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ORIGINAL ARTICLE

Prostate Disease

Transurethral plasmakinetic resection of the prostate is a reliable minimal invasive technique for benign prostate hyperplasia: a meta-analysis of randomized controlled trials

Kai Wang[1,*], Yao Li[2,*], Jing-Fei Teng[3], Hai-Yong Zhou[1], Dan-Feng Xu[2], Yi Fan[1]

To evaluate the efficacy and safety of plasmakinetic resection of the prostate (PKRP) versus transurethral resection of the prostate (TURP) for the treatment of patients with benign prostate hyperplasia (BPH), a meta-analysis of randomized controlled trials was carried out. We searched PubMed, Embase, Web of Science and the Cochrane Library. The pooled estimates of maximum flow rate, International Prostate Symptom Score, operation time, catheterization time, irrigated volume, hospital stay, transurethral resection syndrome, transfusion, clot retention, urinary retention and urinary stricture were assessed. There was no notable difference in International Prostate Symptom Score between TURP and PKRP groups during the 1-month, 3 months, 6 months and 12 months follow-up period, while the pooled Q_{max} at 1-month favored PKRP group. PKRP group was related to a lower risk rate of transurethral resection syndrome, transfusion and clot retention, and the catheterization time and operation time were also shorter than that of TURP. The irrigated volume, length of hospital stay, urinary retention and urinary stricture rate were similar between groups. In conclusion, our study suggests that the PKRP is a reliable minimal invasive technique and may anticipatorily prove to be an alternative electrosurgical procedure for the treatment of BPH.

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Keywords: benign prostate hyperplasia; lower urinary tract symptoms; plasmakinetic resection of prostate; transurethral resection of prostate

INTRODUCTION

Lower urinary tract symptoms or LUTS is a common age-related disease affecting men. Enlargement of the prostate gland is mainly due to a histopathological condition known benign prostate hyperplasia (BPH), which is considered the main reason of LUTS and usually develops beyond the fourth decade of life, affecting about 50% men by the age of 60 years and 90% by the age of 85 years.[1,2] However, the statistic data in China show that the percentage of BPH in men aged 60 years is about 50%, and this figure rises to 83% in men aged 80 years.[3]

Various therapies are available for the treatment of BPH-related LUTS, including follow-up, drugs and surgical intervention.[4–6] Surgical treatment includes minimally invasive and open prostatectomy. Despite advances in minimally invasive therapies, transurethral resection of the prostate (TURP) remains the gold standard for treatment of BPH and represents one of the most common surgeries in the Western world.[7–10] Nevertheless, TURP-associated morbidity rate was reported to be 15%–18%, including clot retention, urethral stricture and TUR syndrome, etc.[11–13] This high morbidity rate fueled the interests of investigators to search for alternative procedures.

Plasmakinetic resection of prostate (PKRP) is a newly developed method in the field of transurethral surgery that uses bipolar energy to resect the enlarged prostate gland.[14] The plasmakinetic system enables to resect or vaporize the prostate tissue by creation of an ionized plasma corona, using an axipolar electrode and electro-conductive solutions.[15] The active and return electrodes of the loop bend in the same axis. The use of normal saline irrigation (NaCl 0.9%) instead of mannitol solution to decrease the morbidity associated with TUR syndrome, and prolonged resection time are the two main supposed advantages. However, the real advantage of PKRP over conventional TURP and whether PKRP can replace TURP as the first-line urological intervention remain to be determined. The aim of this meta-analysis was to evaluate these two techniques by comparing the efficacy and safety in patients with BPH-related-LUTS.

PATIENTS AND METHODS

Publication search

Relevant studies were identified and selected by searching the electronic databases, PubMed, Embase, Web of Science and the Cochrane Library

[1]Department of Urology, Zhejiang Xiaoshan Hospital, Hangzhou 311202, China; [2]Department of Urology, Shanghai Changzheng Hospital, Second Military Medical University, Shanghai 200003, China; [3]Department of Urology, General Hospital of Beijing Military Command, Beijing 100700, China.
*These authors contributed equally to this work.
Correspondence: Dr. Y Fan (fanyi@zjxsh.com) or Dr. DF Xu (xu-danfeng@hotmail.com)
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under the search words "pasmakinetic resection of the prostate," "PKRP," "TURP" and "TURP." We also did a full manual search of references in each relevant article. The article language was restricted to English only. All relevant studies comparing PKRP and TURP were selected in further screening (**Table 1**).

