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META-ANALYSIS

# Prostate artery embolization on lower urinary tract symptoms related to benign prostatic hyperplasia: A systematic review and metaanalysis

Xiao-Yan Wang, Yu-Meng Chai, Wen-Hui Huang, Yong Zhang

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# Abstract

## BACKGROUND

Prostate artery embolization (PAE) is a promising minimally invasive therapy that improves lower urinary tract symptoms (LUTS) related to benign prostatic hyperplasia (BPH). Transurethral resection of the prostate (TURP) is the gold standard therapy for LUTS/BPH.

#### AIM

To evaluate the efficacy and safety of PAE vs TURP on LUTS related to BPH.

#### **METHODS**

A literature review was performed to identify all published articles on PAE vs TURP for LUTS/BPH. Sources included PubMed, Embase, Cochrane library databases, and Chinese databases before June 2022. A systematic review and meta-analysis were conducted. Outcome measurements were combined by calculating the mean difference with a 95% confidence interval. Statistical analysis was carried out using Review Manager 5.3.

## RESULTS

Eleven studies involving 1070 participants were included. Compared with the TURP group, the PAE group had a similar effect on the International Index of Erectile Function (IPSS) score, Peak urinary flow rate (Qmax), postvoid residual volume (PVR), Prostate volume (PV), prostatic specific antigen (PSA), The International Index of Erectile Function short form (IIEF-5) scores, and erectile dysfunction during 24 mo follow-up. Lower quality of life (QoL) score, lower rate of retrograde ejaculation and shorter hospital stay in the PAE group. There was no participant death in either group. A higher proportion of haematuria, urinary



incontinence and urinary stricture was identified in the TURP group.

#### CONCLUSION

PAE may be an appropriate option for elderly patients, patients who are not candidates for surgery, and patients who do not want to risk the potential adverse effects of TURP. Studies with large cases and long follow-up time are needed to validate results.

**Key Words:** Lower urinary tract symptoms; Benign prostatic hyperplasia; Meta-analysis; Prostate artery embolization; Transurethral resection of the prostate

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**Core Tip:** Prostate artery embolization (PAE) is a promising minimally invasive therapy that improves lower urinary tract symptoms (LUTS) related to benign prostatic hyperplasia (BPH). Transurethral resection of the prostate (TURP) is the gold standard therapy for LUTS/BPH. This article uses a metaanalysis to evaluate the efficacy and safety of PAE compared with TURP on LUTS related to BPH. In our conclusion, PAE may be an appropriate option for elderly patients, patients who are not candidate for surgery, and patients who do not want to risk the potential adverse effects of TURP.

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#### INTRODUCTION

Benign prostatic hyperplasia (BPH) is a very common disease in aging males and is positively correlated with age[1]. The morbidity rate of BPH is approximately half of all men aged 60 years or older[2]. Lower urinary tract symptoms (LUTS) are ordinarily secondary to BPH and are not usually life-threatening but often compromise the quality of life (QoL).

The transurethral resection of the prostate (TURP) has been considered a surgical reference standard for LUTS/BPH. Nevertheless, TURP is associated with significant postoperative complications, including hematuria, urinary retention, incontinence, urinary stricture, retrograde ejaculation and erectile dysfunction[3]. Therefore, a growing number of nonresective techniques, such as prostate artery embolization (PAE), have been developed.

PAE is an interventional radiological technique that involves unilaterally or bilaterally injecting small particles directly into the prostatic arteries, which leads to a progressive decrease in prostatic volume due to devascularization. Treatment of LUTS/BPH by PAE offers some advantages, including the continuation of anticoagulant drugs, local anesthesia, and a quick return to normal activities[4].

Although PAE is considered a therapeutic option for LUTS/BPH in the European Association of Urology guidelines and National Institute for Health and Care Excellence, TURP is the traditional gold standard[5], and controversy persists regarding PAE in the treatment of LUTS/BPH. Therefore, we performed a meta-analysis to evaluate the efficacy and safety of PAE compared with TURP, which may help urologists make better choices.

