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ORIGINAL ARTICLE

Ureterovesical anastomotic techniques for kidney transplantation: a systematic review and meta-analysis

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Summary

No consensus exists about which ureterovesical anastomosis technique to use for kidney transplantation. The aim of this systematic review was to compare the existing techniques in relation to the risk of urological complications. All studies that compared ureterovesical anastomotic techniques in kidney transplantation were included. Study endpoints were urinary leakage, ureteral stricture, vesicoureteral reflux and hematuria. Subanalyses of stented and nonstented techniques were performed. Two randomized clinical trials and 24 observational studies were included. Meta-analyses were performed on the Lich-Gregoir (LG) versus Politano-Leadbetter (PL) techniques and LG versus U-stitch (U) techniques. Compared with the PL technique, the LG technique had a significantly lower prevalence of urinary leakage (risk ratio (RR): 0.47, 95% confidence interval (CI): 0.30 to 0.75) and a significantly lower prevalence of hematuria when compared with both PL and U techniques (RR: 0.28, 95% CI: 0.16 to 0.49 and RR: 0.23, 95% CI: 0.11 to 0.50, respectively), regardless of ureteral stenting. There was no difference in the prevalence of ureteral strictures or vesicoureteral reflux between the various techniques. Of the three most frequently used ureterovesical anastomotic techniques, the LG technique results in fewer urological complications than the PL and U techniques.

Introduction

The most important surgical aspects of renal transplantation are the vascular and the ureterovesical anastomoses. The ureterovesical anastomosis is the most frequent source of morbidity following kidney transplantation. The mean prevalence of urological complications ranges between 3% and 5% [1]. However, prevalences between 1% and 30% have also been described [2–5]. Urological complications are urinary leakage, ureteral stricture, vesicoureteral reflux or significant hematuria. The ureterovesical anastomotic technique is an important aspect of kidney transplantation, which can influence the urological complication rate. Since the start of renal transplantation, a number of different ureteroneocystostomy techniques have been developed [6–10]. The most frequently used techniques are the intravesical Politano-Leadbetter (PL), the extravesical Campos Freire technique, better known as Lich-Gregoir (LG) and the Taguchi or U-stitch (U) technique [6,7,9–12]. Several studies have compared these techniques [13–38]. However, the effect of the ureterovesical anastomotic technique on the development of urological complications and which one is to be preferred continues to be a subject of discussion. Additionally, stenting of the ureterovesical anastomosis has been recognized as an independent protective factor in preventing the development of urological complications after kidney transplantation [1,39]. Unstented techniques are often compared with stented or partly stented techniques, which could introduce bias [14,17,24,32,37,38]. The aim of this systematic review was to summarize all randomized clinical trials (RCTs) and observational cohort studies on ureterovesical anastomotic techniques in relation to the risk of urological complications in kidney transplantation and in this way to ascertain which is the superior ureterovesical

anastomotic technique. The effect of stenting of the various ureterovesical anastomotic techniques was also assessed.

Patients and methods

This review was carried out in accordance with the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) statement [40]. Additionally, the Meta-analysis of Observational Studies in Epidemiology (MOOSE) proposal for reporting was used [41].

Inclusion criteria and outcomes

All studies designed to compare any possible variation of ureterocystostomy techniques in kidney-only transplantation were eligible for inclusion. Studies were included regardless of age of the acceptor, anatomical variants of the donor kidney or type of kidney graft. Only studies published in English-language journals were included. Studies that compared ureterovesical anastomostic techniques with ureteroureterostomy or pyeloureterostomy were excluded, as the focus was only on ureterovesicostomy techniques. Case reports were also excluded.

Outcome measures were urological complications that required intervention. These were ureteral leakage or fistula, ureteral stricture, vesicoureteral reflux and hematuria. Ureteral stricture included ureteral obstruction and stenosis. Only strictures located at the ureterovesical junction were included. Ureteropelvic stricture was not considered a relevant outcome measure. Clot retention that needed intervention was considered to be hematuria. Interventions were postoperative percutaneous and transvesical stenting of the ureter, percutaneous urine diversion, balloon dilatation, clot evacuation and surgical revision.

Search methods

Two researchers (VPA and RCM) independently performed a systematic literature search in the Cochrane Database of systematic reviews, the Cochrane central register of controlled trials, PubMed Medline (1946 to October 2012) and EMBASE (1980 to October 2012). The search terms used are presented in Table 1. To supplement the electronic searches, manual reference checks of the included papers were performed. No authors were contacted.

Titles and abstracts were screened independently by VPA and RCM to obtain abstracts of studies that may have been relevant to this review. If the abstracts appeared to meet the inclusion criteria, the full text was retrieved. Each article was independently assessed by two authors (VPA and RCM). The same authors independently carried out data extraction using standard data extraction forms. The inclusion of studies and the data retrieved were then discussed and agreed on. Study quality was assessed independently by VPA and RCM using the checklist for quality assessment developed by the Dutch Cochrane Centre [42]. The study was finally included after consensus was reached. If there were any differences of opinion, these were resolved by discussion between the researchers in a consensus meeting.

Table 1. Electronic search terms.

PubMed (last search October 2013)	EMBASE (1980 to October 2013)
Filter: English-language only	Limit to English language
#1. KIDNEY TRANSPLANTATION (MeSH)	1. Kidney transplantation/
#2. ((kidney transplant*) or (kidney next graft*))	2. (kidney transplant$ or renal transplant$).tw.
#3. ((renal next transplant*) or (renal next graft*))	3. (renal graft$ or kidney graft$).tw.
#4. (#1 or #2 or #3)	4. or/1-3
#5. URETER (MeSH)	5. ureter/
#6. URETERAL OBSTRUCTION (MeSH)	6. ureteral obstruction/
#7. ureter*	7. ureter$.tw.
#8. vesico*	8. vesico$.tw.
#9. (#5 or #6 or #7 or #8)	9. or/5-8
#10. ureteroneocystostom*	10. ureteroneocystostomy.tw.
#11. politano*	11. politano$.tw.
#12. leadbetter*	12. leadbetter$.tw.
#13. intravesical*	13. intravesical$.tw.
#14. lich*	14. lich.tw.
#15. gregoir*	15. gregoir.tw.
#16. extravesical*	16. extravesical$.tw.
#17. taguchi*	17. taguchi.tw.
#18. u-stitch*	18. u-stitch.tw.
#19. full-thickness*	19. full-thickness.tw.
#20. (#10 or #11 or #12 or #13 or #14 or #15 or #16 or #18 or #19)	20. or/10-19
#21. (#4 and #20)	21. and/4,20
#22. (#9 and #21)	22. 9 and 21
Results 236	Results 344

Surgical techniques

The PL technique utilizes a cranial cystotomy to access the interior of the bladder, and a second cystotomy to introduce the ureter into the bladder. The distal ureter is spatulated and sutured to the bladder mucosa. The detrusor muscle is subsequently closed over the anastomosis to create a tunnel with antireflux mechanism (Fig. 1) [12]. In the LG technique, the bladder mucosa is reached via a single cystotomy, and the distal ureter is sutured to the mucosa. Subsequently, a tunnel is created to prevent reflux (Fig. 2) [6,7,43]. The U-stitch technique is performed by placing one or two absorbable U-stitches at the distal tip of the ureter. After introduction of the ureter into the bladder, the sutures are brought through the bladder wall, fixing the

ureter to the bladder (Fig. 3) [8–11]. The full-thickness (FT) technique is an infrequently used technique in which the ureter is anastomosed to the full thickness of the bladder wall without the creation of a tunnel [17,19,44].