Table 1: Searching strategies and results

Database	*Date*	*Search strategy*	*Results*
PubMed	Up to April 2014	Plasmakinetic AND ("transurethral resection of the prostate" or TURP)	72
Embase	Up to April 2014	Plasmakinetic: abstract, title AND ("transurethral resection of the prostate": abstract, title or TURP: abstract, title)	81
Web of science	Up to April 2014	TS=Plasmakinetic AND TS=("transurethral resection of the prostate" or TURP)	67
Cochrane library	Up to April 2014	Plasmakinetic AND ("transurethral resection of the prostate" or TURP)	26

TURP: transurethral resection of the prostate

Inclusion and exclusion criteria

The following inclusion criteria were applied: (i) randomized clinical trials (RCTs) comparing PKRP and TURP; (ii) BPH with LUTS; and (iii) the International Prostate Symptom Score (IPSS) ≥8 and a maximum flow rate (Q_{max}) <15 ml s^{-1}. The exclusion criteria were documented or suspected prostate carcinoma and neurogenic bladder disorders.

Quality assessment of included studies

Two primary investigators completed this procedure from sources mentioned above and all disagreements were resolved by consensus. The methodological quality of RCTs included was scored with the Jadad composite scale.[16,17] This is a five-point scale, where a score ≤ 2 indicates a low quality while a score ≥ 3 indicates a high quality.[17,18] This procedure was independently carried out by two investigators, and any disagreement was resolved by consensus.

Data extraction

Two investigators identified and enrolled all the relevant studies from the sources mentioned above according to the inclusion criteria. Data were extracted and tabulated from each

Table 2: Baseline characteristics of included studies

Studies	*Treatments*	*Number of patients*	*Q_{max} (ml s^{-1})*	*PVR (ml)*	*QoL*	*IPSS*	*Publication type*	*Jadad score*
Iori *et al.*[22]	TURP	26	8.7±2	96±97	3.6±1	20±4	RCT	3
	PKRP	27	7±1	99±58	3±1	21±2		
Seckiner *et al.*[29]	TURP	24	8.3±3.1	138±115		23.2±4.9	RCT	3
	PKRP	24	8.5±2.9	88±74		24.1±5.2		
Autorino *et al.*[24]	TURP	35	6.2±3	75±35.5	3.9±1	24.3±5	RCT	3
	PKRP	35	7.1±2	80±22.5	4.2±1	24.2±4		
Bhansali *et al.*[25]	TURP	33	4.194±1.5046				RCT	3
	PKRP	34	4.367±1.1813					
Muslumanoglu *et al.*[26]	TURP	33					RCT	3
	PKRP	34						
Nuhoglu *et al.*[23]	TURP	30	7.3±2.1	88±20		17.3±5.8	RCT	3
	PKRP	27	6.9±2.8	96±27		17.6±6.1		
Patankar *et al.*[28]	TURP	51	6.4±1.77			23.73±4.6	RCT	3
	PKRP	52	5.9±1.98			23.3±4.85		
de Sio *et al.*[37]	TURP	35	6.3±3	75±35.5	3.9±1	24.3±5	RCT	3
	PKRP	35	7.1±2	80±22.5	4.2±1	24.18±4		
Erturhan *et al.*[27]	TURP	120	9.2±1.7	135±25	3±1	24±6	RCT	3
	PKRP	120	10.9±1.2	114±19	2±1	23±5		
Lv *et al.*[34]	TURP	136	7.2±1.4	75.5±20.2	4.9±1.0	27.2±3.0	RCT	3
	PKRP	193	7.4±1.1	74.9±18.6	4.7±0.8	27.6±3.5		
Sinanoglu *et al.*[35]	TURP	85	8.5±2.73	120.8±59		18.6±7.8	RCT	3
	PKRP	80	8.4±4.2	131.2±74.3		25.6±7.6		
Huang *et al.*[33]	TURP	65	6.95±2.47		4.14±0.95	22.09±3.72	RCT	3
	PKRP	71	6.73±2.43		4.23±0.87	23.38±3.64		
Tefekli *et al.*[36]	TURP	47	8.3±3.6			20.4±3.5	RCT	3
	PKRP	49	7.8±3.7			21.3±3.2		
Giulianelli *et al.*[32]	TURP	80	6.5±4.8	187±195	3.0±2.5	23.4±1.8	RCT	3
	PKRP	80	8.9±2.9	243±241.6	3.3±2.1	22.3±3.2		
Akçayöz *et al.*[30]	TURP	21					RCT	3
	PKRP	21						
Kong *et al.*[39]	TURP	51	4.60±1.61	103±24.83	4.51±0.76	23.9±4.32	RCT	3
	PKRP	51	4.99±1.48	107±28.01	4.47±0.81	23.3±4.77		
Yoon *et al.*[38]	TURP	53	8.4±2.0		4.5±1.2	19.9±4.8	RCT	3
	PKRP	49	8.7±2.7		4.1±1.0	18.7±4.5		
Engeler *et al.*[31]	TURP	101	9.1±6.2	195±361	3.6±1.7	18.2±5.5	RCT	3
	PKRP	111	8.3±4.9	186±253	3.0±2.1	18.4±6.2		

