaluated in four studies (Fig. 3a). The pooled effect estimates for postoperative APPD favoured RP over NRP, with a statistically significant difference (SMD 1.77, 95% CI 0.43–3.10). There was substantial heterogeneity found for this outcome analysis, which could be due to a great diversity in the preoperative APPD and timing of follow-up US across the studies included. Three studies requested a postoperative US uniformly at 6 months [12–14], while one study did US with a range of 36–72 months (mean of 47.2 months) [2]. Preoperative APPD was widely variable, with a mean (SD) minimum size of 23.8 (1.36) mm [2] and maximum mean

Fig. 1 The PRISMA flowchart of the study selection process.



size of 50.9 mm [14]. Subgroup analysis was performed due to substantial heterogeneity, which reduced the I^2 to 0% from 89% (Fig. 3b). Results show no statistically significant difference after the subgroup analysis (SMD 0.60, 95% CI −0.01 to 1.20).

Postoperative DRF

Four studies reported on postoperative DRF outcomes [2,7,12,14] as indicated in Fig. 3c. The pooled effect estimates for this parameter showed no statistically significant difference between RP and NRP (SMD 0.27, 95% CI −0.10 to 0.64; I^2 = 15%). There was no significant heterogeneity found for this outcome analysis. In one study, a renal scan was performed 3 months postoperatively [7]; while in two studies, a postoperative renal scan was uniformly performed at 6 months [12,14]; and in one study a renal scan was done ≥1 year postoperatively [2].

Change in APPD

The values for change in APPD were evaluated in one study [12] while the values for the other three included studies were

Table 1 Study characteristics summary.

Reference, country	Study design	Population	Surgical technique	Measures of outcome
Reismann et al., 2008 [7], Germany	Retrospective cohort	Paediatric and adolescent	Open RP Laparoscopic NRP	DRF Drainage
Burgu et al., 2010 [12], Turkey	Prospective cohort randomised	Paediatric and adolescent	Open RP Open NRP	APPD DRF Drainage
Morsi et al., 2012 [14], Egypt	Prospective cohort randomised	Paediatric	Open RP (up to 2 cm from the calyceal infundibula) Open NRP	APPD DRF GFR Failure rate Postoperative UTI
Daboos et al., 2016 [13], Egypt	Prospective cohort randomised	Paediatric	Open RP (up to 2 cm from the calyceal infundibula) Open NRP	APPD DRF
Yhoshu et al., 2022 [2], India	Prospective cohort randomised	Paediatric	Open RP (leaving only 1 cm of tissue from renal sinus) Open NRP	APPD DRF Drainage

calculated using RevMan based on available parameters [2,13,14]. The pooled effect estimates from four studies for change in APPD favoured RP over NRP (Fig. 3d), with a statistically significant difference (SMD 1.21, 95% CI 0.07–2.36). There was substantial heterogeneity found for this outcome analysis with I^2 = 87%. Hence, subgroup analysis was done reducing I^2 to 0% from 87% (Fig. 3e) and the results revealed no statistically significant difference after the subgroup analysis (SMD 0.38, 95% CI −0.13 to 0.90).

Change in DRF

Only one study showed the change in DRF preoperatively vs postoperatively [12]. Computations were made for the other three studies using the RevMan calculator. Computed meta-analysis for change in DRF showed no statistically significant difference between RP and NRP as seen in Fig. 3f (pooled four studies: SMD 0.68, 95% CI −0.39 to 1.74). As noted, there was significant heterogeneity detected for this outcome (I^2 = 88%). Subgroup analysis decreased I^2 to 0% and results remained as no statistically significant difference shown in Fig. 3g (SMD 0.12, 95% CI −0.29 to 0.54).

Complication Rate and Failure Rate

Only one study [14] reported on complication rates, namely postoperative UTI, which was comparable between the NRP (six renal units [35.2%]) and RP (seven renal units [38.8%]) groups. Failure rates, which were documented as the proportion of patients with postoperative urinary leak and/or obstruction needing additional interventions (re-do pyeloplasty/percutaneous nephrostomy), were also comparable between the NRP (three renal units [15%]) and RP (two renal units [10%]) groups. Meta-analysis was not possible for these parameters due to insufficient data and lacking studies for analysis.

Publication Bias

The funnel plots produced in this analysis showed a low likelihood of publication bias (Fig. S1a–d) with a symmetrical distribution of studies. This balance in the funnel plots suggests that the chance of selective publication, where only positive or significant results are released, is low.