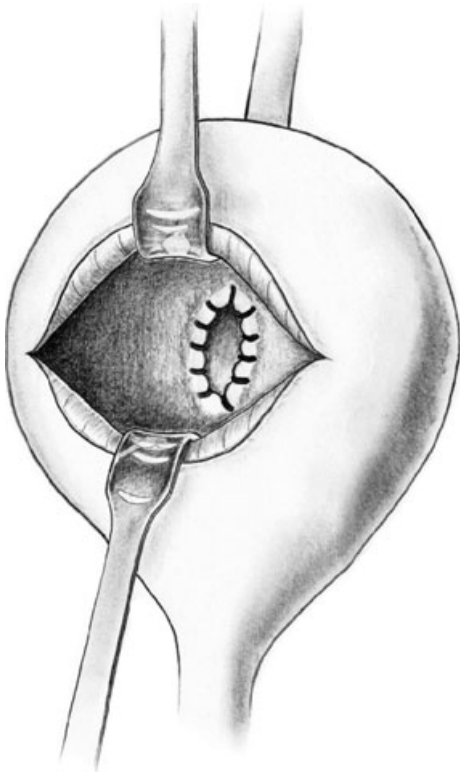

Figure 1 The Politano-Leadbetter technique.

Statistical analyses

Quantitative data were entered into and analyzed with the Cochrane Review Manager software (RevMan) version 5.1 (Copenhagen, The Nordic Cochrane Center, The Cochrane Collaboration, 2011). Data were pooled using the random effects model. The fixed effects model was also used to assess the robustness of the chosen model. Outcomes were expressed as risk ratio (RR) with a 95% confidence interval (CI) and a *P* value for overall effect. A *P* value below 0.05 was considered statistically significant. Heterogeneity was analyzed with the I^2 test, where 25%, 50%, and 75% correspond to low, intermediate, and high levels of heterogeneity, respectively. Forest plots were constructed for each analysis. To assess the amount of bias caused by differences in stent usage between the groups, a subgroup analysis for stented and unstented techniques was carried out. The unstented analysis included studies in which both techniques were completely without the use of ureteral stenting, whereas the stented analysis included studies with various stenting regiments.

Results

A total of 344 potentially relevant studies were identified. Eighty-four non-English-language studies were excluded. After screening the titles and abstracts, 39 studies were selected for further review, after which 13 more articles were excluded (Fig. 4). Twenty-six studies (12 947 patients) were included in this systematic review, of which two RCTs and 24 observational studies [13–38]. Study sizes varied

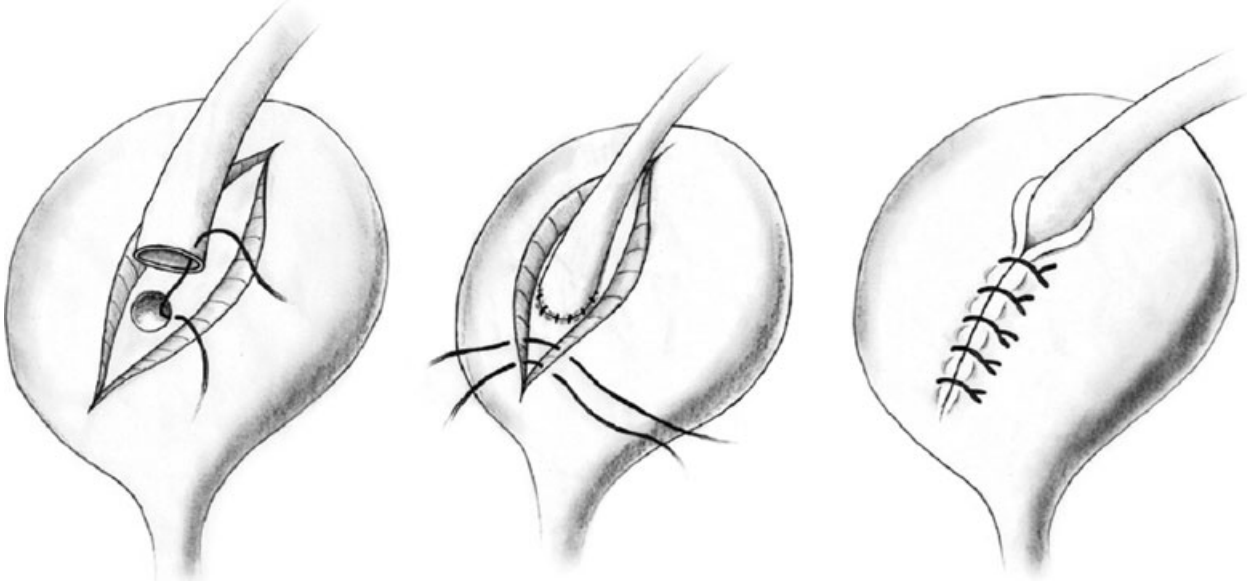

Figure 2 The Lich-Gregoir technique.

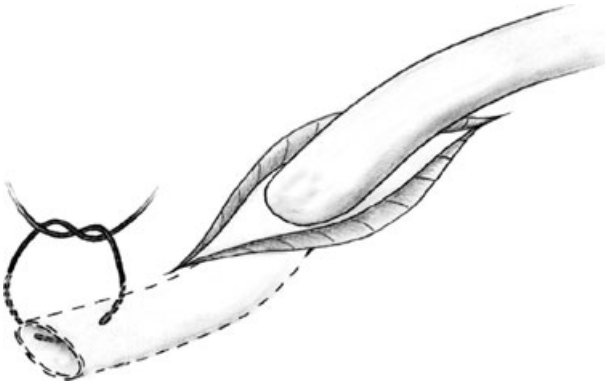

Figure 3 The U-stitch technique.

between 70 and 2548 patients. The characteristics of these studies are shown in Table 2. No dual publications were identified. The techniques for ureteroneocystostomy used in the articles included were categorized into four groups; the PL technique, the LG technique, the U technique and the FT technique. Variations and modifications of these techniques were included in the appropriate groups; the Barry technique was included in the LG group and the Taguchi, MacKinnon and Shanfield techniques were included in the U group [8–11,45]. Instead of one longer incision, Barry's parallel incision technique uses blunt dissection between two parallel bladder incisions to create an antireflux tunnel [45]. The use of ureteral stenting varied widely between studies. Four studies compared an unstented PL group with a stented LG group [14,25,32,38].