TURP: transurethral resection of the prostate; PKRP: transuretheral plasmakinetic resection of the prostate; PVR: postvoiding residual; QoL: quality of life; IPSS: International Prostatic Symptom Score; RCTs: randomized controlled trials

eligible article. The following variables were involved: authors, journal and year of publication, number of patients, Q_{max}, IPSS, operation time, catheterization, hospital stay, irrigated volume, clot retention, transfusion, TUR syndrome, urethral stricture and urinary retention.

Statistical analysis

A formal meta-analysis was made of all RCTs comparing the efficacy and safety of PKRP with those of TURP treating patients with LUTS/BPH. Review Manager Software (version 5.1 Cochrane Collaboration, Oxford, UK) was used to analyze the risk ratio for dichotomous outcomes and mean or standardized mean difference for continuous data, with 95% confidence intervals. When the heterogeneity appears in a meta-analysis, a random-effect model (DerSimonian-Laird method) was used to calculate pooled estimates; otherwise, a fixed-effect model (Mantel-Haenszel method) was applied according to heterogeneity.[19] The significance of pooled effects was determined by the *Z*-test and $P < 0.05$ was considered to display statistical significance.[20,21] The Cochrane Chi-squared test was used to assess the heterogeneity between trials and the inconsistency (I^2) statistic to assess the extent of the inconsistency. $P < 0.10$ was considered as the presence of heterogeneity while I^2 was considered acceptable heterogeneity.

RESULTS

We identified 133 potential articles after a primary search in the database, and 18 RCTs,[22–39] including a total of 2119 patients enrolled in this meta-analysis (**Figure 1**). **Table 2** summarizes the preoperative baseline characteristics of included studies. The results of quality assessment of RCTs are shown in **Table 3**. The 18 RCTs all got a Jadad score of 3, because it was not possible to made double-blinding for RCTs. There were no significant differences in IPSS between the two groups at 1-month, 3 months, 6 months and 12 months after operation (**Figure 2**). The pooled Q_{max} at 1-month suggesting that the PKRP group was statistically superior to that of TURP group, but the pooled Q_{max} between the two groups at 3 months, 6 months, 12 months was no noticeable differences. However, the heterogeneity between the studies was clear (**Figure 3**).

Catheterization was remarkably less frequent in PKRP group than that in TURP group, operation time and hospital stay was shorter in PKRP group, while there was no notable difference in other perioperative data such as irrigated volume between the two groups. In addition, there was great heterogeneity between the studies (**Figure 4**).

There was a remarkable difference in TUR syndrome, clot retention and transfusion rate between TURP and PKRP groups. However, there was no notable difference in urinary retention and urethral stricture between the two groups (**Figure 5**). There was no heterogeneity.

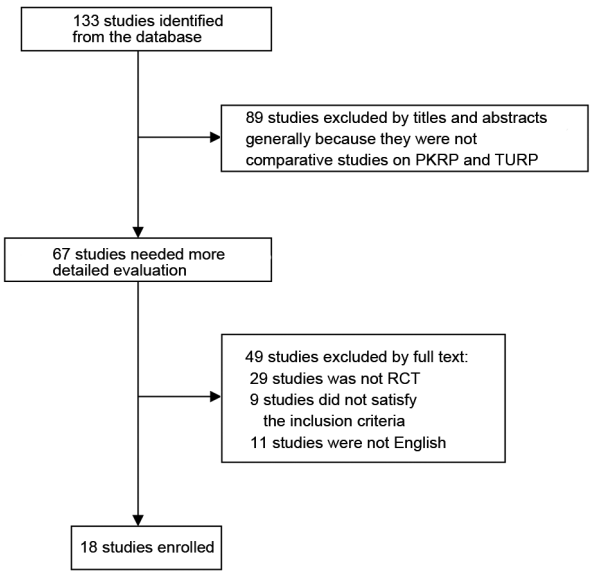

Figure 1: Flowchart showing the selection of studies for meta-analysis.