#### MATERIALS AND METHODS

#### Search strategy

A comprehensive literature search was carried out by two independent reviewers. We searched Reference Citation Analysis (https://www.referencecitationanalysis.com/), PubMed, Embase, the Cochrane library databases and Chinese databases, such as the Chinese National Knowledge Infrastructure (CNKI), Wanfang data and the Chinese Science and Technology Periodicals (VIP) database, before June 2022. The search terms consisted of "BPH", " LUTS", "PAE" and "TURP", and confined fields in the title/abstract. Additionally, the reference lists of the retrieved studies were checked manually.

#### Inclusion criteria

The inclusion criteria for this meta-analysis were as follows: (1) The study was a clinical controlled trial, prospective study or retrospective study; (2) the study subjects were BPH patients with LUT; (3) the intervention measures were PAE in the experimental group and TURP in the control group; (4) at least one of the following outcomes was reported at different follow-up times: International Prostate Symptom Score (IPSS), QoL score, prostate volume (PV), prostate-specific antigen (PSA), peak urine flow rate (Qmax), postvoid residual volume (PVR) and International Index of Erectile Function (IIEF) short form score; and (5) the full text was available; 6. if an identical study was published a different time point in a different journal, the most recently published study was included. If these inclusion criteria were not met, then the study was excluded from this meta-analysis.

#### Quality assessment

The quality assessment was carried out jointly by all of the authors using the methodological index for nonrandomized studies (MINORS)[6]. Twelve items received 2 points for each item. The study received 2 points if it reported the item. If not intact, it received 1 point, and if absent, it received 0 points. Fourteen points was defined as a golden line. All authors agreed with the final results.

#### Data extraction

Two reviewers independently participated in the study screening and data extraction. The differences were resolved through discussion. The following data were extracted from the retrieved studies: (1) Basic information of the included studies: authors, publication time, country, sample size and inclusive criteria; (2) detailed materials used in the PAE group and energy sources in the TURP group; (3) followup duration and outcome measures; (4) procedure time, hospital time and the number of participants with complications; and (5) study quality evaluation of the relevant information.

#### Statistical analysis

The RevMan 5.3 software was used to conduct the meta-analysis. Outcome measurements were combined by calculating the mean difference (MD) with a 95% confidence interval (CI), and P < 0.05 was considered statistically significant. The statistical heterogeneity among studies was analyzed with the  $l^2$ heterogeneity test. If *l*<sup>2</sup> was less than 50%, a fixed-effects model was used; if not, we analyzed the source of heterogeneity. If heterogeneity was detected, the heterogeneity could be improved after a subset analysis and a sensitivity analysis. The evaluation of publication bias was based on funnel plots.

#### RESULTS

#### Study inclusion

Altogether, 382 articles were selected through the search procedure. Finally, 11 articles involving 1070 BPH participants (582 in the PAE group and 488 in the TURP group) were eligible for this meta-analysis [7-17]. Figure 1 shows the flow diagram of the study inclusion process. The main characteristics and quality assessment of eligible studies are presented in Table 1.

#### Efficacy

Changes in IPSS: Subgroup and sensitivity analyses were carried out to examine sources of heterogeneity. Study Insausti2020[12] was eliminated at postoperative 3 mo. Study Gu2018[10] and study Insausti2020[12] were eliminated at postoperative 6 mo. Study Carnevale2016[8] was eliminated at postoperative 12 mo.

Finally, eight studies [7,9,11,13-17] involving 895 participants, seven studies [7,9,11,13-15,17] involving 772 participants, eight studies[7,9,11-15,17] involving 817 participants and three studies[7,9,11] involving 276 participants were enrolled in the analysis of IPSS changes at postoperative 3, 6, 12 and 24 mo, respectively (Figure 2).

The forest plot demonstrated that the difference in IPSS changes between the PAE group and the TURP group was statistically significant at postoperative 3 mo (MD 1.28; 95% CI: 0.63 to 1.93; P = 0.0001), 6 mo (MD 1.82; 95%CI: 1.01 to 2.62; *P* < 0.00001) and 12 mo (MD 1.83; 95%CI: 1.02 to 2.65; *P* < 0.00001) but was not statistically significant at postoperative 24 mo (MD 1.81; 95% CI: 0.01 to 3.60; P = 0.05).