Study quality

Quality assessment on eight aspects is presented in Table 3. Study quality varied between one and seven points, with a higher number indicating better quality. Most studies included a consecutive cohort of kidney transplantations. Secin and Leungwattanakij excluded 22 and nine patients, respectively, mentioning 'nonreliable' or missing data without further specifying the nature of these data [26,29]. Most studies described the surgical techniques used. One study reported that it was comparing the LG technique with the PL technique. However, in their methods section, they describe the LG technique as a 'U-form transfixing suture through the bladder wall' to fix the ureter to the bladder. For this reason, we included these data in the U technique group [18]. Shah and Li Marzi assessed the Barry technique [13,34]. These data were included in the LG group. Taghavi assessed a modified LG technique with minimal bladder wall dissection [15]. These data were also added to the LG group.

All studies assessed only outcomes for which clinical intervention was indicated. Most studies did not routinely assess vesicoureteral reflux after kidney transplantation; therefore, it is only symptomatic reflux that is reported. In the RCTs, only Pleass and Waltke carried out randomization [17,21]. None of the studies used blinding.

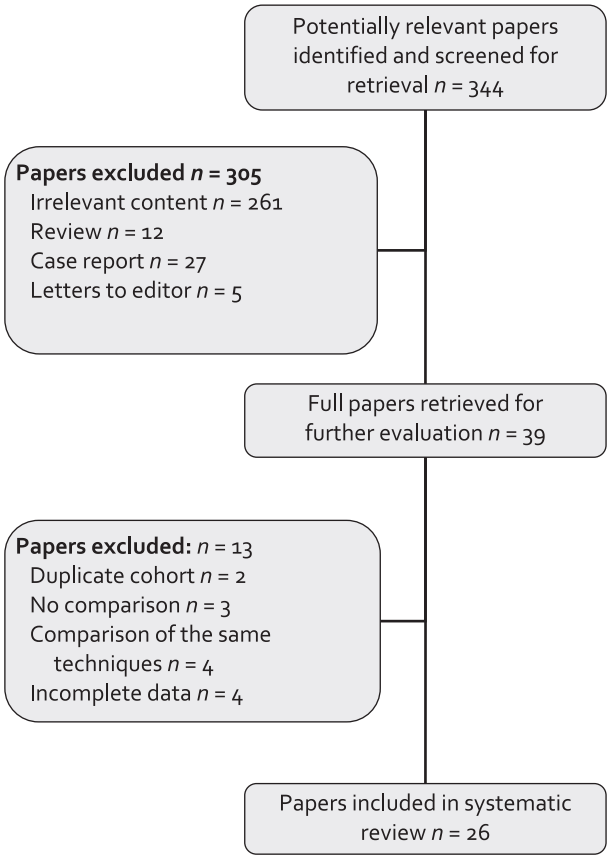

Figure 4 Flowchart of articles included in the systematic review.

Outcome variables

Twenty-three studies were included in the meta-analyses (Table 4) [13–16,20–38]. Data were pooled for the LG versus PL comparison and for the LG versus U comparison [13–16,20–38]. The mean prevalence of outcome variables is presented in Table 5.

There were significantly fewer ureterovesical anastomotic leakage events in the LG group than in the PL group (RR: 0.47, 95% CI: 0.30 to 0.75, $P < 0.01$, $I^2 = 37\%$). Subgroup analyses on ureteral stenting showed comparable results for both stented and unstented groups (Fig. 5). There was no significant difference in the prevalence of leakage between the LG and U techniques. However, there were significantly fewer cases of urinary leakage in the stented LG group (Fig. 6). Stricture at the ureterovesical junction was significantly less in the LG group than in the PL group (RR: 0.55, 95% CI: 0.39 to 0.76, $P < 0.01$,

Table 2. Characteristics of included studies.

				Number of patients							Study outcome			
Study	Year*	Country	Study type	PL	LG	U	FT	Stent†	Living donor‡	Follow-up§	Leakage	Stricture	Reflux	Hematuria
Kayler [19]	2012	USA	Cohort		307		327	LG: 95%, FT: 3%	LG: 25%, FT: 8%	>6	x	x		x
Ameer [33]	2011	Canada	Cohort		163	209		LG: 0%, U: 0%	LG: 37%, U: 35%	40		x		x
Whang [38]	2011	USA	Cohort	72	2476			PL: no stent, LG: stent	45%	NR	x	x	x	x
Tillou [24]	2009	France	Cohort	265	412			PL: 100%, LG: 92%	1%	NR	x	x		
Georgiev [14]	2007	Switzerland	Cohort	149	348			PL: no stent, LG: stent	PL: 9%, LG: 32%	>12	x	x		x
Lee [30]	2007	USA	Cohort		238	73		LG: 14%, U: 17%	LG: 27%, U: 7%	>33	x	x	x	x
Moreira [28]	2007	Portugal	Cohort		217	60		NR	NR	>24	x	x	x	
Pacovsky [37]	2007	Czech	Cohort		25	22		LG: 4%, U: 23%	NR	>27		x	x	
Veale [36]	2006	USA	Cohort		360	353		LG: 20%, U: 24%	LG: 43%, U: 47%	NR	x	x		x
Li Marzi [13]	2005	Italy	Cohort	199	260			PL: 100%, LG: 100%	1%	NR	x	x		
Taghavi [15]	2003	Iran	Cohort	50	472			PL: 100%, LG: 100%	NR	NR	x	x	x	
Tzimas [23]	2003	Canada	Cohort		148	64		LG: 0%, U: 0%	NR	31	x	x		x
Secin [26]	2002	Argentina	Cohort		416	159		LG: 0%, U: 0%	LG: 64%, U: 28%	62	x	x	x	x
Leungwattanakij [29]	2000	Thailand	Cohort	93	245			NR	39%	NR	x	x	x	x
Masahiko [20]	2000	Japan	Cohort	962	225			NR	PL: 87%, LG: 87%	>12	x	x	x	x
Butterworth [32]	1997	England	Cohort	140	108			PL: no stent, LG: stent	PL: 8%, LG: 15%	>3	x	x		x
Rizvi [27]	1996	Pakistan	Cohort	202	148			NR	PL: 100%, LG: 100%	NR	x	x		
Pleass [21]	1995	England	RCT	150	150			PL: 50%, LG: 50%	NR	>3	x	x		x
Hakim [22]	1994	USA	Cohort	410	295	478		NR	53%	NR	x	x		x
Jindal [35]	1994	USA	Cohort	116	69			PL: 0%, LG: 0%	PL : 27%, LG : 14%	NR	x	x	x	
Thrasher [25]	1990	USA	Cohort	160	160			PL: no stent, LG: stent	PL: 24%, LG: 13%	NR	x	x		
Shah [34]	1988	India	Cohort	125	125			NR	PL: 100%, LG: 100%	NR	x	x		
Belli [16]	1985	Italy	Cohort	185	115			NR	15%	NR	x	x		
Dohi [31]	1984	Japan	Cohort	21	49			NR	83%	NR	x	x		x
Waltke [17]	1982	USA	RCT	59			72	PL: no stent, FT: stent	PL: 0%, FT 0%	NR	x	x	x	
Hooghe [18]	1977	Belgium	Cohort	108		133		NR	PL: 20%, U: 4%	NR	x	x		
Total patients				3466	7531	1551	399							