Table 3: The Jadad scale for quality assessment of RCTs

Studies	*Was the study described as randomized (e.g., using the words randomly, random and randomization)?*	*Was the method of randomization described and appropriate (e.g., table of random numbers, computer-generated)?*	*Was the study described as double-blind?*	*Was the method of blinding described and appropriate (e.g., identical placebo, active placebo, dummy)?*	*Was there a description of withdrawals and dropouts?*	*Total*
Iori *et al.*[22]	1	1	0	0	1	3
Seckiner *et al.*[29]	1	1	0	0	1	3
Autorino *et al.*[24]	1	1	0	0	1	3
Bhansali *et al.*[25]	1	1	0	0	1	3
Muslumanoglu *et al.*[26]	1	1	0	0	1	3
Nuhoglu *et al.*[23]	1	1	0	0	1	3
Patankar *et al.*[28]	1	1	0	0	1	3
de Sio *et al.*[37]	1	1	0	0	1	3
Erturhan *et al.*[27]	1	1	0	0	1	3
Lv *et al.*[34]	1	1	0	0	1	3
Sinanoglu *et al.*[35]	1	1	0	0	1	3
Huang *et al.*[33]	1	1	0	0	1	3
Tefekli *et al.*[36]	1	1	0	0	1	3
Giulianelli *et al.*[32]	1	1	0	0	1	3
Akçayöz *et al.*[30]	1	1	0	0	1	3
Kong *et al.*[39]	1	1	0	0	1	3
Yoon *et al.*[38]	1	1	0	0	1	3
Engeler *et al.*[31]	1	1	0	0	1	3