Discussion

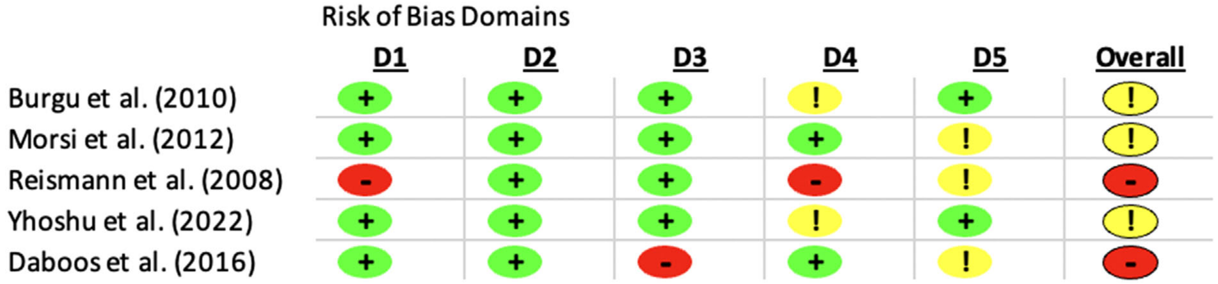
Classically, the 'gold standard' surgical procedure for treatment of PUJO was open dismembered pyeloplasty as described by Anderson and Hynes in 1949, producing outstanding long-term perioperative and functional outcomes at over 90% [15]. The method involves an incision involving the dysfunctional segment of the proximal ureter and the redundant dilated renal pelvis [16]. Excision of redundant renal pelvis provided potential advantages, such as avoiding urine stasis and avoiding ureteric kinks behind a newly formed anastomosis [12,13]. However, some surgeons do not promote pelvic reduction, as they argue that the redundant pelvis has useful properties [12]. Omitting extensive renal pelvis excision requires less retroperitoneal field exposure and less suturing, resulting in decreased operative time, both in the laparoscopic and open procedures [7,12]. Shorter recovery time may be expected, as less trauma is dealt to the kidney. Sparing the renal pelvis during pyeloplasty avoids unnecessary viable tissue excision and provides additional protection during recovery after surgery, as renal histological architecture is preserved [17]. Furthermore, additional surgical steps are thought to increase surgical time and risk of complications, such as urine leakage or prolonged

Table 2 Included study data summary.

Reference, country	Parameter	RP	NRP	Remarks
Reismann et al., 2008 [7], Germany	Sample size	*N* = 12	*N* = 12	No data on complications and failure rate
	Age at operation, years, mean (range)	3.4 (0.5–9.5)	3.4 (0.5–9.5)	
	Preoperative DRF, %, mean (SD)	42.2 (9.0)	42.2 (9.0)	
	Preoperative drainage (^{123}I-ortho-iodohippurate renography), %, mean (SD)	45.1 (23.7)	35.1 (10.7)	
Burgu et al., 2010 [12], Turkey	Sample size	*N* = 20	*N* = 22	No data on complications and failure rate
	Age at operation, months, mean (SD)	14 (2.1)	12.8 (1.2)	
	Preoperative APPD, mm, mean (SD)	33.9 (5.1)	29.4 (3.7)	
	Preoperative DRF, %, mean (SD)	38 (4)	33.9 (3.3)	
	MAG3 t½, min, mean (SD)	19.1 (2.2)	18.5 (1.9)	
	MAG3 TTP, min, mean (SD)	18.3 (3)	15.9 (2.1)	
Morsi et al., 2012 [14], Egypt	Sample size	*N* = 20	*N* = 20	
	Renal stones, *n* (%)	1 (5)	3 (15)	
	Age at operation, years, mean (SD)	4.81 (6.78)	5.71 (6.36)	
	Preoperative APPD, mm, mean	49.9	50.9	
	Preoperative GFR, mL/min/1.73 m^2, mean (SD)	37.25 (15.33)	31.3 (18.50)	
	Preoperative DRF, %, mean (SD)	39 (22.47)	34.92 (16.79)	
	Follow-up time, months, mean (range)	9 (6–12)	9 (6–12)	
	Failure rate, *n* (%)	2 (10)	3 (15)	*P* = 1
	Postoperative UTI, *n* (%)	7 (38.8)	6 (35.2)	*P* = 0.1
Daboos et al., 2016 [13], Egypt	Sample size	*N* = 10	*N* = 10	No data on complications and failure rate
	Age at operation, years, mean (SD)	18.40 (6.26)	10 (6.86)	
	Preoperative APPD, mm, mean (SD)	45.20 (3.12)	41.60 (4.14)	
	Preoperative DRF, %, mean (SD)	34.20 (4.10)	32.80 (4.08)	
	Follow-up time, months	6	6	
Yhoshu et al., 2022 [2], India	Sample Size	*N* = 21	*N* = 21	No data on complications and failure rate
	Age at operation, years, mean (SD)	2.75 (2.7)	2.98 (4.21)	
	Gender, *n*			
	Female	3	3	
	Male	18	18	
	Laterality, *n* (%)			
	Left	10 (47.6)	14 (66.7)	
	Right	8 (38.1)	5 (23.8)	
	Bilateral	3 (14.3)	2 (9.5)	
	Solitary kidney, *n*	1	1	
	Preoperative DRF, %, mean (SD)	45.88 (14.42) (*n* = 17)	39.22 (9.75) (*n* = 18)	
	Preoperative APPD, cm, mean (SD)	3.14 (2.28)	2.38 (1.36)	
	Preoperative lower pole calyceal separation, mm, mean (SD)	7.65 (2.43)	8.29 (3.73)	
	Parenchymal thickness, mm, mean (SD)	5.3 (1.76)	6.34 (2.5)	
	Aberrant crossing vessel, *n*	0	2	