PL, Politano-Leadbetter; LG, Lich-Gregoir; U, U-stitch; FT, Full-Thickness; NR, not reported; RCT, randomized controlled trial.

*Year is year of publication.

†Stenting in percentages, unless not specified.

‡Living donors in percentages, if specified.

§Median, in months.

Table 3. Quality assessment of included studies.

Study	Clear definition of study population	Can selection bias be excluded sufficiently?	Clear description of methods?	Clear definition of outcomes and their assessment?	Independent assessment of outcome parameters?	Follow-up of at least 6 months?	No selective loss to follow-up?	Important confounders identified?	Quality score*
Kayler [19]	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	7
Ameer [33]	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	7
Whang [38]	Yes	Yes	Yes	Yes	No	?	?	Yes	5
Tillou [24]	Yes	Yes	No	Yes	No	?	?	No	3
Georgiev [14]	Yes	Yes	No	Yes	No	?	?	Yes	4
Lee [30]	Yes	Yes	No	Yes	No	Yes	Yes	Yes	6
Moreira [28]	Yes	Yes	No	No	No	Yes	Yes	No	4
Pacovsky [37]	Yes	Yes	Yes	No	No	Yes	Yes	Yes	6
Veale [36]	Yes	Yes	Yes	Yes	No	?	?	Yes	5
Li Marzi [13]	Yes	Yes	No	No	No	?	?	Yes	3
Taghavi [15]	Yes	Yes	No	Yes	No	?	?	Yes	4
Tzimas [23]	Yes	Yes	No	Yes	No	Yes	?	Yes	5
Secin [26]	Yes	Yes	Yes	Yes	No	Yes	?	Yes	6
Leungwattanakij [29]	Yes	No	No	Yes	No	?	?	Yes	3
Masahiko [20]	Yes	Yes	Yes	No	No	?	?	Yes	4
Butterworth [32]	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	7
Rizvi [27]	Yes	No	No	No	No	?	?	No	1
Pleass [21]	Yes	Yes	Yes	No	No	No	?	No	3
Hakim [22]	Yes	Yes	Yes	Yes	No	?	?	?	4
Jindal [35]	Yes	Yes	Yes	Yes	No	?	?	Yes	5
Thrasher [25]	Yes	Yes	Yes	No	No	?	?	Yes	4
Shah [34]	Yes	Yes	No	No	No	?	?	?	2
Belli [16]	Yes	Yes	No	No	No	?	?	Yes	3
Dohi [31]	Yes	?	Yes	No	No	?	?	No	2
Waltke [17]	Yes	Yes	Yes	Yes	No	?	?	Yes	5
Hooghe [18]	Yes	Yes	Yes	No	No	?	?	Yes	4

*The study quality score was calculated by the number of questions answered with 'yes'?: Unclear.

Table 4. Meta-analyses and outcomes.

Analysis	Number of studies	Number of participants	Risk Ratio*	*P* value	I^2 test
Lich-Gregoir versus Politano-Leadbetter					
Urinary leakage	16	9024	0.47 (0.30–0.75)	0.002	37%
Ureteral stricture	15	8954	0.55 (0.39–0.76)	<0.001	3%
Vesicoureteral reflux	5	4848	0.83 (0.35–1.96)	0.67	0%
Hematuria	7	3345	0.28 (0.16–0.49)	<0.001	0%
Lich-Gregoir versus U-stitch					
Urinary leakage	6	2861	0.69 (0.36–1.32)	0.26	43%
Ureteral stricture	8	3280	0.92 (0.55–1.52)	0.74	21%
Hematuria	6	2956	0.23 (0.11–0.50)	<0.001	65%

*Risk ratios are presented with 95% confidence intervals in brackets.

$I^2 = 3\%$). However, subgroup analyses showed no differences in the prevalence of ureteral strictures between the PL and LG techniques if no ureteral stents were used (Fig. 7). There were no significant differences between the LG and U techniques in relation to ureteral stricture (Fig. 8). There were no significant differences between the LG and PL techniques for vesicoureteral reflux (Fig. 9). There were significantly fewer cases of hematuria in the LG group when compared to both the PL technique (RR: 0.28, 95% CI: 0.16 to 0.49, $P < 0.01$, $I^2 = 0\%$, Fig. 10) and the U technique (RR: 0.23, 95% CI: 0.11 to 0.50, $P < 0.01$, $I^2 = 65\%$, Fig. 11). Subgroup analyses of ureteral stenting showed comparable significant results for both stented and unstented groups.

There were not enough data to conduct a meta-analysis of the FT technique. The two studies that assessed the FT technique found no significant differences in overall urological complications on comparison with the PL and LG techniques [17,19]. However, one study did find a significantly lower number of ureteral strictures in the PL group than in the FT group [17]. One study compared the PL and U techniques and found a significant increase in urinary leakage where the PL technique was used (6.5% vs. 0.8%, $P < 0.01$) [18].

In the LG versus PL meta-analysis, there was a low level of heterogeneity ranging from 0% to 36%. There were minimal differences when the random effects model of the LG versus PL comparison was compared with the fixed effects model, which implies that important statistical heterogeneity is unlikely. The difference was slightly higher in the LG versus U comparison. The level of heterogeneity was intermediate in the LG versus U comparison (22% to 65%).

Table 5. Prevalence of urological complications in all included studies.

	Ureterovesical anastomotic technique		
Complication	PL	LG	U
Leakage	95/3299 (2.9%)	116/7104 (1.6%)	40/1187 (3.4%)
Ureteral stricture	106/3278 (3.2%)	138/7243 (1.9%)	52/1418 (3.7%)
Vesicoureteral reflux	20/1293 (1.5%)	85/3555 (2.4%)	
Hematuria	79/1925 (4.1%)	52/3040 (1.7%)	96/1336 (7.2%)

PL, Politano-Leadbetter; LG, Lich-Gregoir; U, U-stitch.