RCTs: randomized clinical trials

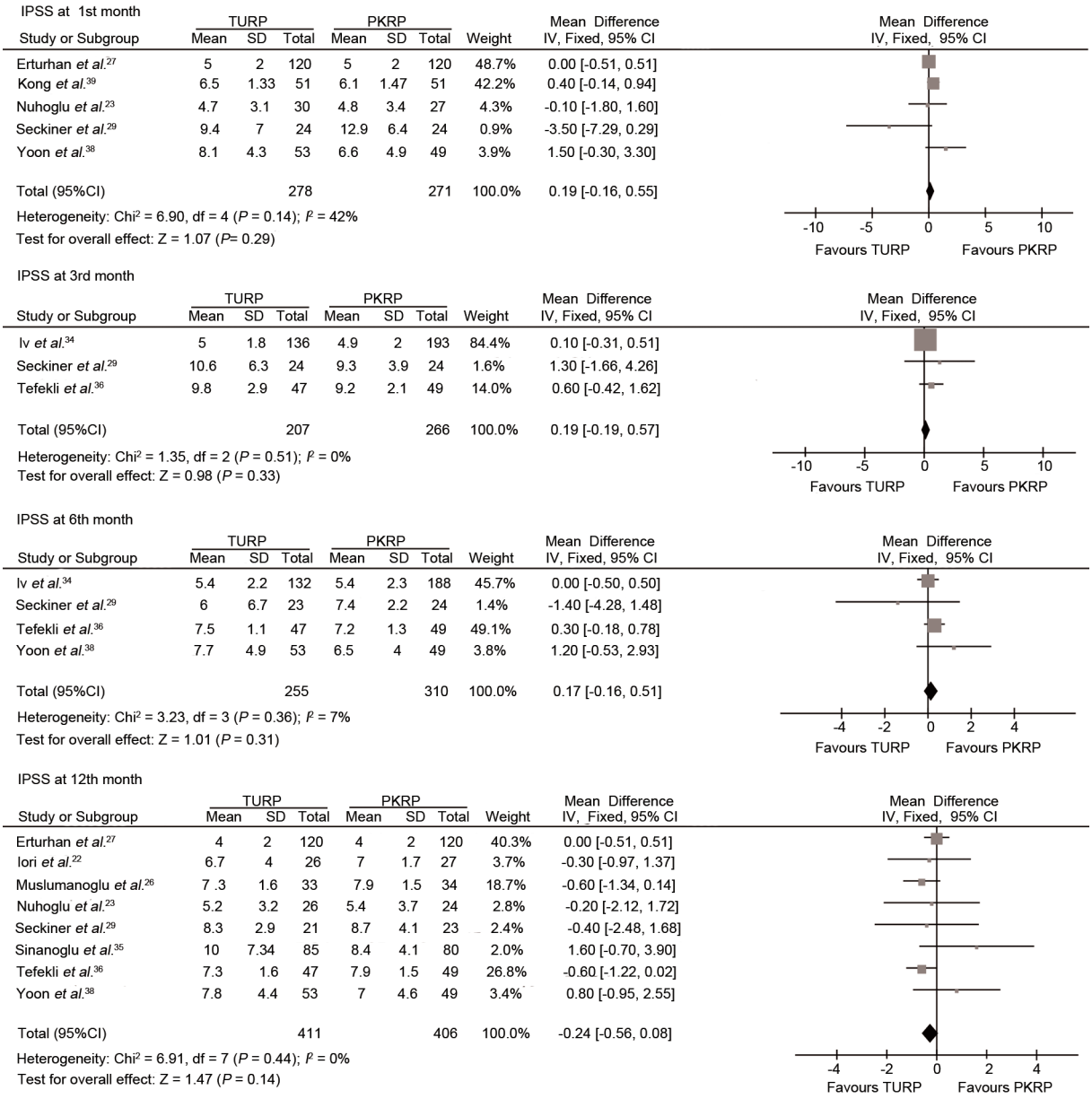

Figure 2: Pooled estimates of International Prostate Symptom Score at 1-month, 3 months, 6 months and 12 months follow-up.

DISCUSSION

Although, TURP is considered safe and effective method for the treatment of LUTS secondary to BPH and has been regarded as the reference standard for decades, its morbidity and related mortality remain a clinical challenge for urologists. Many attempts have been made to search surgical alternatives or advance new resectoscope and electrosurgical devices[22] such as holmium laser enucleation of the prostate, photoselective vaporization of the prostate and thulium laser resection of the prostate, all of which are considered extremely promising technologies.[40–42]

Plasmakinetic resection of the prostate is another novel electrosurgical technique that was first used for BPH therapy in 2001.[23] Many studies have already proven the efficacy and safety of PKRP.[22–29] In our meta-analysis, we have displayed the overall efficacy and safety of PKRP compared with TURP.

Monopolar TURP has a limitation in treating large prostates, especially those larger than ≥ 80 ml, because it requires a longer operation time. In addition, some irrigation fluid may enter the circulation via the prostate blood vessels opened, eventually leading to the development of the TUR syndrome. Although rare, TUR syndrome is the most dreaded complication of monopolar TURP. The Gyrus PlasmaKinetic System uses a bipolar coaxial system with an active and return electrodes placed on the same axis separated by a ceramic insulator,[24] so the system permits an effective operation because it is immersed in conductive normal saline as the irrigation fluid rather than in glycine or sorbitol. As a result, it decreases the risk of dilutional hyponatremia and TUR syndrome. The present meta-analysis showed that the PKRP group was remarkable shorter in operation time. The reason may be that urologists were now skilled in PKRP, compared with TURP. The rate of TUR syndrome was notably lower in PKRP