MAG3, mercapto-acetyltriglycine, t½, half-life; TTP, time to peak.

Fig. 2 Risk of bias assessment using the RoB 2 tool.



hospitalisation. With the advent of minimally invasive surgery, laparoscopic dismembered pyeloplasty without excision of the renal pelvis became feasible, with comparable perioperative and functional outcomes compared to its open counterpart [1,2,7,12].

This meta-analysis contributes important data to the ongoing debate on RP vs NRP, as advocates of each technique have claimed varying degrees of success. Among the included studies in this meta-analysis, criteria for surgical correction of PUJO were variable, but all studies included patients with increased APPD, declining renal function, and impaired drainage [2,7,12–14]. The results in this study favoured RP over NRP in terms of postoperative APPD and change in APPD. This finding is expected to favour RP, as the procedure itself involves resection of the redundant pelvis. However, on subgroup analysis, NRP was comparable to RP in terms of structural outcomes. Determination of surgical success of PUJO treatment is a complex process and involves clinical reassessment, serial US, and dynamic renal scan, which supplement each other but cannot serve as substitutes for each other. Detection of surgical failure is an equally complicated task in that deteriorating DRF or unimproved hydronephrosis, especially in the early postoperative phase, does not necessarily mean a failure and warrant a re-do procedure. In brief, the more favourable outcomes for APPD in RP may be negligible and not be of clinical significance.

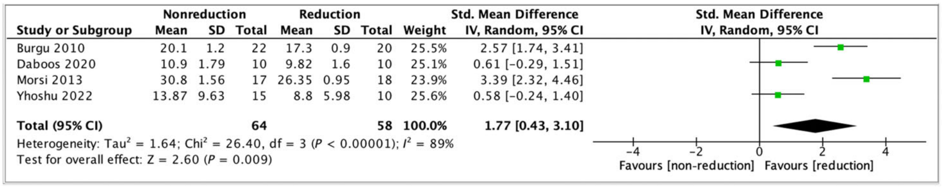
Postoperative DRF for renal units undergoing RP and NRP showed no statistically significant difference. Postoperative preservation, as well as improvement, if any, of DRF are considered positive outcomes. In one study, about 72% of patients undergoing pyeloplasty had unchanged DRF at 18 months and only one in 80 patients had deterioration in DRF [18]. In another study by Li et al. [19] evaluating 95 patients with unilateral PUJO, 70.5% of patients had preserved postoperative DRF and 29.5% had improvement of DRF, defined as ≥5% increase if preoperative DRF was <55%. Preservation of DRF is an equally important positive outcome to improvement of DRF in some cases and this study suggests that NRP is comparable to RP in terms of functional DRF outcomes.

Reduction pyeloplasty led to a more dramatic improvement of US hydronephrosis in the early postoperative phase compared to NRP [12,14]. It should be noted that by the sixth month, the APPDs of RP vs NRP were not statistically significant in these two studies [12,14]. US stabilisation, described as two consecutive US post-pyeloplasty, a minimum of 1 month apart, with the same degree of hydronephrosis according to the Society for Fetal Urology (SFU) grading system, greatly varies among cases and it could range from as short as 3 months to as long as 7 years [20]. A longer period for the APPD to stabilise is expected if the redundant pelvis is not excised and early non-resolution of hydronephrosis should not simply be considered a failure. It has been previously noted that hydronephrotic changes following pyeloplasty may take up to 8 months to demonstrate improvement, up to 60 months for hydronephrosis to completely normalise [21]. Similarly, in a study by Nordenström et al. [18], ~20% of the participants saw an improvement in DRF after 3 months, and >25% had a DRF increase of >5% at the 18-month follow-up. These observations indicate that recovery from PUJO after surgery is a lengthy process, at least from an imaging standpoint.