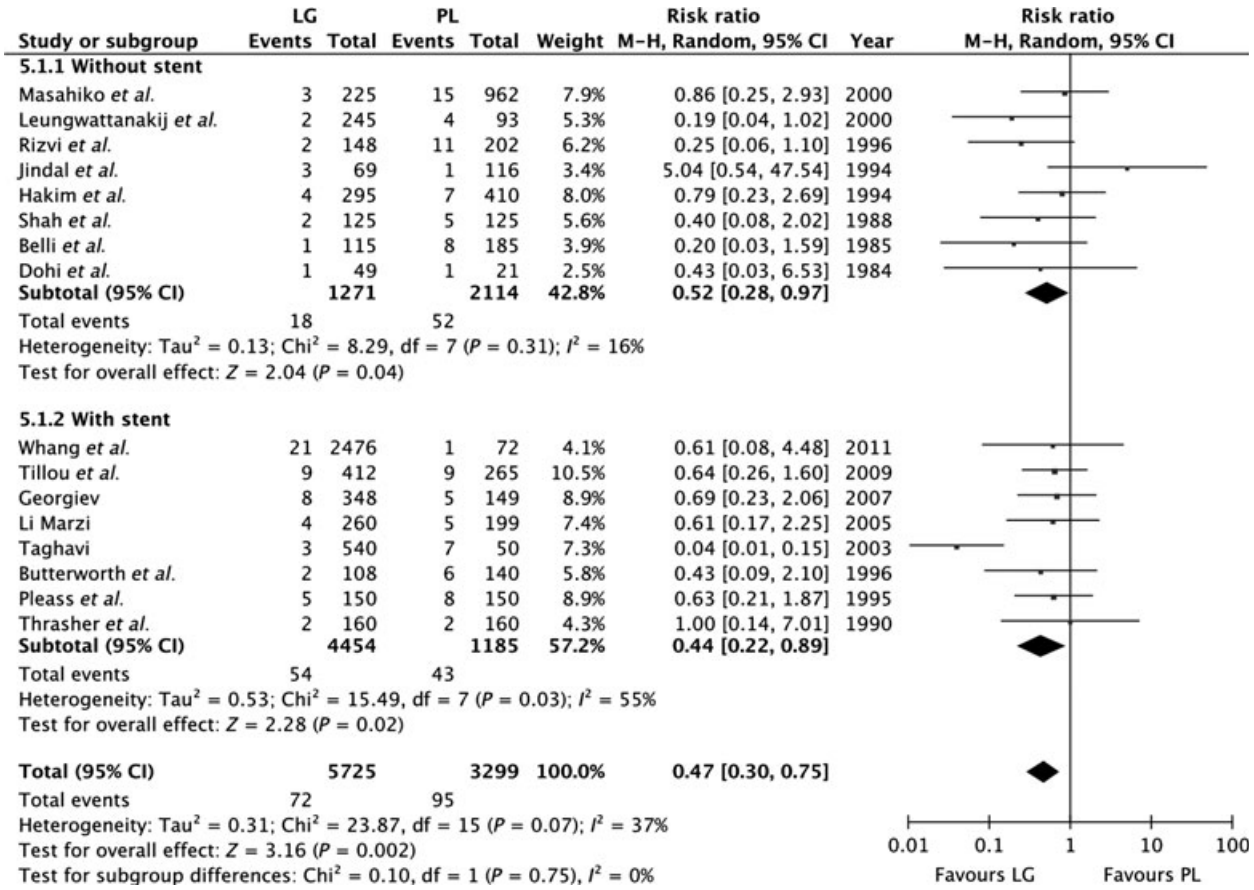

Figure 5 Forest plot Lich-Gregoir (LG) versus Politano-Leadbetter (PL); outcome leakage.

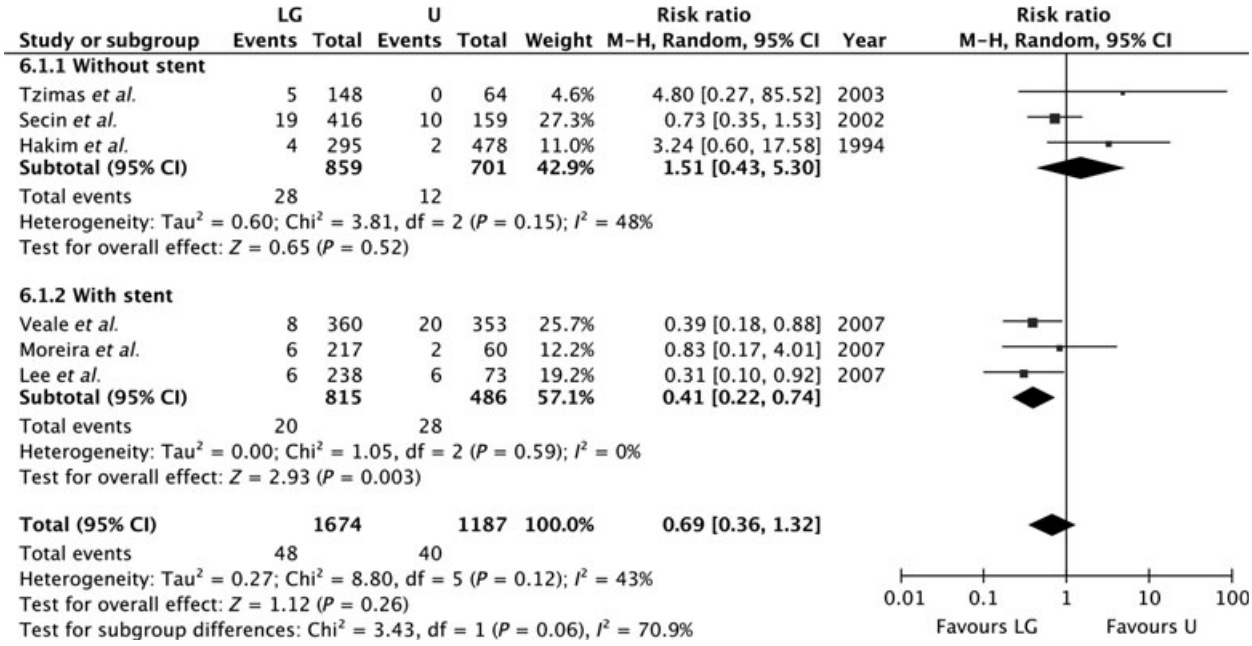

Figure 6 Forest plot Lich-Gregoir (LG) versus U-stitch; outcome leakage.