#### Changes in QoL

Subgroup and sensitivity analyses were carried out to examine sources of heterogeneity. Study Insausti2020[12] and study Wang2018[16] were eliminated at postoperative 3 mo. Study Gu2018[10] and study Insausti2020[12] were eliminated at postoperative 6 mo. Study Insausti2020[12] and study Ray2018[14] were eliminated at postoperative 12 mo.

Finally, seven studies [7,9,11,13-15,17] involving 772 participants, seven studies [7,9,11,13-15,17] involving 772 participants, seven studies [7-9,11,13,15,17] involving 497 participants and three studies [7, 9,11] involving 276 participants were enrolled in the analysis of QoL changes at postoperative 3 mo, 6



Table 1 Th	e main charac	teristic and	l qualit	y assess	sment of eligible	studies				
Studies	Study design	Country	Samp PAE	ole size TURP	Inclusion criteria	Interventions PAE	TURP	Follow- up (mo)	Outcome measuresª	Quality assessment⁵
Abt 2021	Prospective study	Switzer land	48	51	Age ≥ 40 yr; PV 25-80 mL; IPSS ≥ 8; QoL ≥ 3; Qmax ≤ 12 mL/s	Bilateral (36); unilateral (12); 250- 400 µm microspheres	Monopolar	3, 6, 12, 24	1, 2, 3, 4, 5, 6, 7, 8, 9	19
Carnevale 2016	Prospective study	Brazil	15	15	Age ≥ 45yr; PV 30-90 mL; IPSS ≥ 19	Bilateral (13); unilateral (2); 300- 500µm microspheres	Monopolar	12	1, 2, 3, 4, 5, 6, 7, 8	21
Gao 2014	Prospective study	China	54	53	PV 20-100 mL; IPSS > 7; Qmax ≤ 15 mL/s	Bilateral (48); unilateral (6); 355- 500 µm polyvinyl alcohol microspheres	Bipolar	1, 3, 6, 12, 24	1, 2, 3, 4, 5, 6, 8, 9	21
Gu 2018	Prospective study	China	50	50	Age > 55 yr; PV 70-150 mL; IPSS ≥ 25; QoL ≥ 5	Bilateral or unilateral; BioSphere Medical S.A 100-300 µm	Bipolar	6	1, 2, 3, 4, 5	19
Hou 2016	Retrospective study	China	31	39	Age ≥ 49 yr; PV 60-110 mL; IPSS > 7; QoL > 3; Qmax < 12 mL/s	Bilateral; polyvinyl alcohol microspheres	Bipolar	3, 6, 12, 24	1, 2, 3, 4, 5	17
Insausti 2020	Prospective study	Spain	23	22	Age > 60yr; IPSS > 19; QoL > 3; Qmax ≤ 10 mL/s	Bilateral; 300-500 μm polyvinyl alcohol microspheres	Bipolar	3, 6, 12	1, 2, 3, 4, 5, 6, 8, 9	21
Qiu 2017	Retrospective study	China	17	40	Age > 60 yr; PV > 50mL; IPSS > 7; QoL > 3; Qmax < 13 mL/s	Bilateral or unilateral; 90-180 μm embosphere microspheres	Bipolar	3, 6, 12	1, 2, 3, 5	17
Ray 2018	Prospective study	British	216	89	Age > 60 yr; PV > 50mL; IPSS > 7; QoL > 3; Qmax < 15 mL/s	Bilateral; polyvinyl alcohol microspheres	Monopolar (45) Bipolar (44)	1, 3, 6, 12	1, 2, 3, 4, 5, 7	19
Tan 2018	Prospective study	China	47	47	Age ≥ 50 yr; PV > 60 mL; IPSS > 19; QoL > 4; Qmax < 13 mL/s	Bilateral; polyvinyl alcohol microspheres	Bipolar	3, 6, 12	1, 2, 3, 4, 5, 6, 9	21
Wang 2018	Prospective study	China	61	62	Age > 55 yr; PV > 45 mL; IPSS > 19; QoL > 3; Qmax < 10 mL/s	Bilateral; polyvinyl alcohol microspheres	Bipolar	3	1, 2, 3, 4, 7, 8, 9	20
Zhu 2018	Prospective study	China	20	20	Age ≥ 49 yr; PV>60mL; IPSS>7; QoL>3; Qmax < 12 mL/s	Bilateral; 100-300 or 310-500μm Microspheres	Bipolar	3, 6, 12	1, 2, 3, 4, 5, 6	19

<sup>a</sup>Outcome measures: 1. IPSS; 2. QoL; 3. Qmax; 4. PVR; 5. PV; 6. PSA; 7. IIEF; 8. Procedure time; 9. Hospital stay.