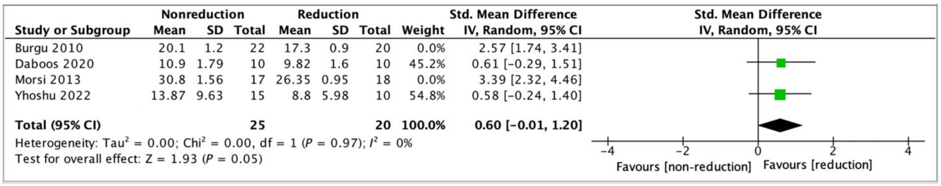
Assessment of renal drainage is an important determinant of success in pyeloplasty, especially in equivocal postoperative US findings [22]. Using ^{123}I-ortho-iodohippurate renography to evaluate renal drainage, Reismann et al. [7] concluded that there was no significant difference between RP and NRP in terms of renal drainage. Similarly, Yhoshu et al. [2] utilised an ethylene dicysteine scan to evaluate renal drainage and showed that RP demonstrates superior recovery in the early postoperative phase (3 months), but no significant difference compared to NRP at 1 year. In summary, based on the limited studies, we do not have evidence to suggest a significant difference in improvement of renal drainage between RP and NRP.

In this study, we looked into the potential risk of both modifications of Anderson–Hynes dismembered pyeloplasty (AHDP) in terms of complications and morbidity. While the traditional AHDP included excision of the redundant renal pelvis in the classical technique, recent evidence reports that most laparoscopic procedures deviate from the original AHDP procedure and omit pelvis reduction [23]. The wisdom behind omission of reduction is the idea of less overall morbidity, while enjoying a comparable functional outcome. Technically speaking, it entails a longer duration of surgery and is more prone to urine leak and anastomotic tension. Moreover, there is currently no study strongly demonstrating a proven benefit of doing pelvis excision in patients with PUJO undergoing AHDP [7,23]. In some situations, such as when the renal pelvis is severely dilated, NRP may be chosen because it avoids unnecessarily altering the collecting system anatomy, which is necessary for function [24]. Additionally, younger children with PUJO tend to have smaller renal pelvis even when dilated, thereby not warranting RP in the first place, as it will pose technical difficulties and may lead to morbidities [25]. Proponents of NRP claim that it is a less invasive surgery, leading to shorter operation times and potentially lower rates of postoperative complications. In the study of Morsi et al. [14] comparing outcomes of RP vs NRP, the researchers took account of postoperative complications (UTI), as well as failure rate, showing no statistically significant difference between the two groups. To date, there is limited information highlighting peri- and postoperative complications of RP and NRP.

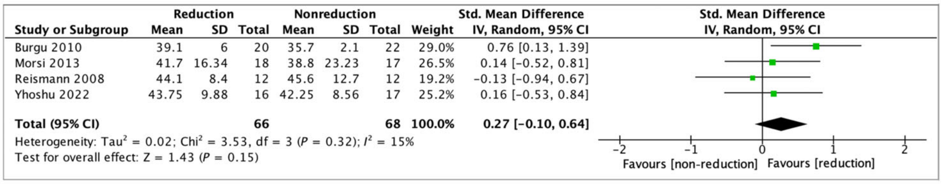
While the meta-analysis provides valuable insights, several limitations should be noted. The inclusion of only five



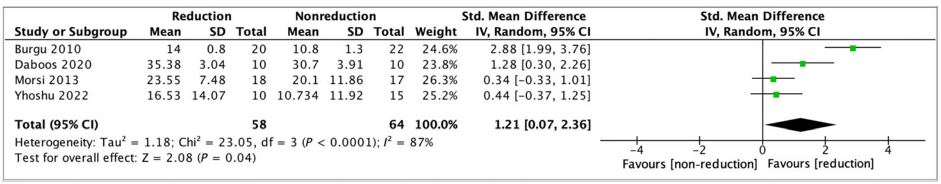
(a) Forest plot of comparison: 1 Reduction vs Nonreduction Pyeloplasty, outcome: 1.1 APPD.