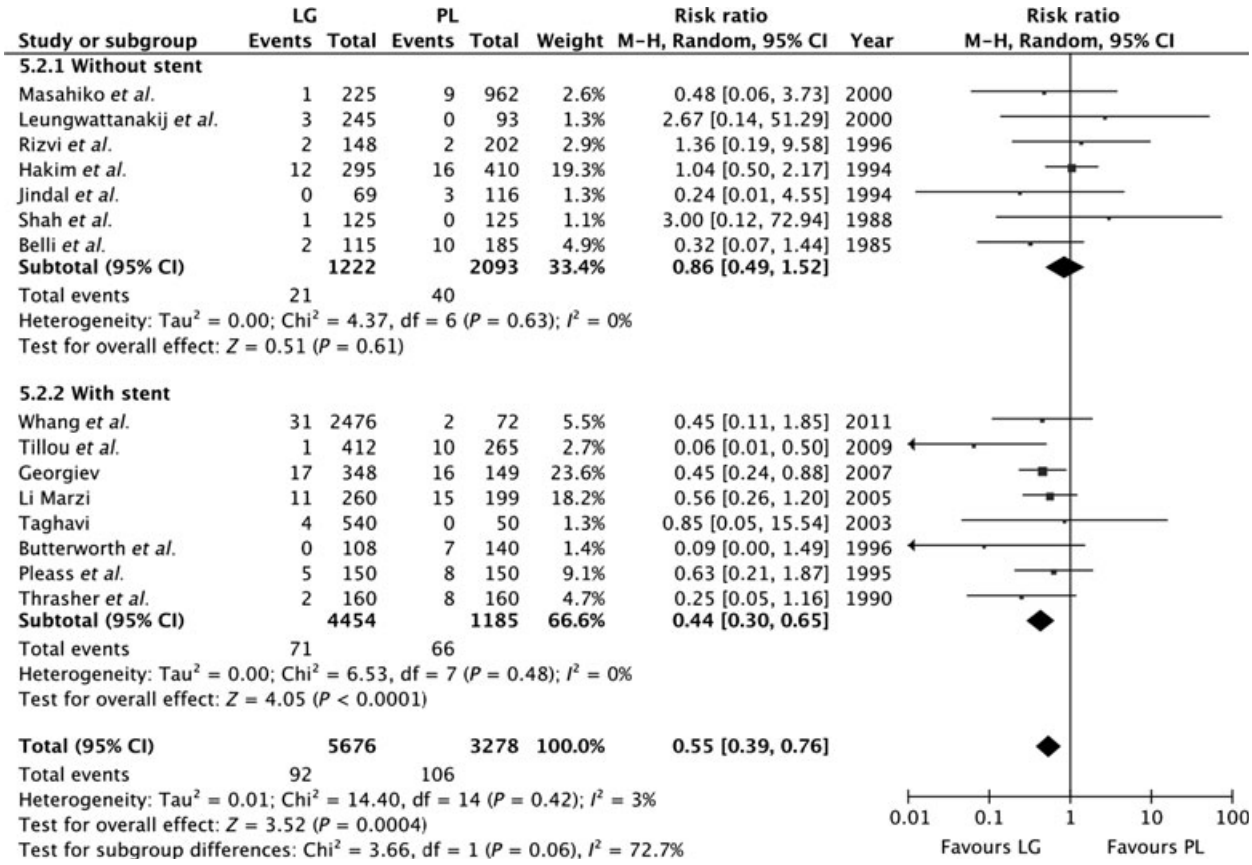

Figure 7 Forest plot Lich-Gregoir (LG) versus Politano-Leadbetter (PL); outcome ureteral stricture.

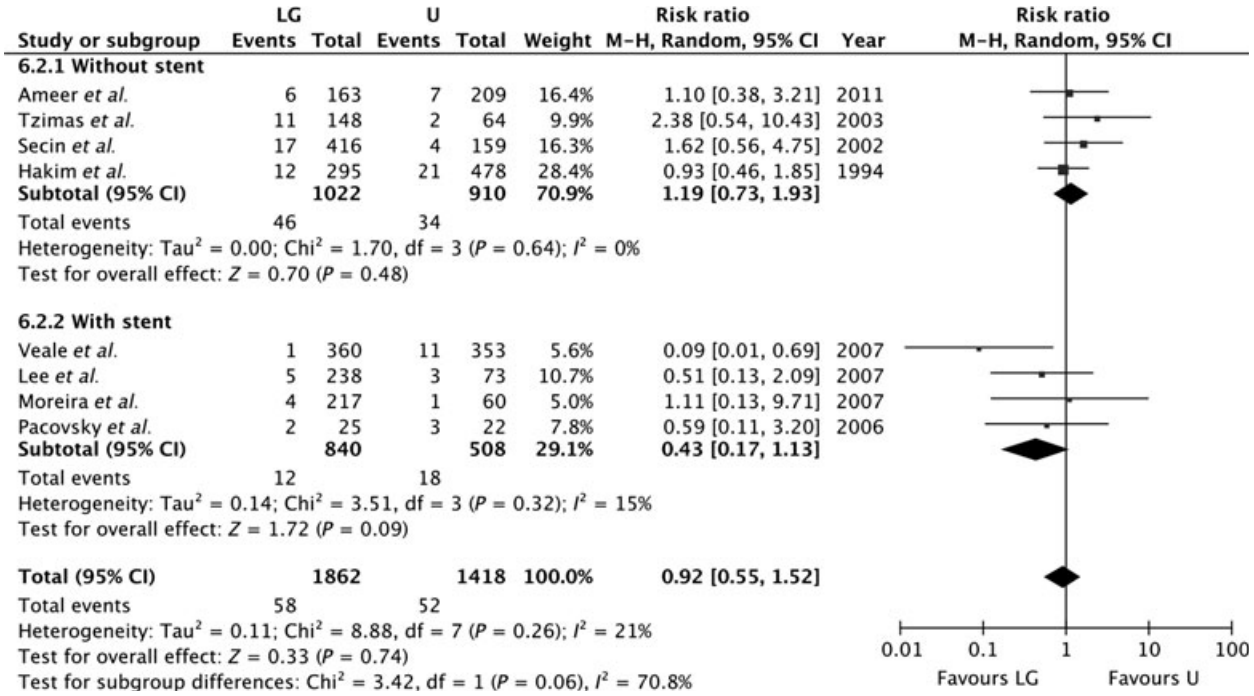

Figure 8 Forest plot Lich-Gregoir (LG) versus U-stitch; outcome ureteral stricture.