<sup>b</sup>Quality assessment is based on the methodological index for nonrandomized studies.

BPH: Benign prostatic hyperplasia; IIEF-5: International index of erectile function; IPSS: International prostate symptom score; LUTS: Lower urinary tract symptoms; PAE: Prostate artery embolization; PSA: Prostate-specific antigen; PV: Prostate volume; PVR, Postvoid residual; Qmax: Peak urinary flow rate; QoL: Quality of life; TURP: Transurethral resection of the prostate.

mo, 12 mo and 24 mo, respectively (Figure 3).

The forest plot demonstrated that the difference in QoL changes between the PAE group and the TURP group was statistically significant at postoperative 3 mo (MD 0.42; 95% CI: 0.24 to 0.61; P < 10000.00001), 6 mo (MD 0.41; 95% CI: 0.22 to 0.59; *P* < 0.0001), 12 mo (MD 0.43; 95% CI: 0.20 to 0.65; *P* = 0.0002) and 24 mo (MD 0.62; 95%CI: 0.09 to 1.15; *P* = 0.02).





Figure 1 The flow diagram of the study inclusion process.

#### Changes in Qmax

Subgroup and sensitivity analyses were carried out to examine sources of heterogeneity. Study Gu2018 [10] was eliminated at postoperative 6 mo. Study Carnevale2016[8] was eliminated at postoperative 12 mo.

Finally, eight studies[7,9,12,13-17] involving 900 participants, seven studies[7,9,11-13,15,17] involving 512 participants, eight studies[7,9,11-15,17] involving 817 participants and three studies[7,9,11] involving 276 participants were enrolled in the analysis of Qmax changes at postoperative 3 mo, 6 mo, 12 mo and 24 mo, respectively (Figure 4).

The forest plot demonstrated that the difference in Qmax changes between the PAE group and the TURP group was statistically significant at postoperative 3 mo (MD -3.97; 95% CI: -6.05 to -1.89; P =0.002), 6 mo (MD -2.36; 95% CI: -4.53 to -0.19; P = 0.03) and 12 mo (MD -2.45; 95% CI: -4.52 to -0.38; P = 0.02) but was not statistically significant at postoperative 24 mo (MD -2.85; 95% CI: -6.82 to 1.11; P =0.16).

#### Changes in PVR

Subgroup and sensitivity analyses were carried out to examine sources of heterogeneity. Study Abt2021 [7] and study Ray2018 [14] were eliminated at postoperative 3 mo. Study Abt2021 [7] was eliminated at postoperative 6 mo. Study Abt2021[7] and study Ray2018[14] were eliminated at postoperative 12 mo. Study Abt2021[7] was eliminated at postoperative 24 mo.

Finally, six studies[9,11,12,15-17] involving 479 participants, six studies[9-11,12,15,17] involving 456 participants, six studies[8,9,11,12,15,17] involving 386 participants and two studies[9,11] involving 177 participants were enrolled in the analysis of PVR changes at postoperative 3 mo, 6 mo, 12 mo and 24 mo, respectively(Figure 5).

The forest plot demonstrated that the difference in PVR changes between the PAE group and the TURP group was statistically significant at postoperative 3 mo (MD 3.35; 95% CI: 0.96 to 5.73; P = 0.006) but was not statistically significant at postoperative 6 mo (MD 1.07; 95% CI: -0.73 to 2.86; P = 0.24), 12 mo (MD 0.28; 95% CI: -2.47 to 3.03; *P* = 0.84) and 24 mo(MD -0.56; 95% CI: -7.49 to 6.37; *P* = 0.87).

#### Changes in PV

Subset and sensitivity analysis were carried out to improve the heterogeneity.