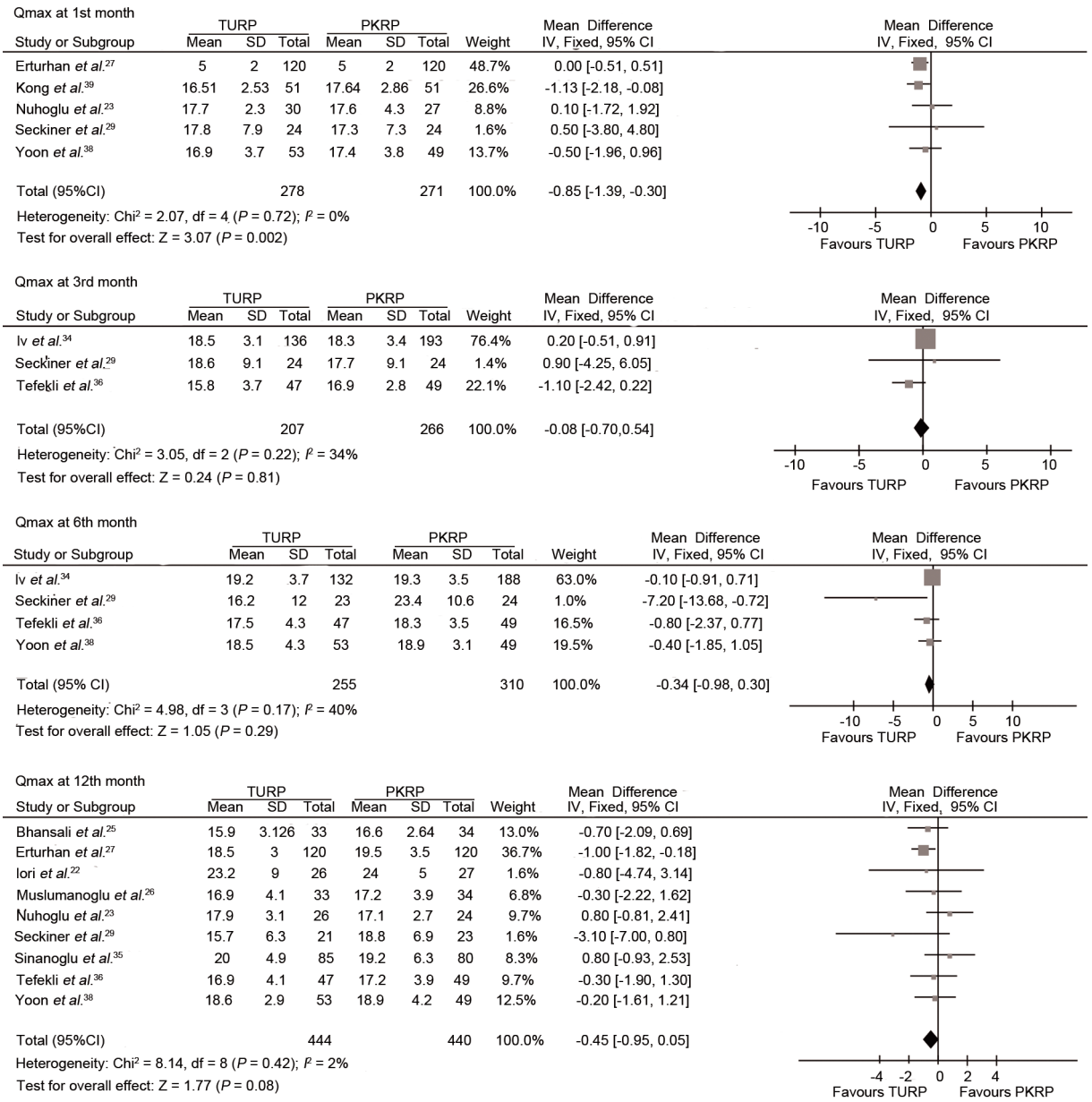

Figure 3: Pooled estimates of Qmax at 1-month, 3 months, 6 months and 12 months follow-up.

group than that in TURP group. None of 595 patients in PKRP group developed TUR syndrome. This could be an advantage for procedures with large prostate glands. The complication of urinary stricture was probably related to high ablative energy and violent manipulation. The early irritative symptoms and urinary retention were mainly attributed to urethral edema and obstruction of the residual prostate tissue. There was no statistical difference in the two complications between the two groups. However, there was more clot retention in TURP group than that in PKRP group because of greater thermal damage and more granulation tissue induced by the monopolar current.

Although the catheterization time in PKRP group was remarkably shorter than that in TURP group, there was no statistical difference in bladder irrigation volume between the two groups ($P = 0.14$), nor was there statistical difference in hospital stay ($P = 0.04$). The pooled estimates of our meta-analysis gave similar results for PKRP and TURP in IPSS (1-month, 3 months, 6 months and 12 months), but the Q_{max} (1-month) was noticeably higher in PKRP group.

Some authors have argued about excessive blood loss in conventional TURP. Bhansali *et al.*[25] reported that blood loss in TURP group was remarkably higher than that in PKRP, and even higher in cases of larger prostate glands. Nuhoglu *et al.*[23] believed that less bleeding should be expected in PKRP technique because it both resects the prostate tissue and can controls bleeding. de Sio *et al.*[37] reported that the mean decrease in hemoglobin level 24 h after operation was lower in PKRP, though the difference was not statistically notable when compared with TURP group.