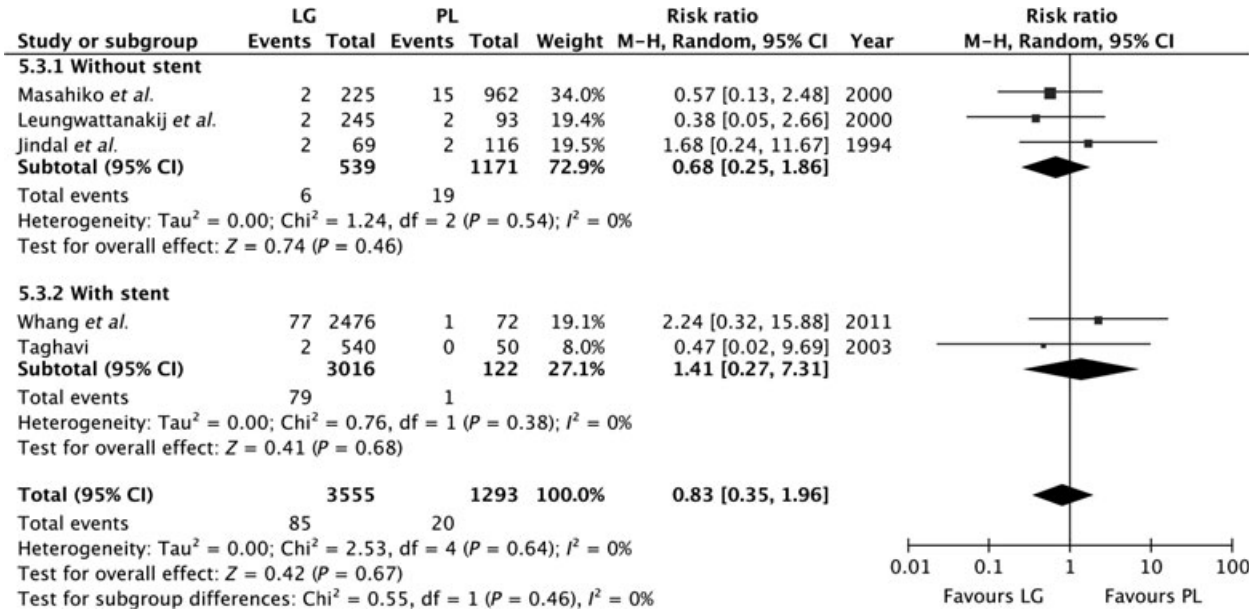

Figure 9 Forest plot Lich-Gregoir (LG) versus Politano-Leadbetter (PL); outcome vesicoureteral reflux.

Discussion

The LG technique significantly lowers the risk of ureteral leakage when compared with the PL technique and significantly lowers the risk of hematuria when compared with both the PL technique and the U technique in kidney transplantation. There were no differences in the prevalence of ureteral strictures and vesicoureteral reflux between the various techniques.

The higher risk of urinary leakage in the PL group might be the result of the second cystotomy, which creates a potential extra leakage site. Also, it is hypothesized that the

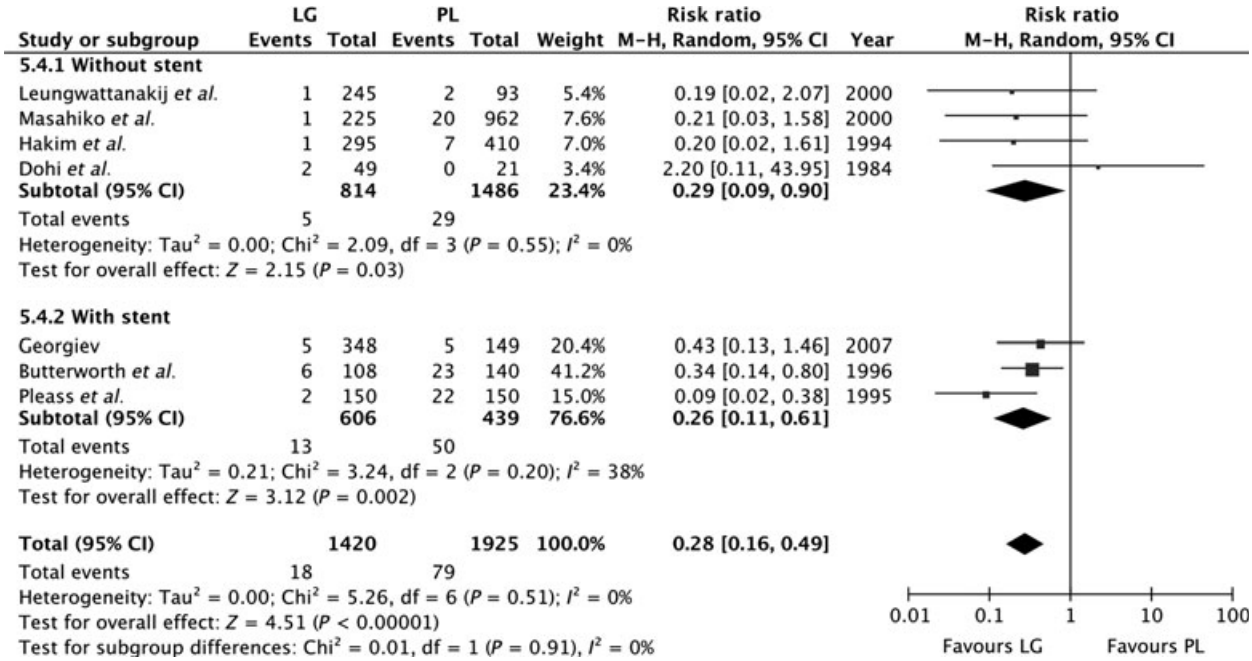

Figure 10 Forest plot Lich-Gregoir (LG) versus Politano-Leadbetter (PL); outcome hematuria.