Finally, eight studies [7,9,11-15,17] involving 817 participants, seven studies [9-13,15,17] involving 513 participants, seven studies[8,9,11-14,17] involving 443 participants and three studies[7,9,11] involving 276 participants were enrolled in the analysis of PV changes at postoperative 3 mo, 6 mo, 12 mo and 24 mo, respectively (Figure 6).

The forest plot demonstrated that the difference in PV changes between the PAE group and the TURP group was statistically significant at postoperative 6 mo (MD 6.81; 95%CI: 1.13 to 12.49; P = 0.02) and 12 mo (MD 7.14; 95%CI: 3.02 to 11.27; P = 0.0007) but was not statistically significant at postoperative 3 mo (MD 8.32; 95% CI: 0.01 to 16.64; *P* = 0.05) and 24 mo (MD 8.28; 95% CI: -7.56 to 24.12; *P* = 0.31).



		PAE			TURP			Mean Difference	Mean Difference			
Study or Subaroup	Mean	SD	Total	Mean	SD	Total	Weight	IV. Fixed, 95% CI	IV. Fixed, 95% CI			
1.1.1 IPSS-3m												
Ab+2021	0 22	£ 35	48	-10 77	6 67	51	2.16	1 54 60 82 2 901				
Gao2014	-5.23	25 72	40	-12 7	10.02	51	0.28					
Ud02014	12 62	5 40	21	-16 10	£ 10	30	2.24	2 57 60 17 5 211				
H002010	-13.02	5.49	31	-10.19	0.19	39	2.37	2.57 [-0.17, 5.31]				
Insausti2020	-21.0	5.39	23	-14.3	7.51	22	0.0%	-7.30 [-11.13, -3.47]				
Qu2017	-6.4	4.55	17	-12.2	4.3	40	2.7%	3.60 [1.26, 6.34]				
Ray2016	-11.7	6.7	216	-11.83	5.6	69	7.6%	0.13 [-1.37, 1.63]	Ť			
Tan2018	-14.51	3.69	47	-16.66	3.77	47	7.7%	2.15 [0.64, 3.66]				
Wang2018	-19.36	3.14	61	-19.7	3.21	62	13.9%	0.34 [-0.78, 1.46]	Ť			
Zhu2018	-13.61	3.72	20	-16.05	3.77	20	3.2%	2.44 [0.12, 4.76]				
Subtotal (95% CI)			494			401	41.0%	1.28 [0.63, 1.93]	•			
Heterogenetty: $Ch^{-} = 12.57$ , $df = 7$ ( $P = 0.08$ ); $f^{-} = 44\%$												
Test for overall effect: Z = 3.84 (P = 0.0001)												
1.1.2 IPSS-6m												
Abt2021	-9.19	6.7	48	-11.91	5.55	51	3.0%	2.72 [0.29, 5.15]	<u> </u>			
Gao2014	-11.5	22.6	54	-13.4	20.55	53	0.3%	1.90 [-6.28, 10.08]				
Gu2018	-19.2	2.1	50	-18.1	1.77	50	0.0%	-1.10 [-1.86, -0.34]				
Hou2016	-18.21	5.59	31	-18.93	6.26	39	2.3%	0.72 [-2.06, 3.50]				
Insausti2020	-22.5	6.59	23	-16.7	7.81	22	0.0%	-5.80 [-10.03, -1.57]				
Qlu2017	-11.8	4.35	17	-16.2	4.23	40	2.9%	4.40 [1.95, 6.85]				