There are two limitations in our meta-analysis. First, the follow-up periods were not long enough. Only one study[26] reported a 100 months

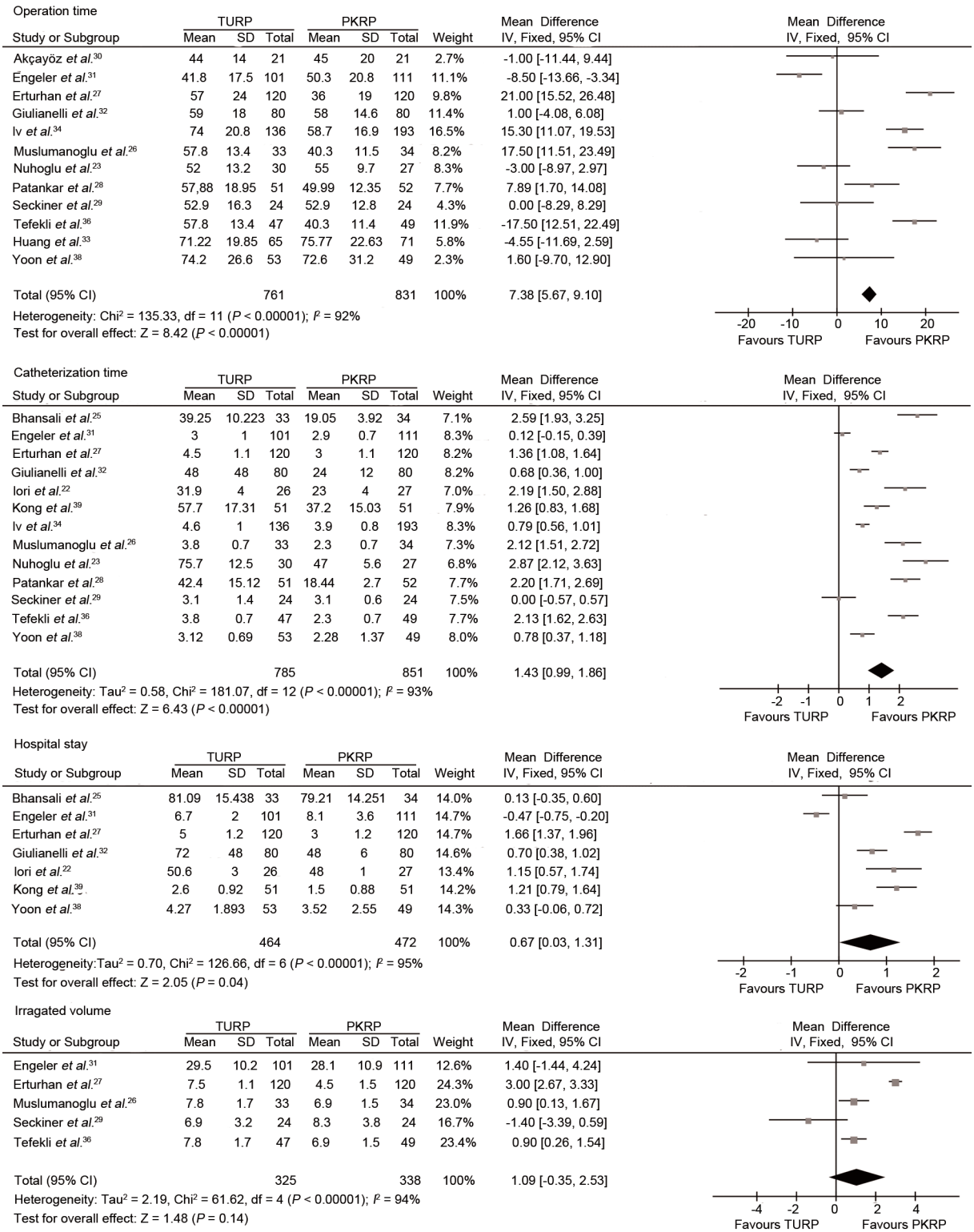

Figure 4: Pooled estimates of perioperative variables.

follow-up period, while the other studies had only 1-year follow-ups without including PVR and QoL. Thus, we were unable to evaluate the long-term efficacy and safety of PKRP. Secondly, the complications were not described sufficiently, such as sexual dysfunction, bladder neck contracture and the re-intervention rate.