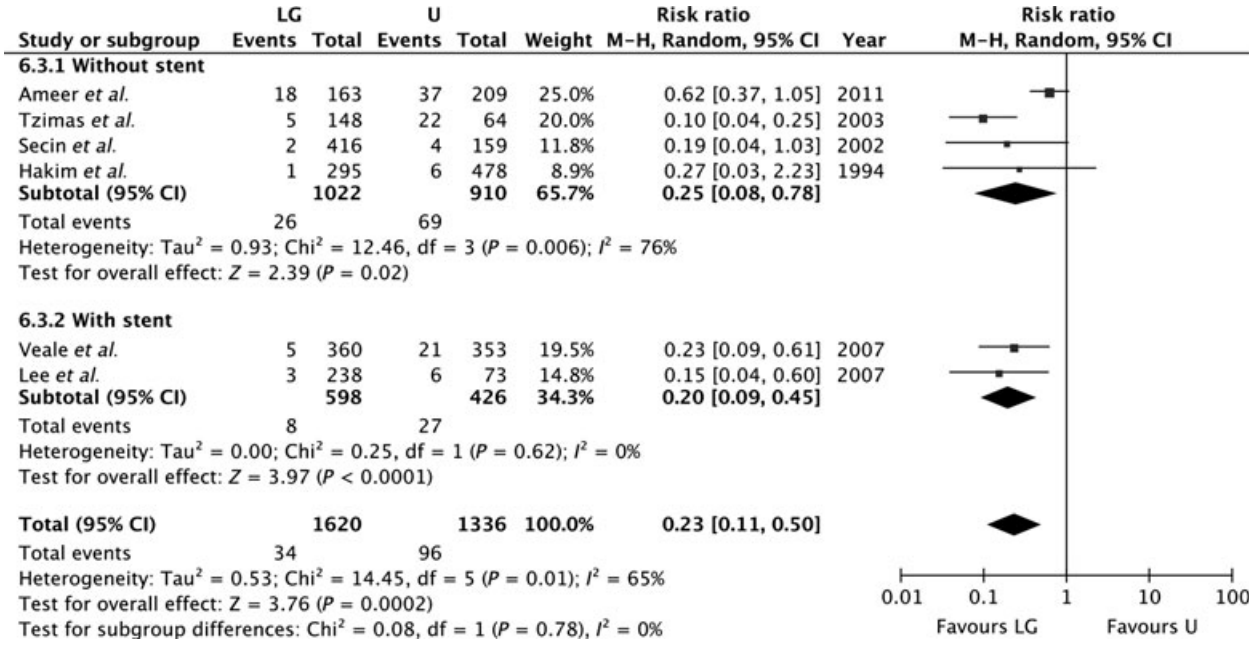

Figure 11 Forest plot Lich-Gregoir (LG) versus U-stitch; outcome hematuria.

use of a shorter segment of the ureter in the LG technique decreases the risk of distal ureteral necrosis and therefore results in a lower risk of urine leakage at the ureterovesical junction [20,46]. The higher rate of hematuria in the PL group might also be explained by the extra cystotomy, from which bleeding can arise. The increased rate of hematuria in the U group could originate in small longitudinal ureteral vessels. These vessels are more likely to be ligated in the process of creating an anastomosis with running sutures, whereas the U-stitch technique allows them to remain open. Urokinase in the urine may also compromise hemostasis in these small vessels. Ureterovesical reflux as

complication after kidney transplantation is considered controversial, as it usually causes no clinical symptoms. Some researchers suggest that it might significantly increase the risk of recurrent urinary tract infections and reflux nephropathy in the long term, however, without compromising long-term graft outcomes [47–49]. A study by Margreiter *et al.* has shown that vesicoureteral reflux has no effect on long-term outcomes after kidney transplantation, although this study has several limitations [50]. Owing to the difficulty to sufficiently detect vesicoureteral reflux and the disputable clinical implications, it was decided not to assess this outcome variable.

Ureteral stenting has a significant protective effect against the development of urological complications after renal transplantation, as described in a meta-analysis by Mangus *et al.* and a Cochrane review by Wilson *et al.* [1,39]. However, it remains debated if ureteral stenting is preferably performed by routine or that selective stenting of problematic anastomoses is sufficient [14,51,52]. Some studies have shown an increase in urinary tract infections (UTIs) with ureteral stenting [39,53–55]. Wilson *et al.* describes a relative risk of 1.49 (95% CI: 1.04 to 2.15) for UTIs with ureteral stenting, unless the patients were given prophylactic antibiotics, in which case the prevalence was equal to the nonstented group (RR: 0.97, 95% CI: 0.71 to 1.33) [39]. There were not enough data in the included studies to assess the effect of ureteral stenting on UTIs. Recognition of its benefits has led to an increase in ureteral stenting over the years. Differences in the prevalence of ureteral stenting may cause significant bias when comparing ureterovesical anastomotic techniques. During study assessment, many studies were found to contain different rates of ureteral stenting between study groups. When compared with the unstented PL group, ureteral stricture was significantly lower in the stented LG group, but comparable with the unstented LG group. Four studies compared an unstented PL group with a stented LG group [14,25,32,38]. Therefore, it is important to correct for stenting bias, as was performed in the current meta-analysis.

Recently, Slagt *et al.* conducted a systematic review and meta-analysis of the intravesical versus extravesical ureteroneocystostomy [56]. Their results are comparable with the PL versus LG comparison in the current meta-analysis. However, they did not compare the differing stenting regimens between the groups. They found a significantly lower prevalence of ureteral strictures in the extravesical group. However, these results may be biased by the differences in ureteral stenting, as shown in this systematic review. Another nonsystematic review compared four different techniques of ureterovesical anastomosis; the LG, PL, U, and FT techniques [46]. They found no significant differences in the prevalence of urological complications, with the exception of a higher prevalence of hematuria when using the U technique. Unfortunately, they did not conduct statistical analyses.

Limitations of the current systematic review may be caused by several sources of bias. The lack of a description of surgical methods might introduce bias, because one study reported on a ureterovesical anastomotic technique that appeared to be of a different type than stated in the article [18]. The majority of studies are observational, inducing potential selection and measurement bias. In the 1990s, many study centers changed the ureteroneocystostomy technique they used from PL to LG. This introduces a cohort effect bias when the techniques are compared, as other surgical techniques have also evolved. Additionally, the use of high-dose steroids during the precyclosporine era is associated with an increased rate of urological complications [57]. The prevalence of urological complications is influenced not only by the ureterovesical anastomotic technique but also by the quality of the implanted ureter, that is, ureteral length, peri-ureteral fat, peri-ureteral blood vessels, quality of the bladder, pre-existing uropathy, pre-transplant residual urinary output, as well as by the episodes of rejection. Additionally, the use of induction therapy, novel immunosuppressive regimens, ABO incompatible transplantation protocols and viral infections such as BK-polyomavirus-associated nephropathy may also have an influence on urological complications [58–60]. These variables are seldom reported and therefore could not be included in the analyses. The quality of included studies was reasonable to good. Most studies had a clear definition of study population and a clear description of their methods and outcomes. Most important confounders were identified. Follow-up was often not clearly reported. The year of publication ranged from 1977 to 2012. Although study quality varied widely, the outcome variables were clearly defined and objectively measurable. Therefore, it is not likely that the variation in study quality is of much influence on the results. There was an intermediate level of heterogeneity in the LG versus U comparison. This might introduce some bias in the results. The level of heterogeneity in the LG versus PL comparison was low.

This systematic review assessed all ureteroneocystostomy techniques used in kidney transplantation. When compared with both the PL technique and the U techniques, the LG ureterovesical anastomotic technique results in fewer postoperative urological complications. There is insufficient data to conduct a meta-analysis on the FT technique.

Authorship

VPA: performed study, collected data, wrote the paper. MMI, DAL, MPL: made significant intellectual contribution. RCM: designed study, performed study, collected data.

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