Rav2018	-11.2	6.7	216	-13.63	5.8	89	7.8%	2.43 [0.93, 3.93]	-			
Tan2018	-19.15	3.69	47	-19.78	3.81	47	7.6%	0.63 [-0.89, 2.15]				
Zhu2018	-18.07	3.72	20	-18.8	3.8	20	3.2%	0.73 [-1.60, 3.06]				
Subtotal (95% CI)	-0.07		433	-0.0	0.0	339	27.0%	1.82 [1.01, 2.62]	•			
Haterogeneity: Chi <sup>2</sup> -	9 23 dF.	- 6 (2 -	0 161	P - 359	2				·			
Tast for overall effect	7 - 4 42	10 - 0	00001									
rest for overall effect.		\r < 0.	00001)									
1 1 3 IPSS-12m												
46-2021	0.2	7 41	40	11 70	5.43	61	2.64	2 40 1 0 08 5 061				
AU(2021	12.5	6.04	40	-11.75	7.52	10	2.07	2.45 [-0.08, 5.00]				
Carnevale2010	-12.5	0.94	15	-21.5	1.55	13	0.0%	9.00 [3.62, 14.16]				
0402014	-13.4	20.03	24	-14.5	19.93	22	0.37	1.10 [-0.59, 6.79]				
Houzule	-17.62	3.5	31	-18.0	6.31	39	2.37	0.96 [-1.79, 3.75]				
insausti2020	-21	48.50	23	-16.2	0.66	22	0.0%	-2.60 [-22.65, 17.25]				
Qu2017	-10.8	4.37	17	-14.3	4.66	40	2.7%	3.50 [0.97, 6.03]				
Ray2018	-11.3	6.7	216	-14.43	5.8	69	7.6%	3.13 [1.63, 4.63]	-			
Tan2018	-19.47	3.7	47	-19.96	3.61	47	7.6%	0.49 [-1.03, 2.01]	+			
Zhu2018	-18.35	3.73	20	-19	3.82	20	3.2%	0.65 [-1.69, 2.99]	<u>+</u>			
Subtotal (95% CI)			456			361	26.6%	1.83 [1.02, 2.65]	•			
Heterogeneity: Chi <sup>2</sup> =	9.38, df	= 7 (P -	0.23);	r = 25%	i							
Test for overall effect:	Z = 4.43	(P < 0.	00001)	•								
1.1.4 IPSS-24m												
Abt2021	-9.67	7.15	48	-12.4	5.2	51	2.9%	2.73 [0.25, 5.21]				
Gao2014	-15.6	20.6	54	-16.3	19.87	53	0.3%	0.70 [-6.97, 8.37]				
Hou2016	-17.43	5.53	31	-18.23	6.26	39	2.3×	0.80 [-1.97, 3.57]				
Subtotal (95% CI)			133			143	5.4%	1.81 [0.01, 3.60]	◆			
Heterogeneity: Chi <sup>2</sup> =	1.12, df	= 2 (P -	0.57);	r <sup>2</sup> = 0%								
Test for overall effect:	Z = 1.98	(P = 0.	05)									
Total (95% CI)			1516			1244	100.0%	1.60 [1.18, 2.02]	•			
Heterogeneity: Chi <sup>2</sup> =	33.89. di	= 25 (	P = 0.1	1): $f^2 = 2$	6%							
Test for overall effects	Z = 7.50	(P < 0	00001									
Test for subgroup diff	erences: 6	$Cht^2 = 1$	.58. df	= 3 (P =	0.66)	<sup>2</sup> = 0¥			Favours [PAE] Favours [TURP]			
				. v. –			DOI:	10.12998/wjcc.v10.i32	.11812 <b>Copyright</b> ©The Author(s) 2022.			