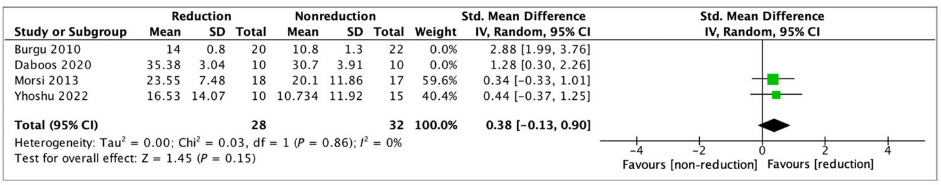
(b) Subgroup Analysis: 1 Reduction vs Nonreduction Pyeloplasty, outcome: 1.1 APPD.



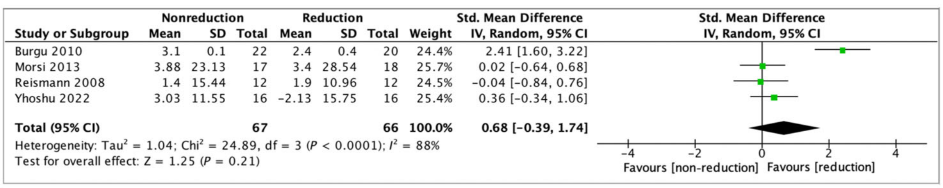
(c) Forest plot of comparison: 1 Reduction vs Nonreduction Pyeloplasty, outcome: 1.2 DRF.



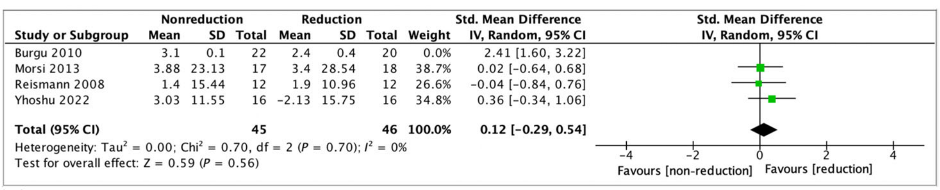
(d) Forest plot of comparison: 1 Reduction vs Nonreduction Pyeloplasty, outcome: 1.3 Change in APPD.



(e) Subgroup Analysis: 1 Reduction vs Nonreduction Pyeloplasty, outcome: 1.1 Change in APPD.



(f) Forest plot of comparison: 1 Reduction vs Nonreduction Pyeloplasty, outcome: 1.4 Change in DRF.



(g) Subgroup Analysis: 1 Reduction vs Nonreduction Pyeloplasty, outcome: 1.1 Change in DRF.

Fig. 3 Forest plots. (**a**) Forest plot of comparison: 1 RP vs NRP, outcome: 1.1 APPD. (**b**) Subgroup analysis: 1 RP vs NRP, outcome: 1.1 APPD. (**c**) Forest plot of comparison: 1 RP vs NRP, outcome: 1.2 DRF. (**d**) Forest plot of comparison: 1 RP vs NRP, outcome: 1.3 change in APPD. (**e**) Subgroup analysis: 1 RP vs NRP, outcome: 1.1 change in APPD. (**f**) Forest plot of comparison: 1 RP vs NRP, outcome: 1.4 change in DRF. (**g**) Subgroup analysis: 1 RP vs NRP, outcome: 1.1 change in DRF.

studies, with relatively small sample sizes and high risk of bias, limits the strength of the conclusions that can be drawn from this analysis. Additionally, the analysis primarily focused on short- to medium-term outcomes; long-term functional evaluations, ideally >12 months postoperatively, remain sparse. All of the patients in the included studies were paediatric and adolescent patients, with some studies not specifying if PUJO diagnosis was made prenatally or postnatally. Symptom control for symptomatic PUJO is a key outcome and determinant of surgical failure, which was not assessed in the included studies. Further high-quality, randomised controlled trials with longer follow-up are needed to definitively strengthen the evidence to support RP or NRP in the management of PUJO.

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None.

Disclosure of Interests

The authors declare that they have no financial, personal or other conflicts of interest in connection with the study. Involvement of the authors in this study is unbiased and based solely on professional and academic interest.

Ethical Approval

This study was granted a letter of exemption approved by the Institutional Ethics Review Committee of St. Luke's Medical Center, Quezon City, Philippines (Approval No: SL-23369).

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Abbreviations: AHDP, Anderson–Hynes dismembered pyeloplasty; APPD, anteroposterior pelvic diameter; DRF, differential renal function; NRP, non-reduction (pelvis-sparing) pyeloplasty; PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses; PUJO, PUJ obstruction; RevMan, ReviewManager; ROB 2, Cochrane Risk of Bias 2 (tool); RP, reduction pyeloplasty; RR, relative risk; SMD, standard mean difference; US, ultrasonography/ultrasonographic.

Supporting Information

Additional Supporting Information may be found in the online version of this article:

Fig. S1. Funnel plots.