CONCLUSION

The advantage of PKRP over TURP seems to lie in decreasing the risk of TUR syndrome, reducing the time of operation, catheterization and hospital stay, lowering the incidence of transfusion and clot retention, and increasing Q_{max} (1-month). IPSS (1-month,

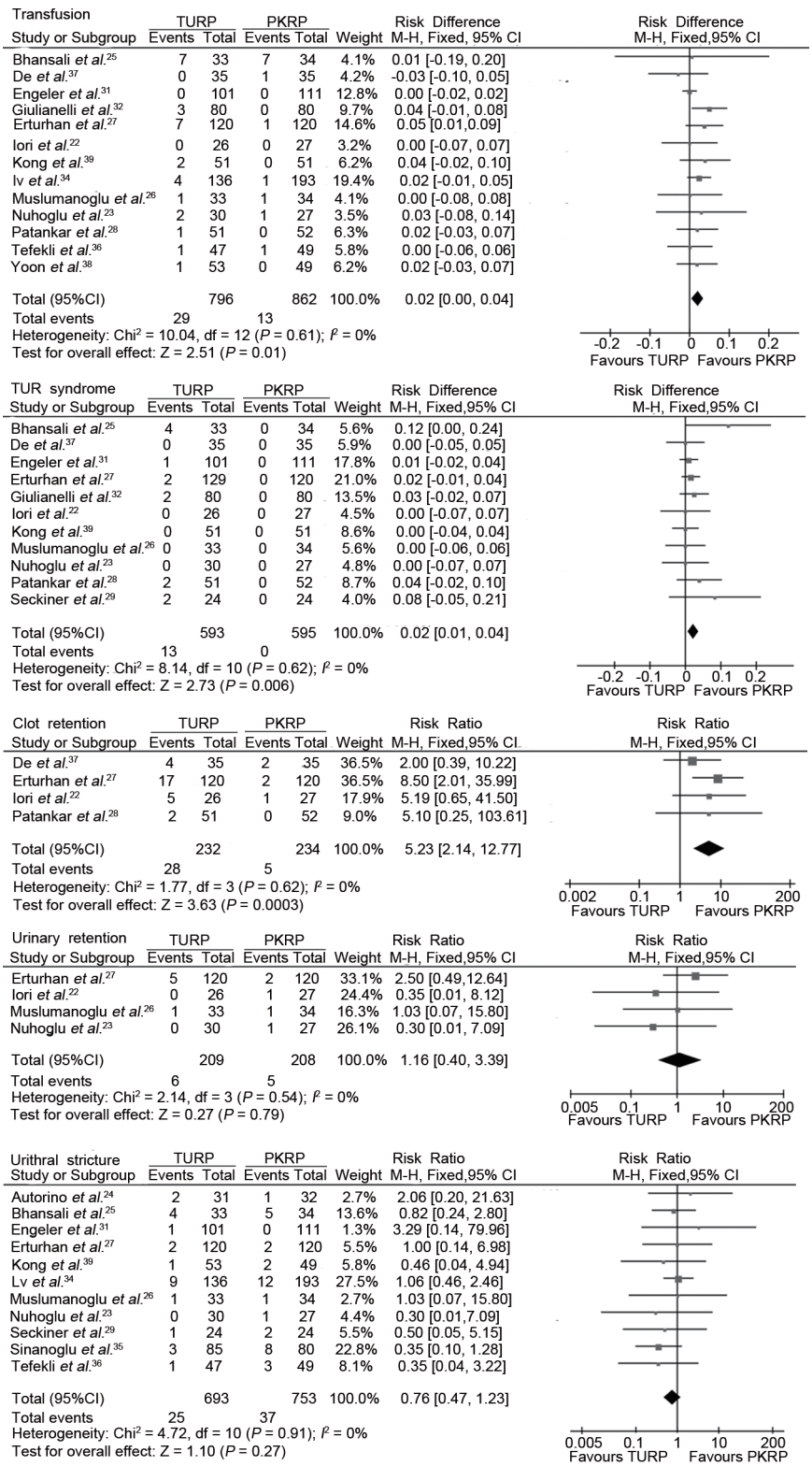

Figure 5: Pooled estimates of adverse events.

3 months, 6 months and 12 months), Q_{max} (3 months, 6 months and 12 months), urinary retention rate, urinary stricture rate, irrigation volume in PKRP group were similar to those in TURP group. PKRP may anticipatorily prove to be a reliable minimal invasive technique and an alternative electrosurgical procedure for treating BPH.

AUTHOR CONTRIBUTIONS

KW and YL contributed to the conception, design, acquisition, analysis and interpretation of data, drafting the manuscript, critical revision for important intellectual content. JFT participated in the design of the study and performed the statistical analysis. HYZ contributed to the acquisition of data. DFX and YF evaluated the results and supervised the project. All authors read and approved the final manuscript.

COMPETING FINANCIAL INTERESTS

All authors declare no competing interests.

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