Figure 2 Forest plot about postoperative International Prostate Symptom Score changes at postoperative 3 mo, 6 mo, 12 mo and 24 mo between the prostate artery embolization group and the transurethral resection of the prostate group.

#### Changes in PSA

Subgroup and sensitivity analyses were carried out to examine sources of heterogeneity. Finally, five studies[7,9,12,15,17] involving 385 participants, four studies[7,9,15,17] involving 340 participants, six studies[7,8,9,12,15,17] involving 415 participants and two studies[7,9] involving 206 participants were enrolled to analyze PSA changes at postoperative 3 mo, 6 mo, 12 mo and 24 mo (Figure 7).

The forest plot demonstrated that the difference in PSA changes between the PAE group and the TURP group was statistically significant at postoperative 3 mo postoperatively (MD 1.00; 95% CI: 0.28 to 1.72; P = 0.006) but was not statistically significant at postoperative 6 mo(MD 0.34; 95% CI: -0.42 to 1.09; P = 0.38), 12 mo (MD 0.43; 95% CI: -0.25 to 1.10; P = 0.21) or 24 mo (MD 0.64; 95% CI: -0.75 to 2.03; P = 0.37).

#### Changes in sexual function

Subgroup and sensitivity analyses were carried out to examine sources of heterogeneity. Finally, three studies[7,14,16] involving 527 participants, two studies[7,14] involving 414 participants and three[7,8,14] studies involving 434 participants were enrolled to analyze IIEF changes at postoperative 3 mo, 6 mo and 12 mo, respectively (Figure 8A).

The forest plot demonstrated that the difference in IIEF changes between the PAE group and the TURP group was not statistically significant at postoperative 3 mo (MD 1.77; 95% CI: -0.32 to 3.87; P = 0.10), 6 mo (MD -0.73; 95% CI: -4.20 to 2.74; P = 0.68) and 12 mo (MD -0.73; 95% CI: -4.29 to 2.83; P = 0.69).



		PAE		1	TURP			Mean Difference	Mean Difference				
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV. Fixed, 95% CI	IV. Fixed, 95% CI				
2.1.1 3m								,					
Abt2021	-2.33	1.36	48	-2.69	1.3	51	4.5%	0.36 [-0.16, 0.88]					
Gap2014	-1.9	3.36	54	-2.3	3.22	53	0.8%	0.40 [-0.85, 1.65]					
Hou2016	-1.96	1.27	31	-2.57	1.33	39	3.3%	0.61 [-0.00, 1.22]					
Insausti2020	-3.57	0.95	23	-2.64	1.16	22	0.0%	-0.93 [-1.55, -0.31]					
Olu2017	-1.3	0.96	17	-2	0.79	40	4.6%	0.70 [0.18, 1.22]					
Ray2018	-2.7	1.1	216	-3	1.1	89	16.8%	0.30 [0.03, 0.57]	<b></b>				
Tan2018	-1.98	1.3	47	-2.45	1.35	47	4.3%	0.47 [-0.07, 1.01]					
Wang2018	-2.41	1.05	61	-2.16	1.15	62	0.0%	-0.25 [-0.64, 0.14]					
Zhu2018	-1.97	1.3	20	-2.48	1.33	20	1.9%	0.51 (-0.31, 1.33)					
Subtotal (95% CI)			433			339	36.2%	0.42 [0.24, 0.61]	•				
Heterogeneity: Chi <sup>2</sup> =	2.38. d	F = 6 ()	P = 0.8	8): 1 <sup>2</sup> =	0%				•				
Test for overall effect: $Z = 4.45$ (P < 0.00001)													
rest for overall encet.		24. 4	0.000	<b>(</b> 1)									
2.1.2 6m													
Abt2021	-2.43	1.33	48	-3.11	1.29	51	4.6%	0.68 [0.16, 1.20]					
Gan2014	-2.6	3.61	54	-2.3	2.96	53	0.8%	-0.30 [-1.55, 0.95]					
Gu2018	-3.6	1.04	50	-3.3	0.96	50	0.0%	-0.30 [-0.69, 0.09]					
Hou2016	-2.73	1.28	31	-2.74	1.33	39	3.34	0.01 [-0.60, 0.62]					
Insausti2020	-3.83	0.92	23	-3.05	1 31	22	0.0%	-0.78 [-1.44 -0.12]					
0102017	-1.6	0.96	17	-2.2	0.79	40	4.6%	0.60 0.08 1.121					
Ray2018	-2.5	11	216	-3	11	89	16.8%	0 50 10 23 0 771					
Tan2018	-2 88	1 33	47	-2 89	1 85	47	2.9%	0.01 [-0.64, 0.66]					
7hu2018	-2.9	1 31	20	-2 89	1 37	20	1.8%	-0.01 [-0.84, 0.82]					
Subtotal (95% CI)		1.91	433	2.00	1.97	339	34.9%	0.41 [0.22, 0.59]	•				
Heterogeneity: Chi <sup>2</sup> =	7 29 d	- 6 (	3	0)· F =	18%				•				
Test for overall effect:	Z = 4.2	2 (P <	0.000	1)	10/4								
				-/									
2.1.3 12m													
Abt2021	-2.47	1.28	48	-3.33	1.21	51	5.1%	0.86 [0.37, 1.35]					
Carnevale2016	-2.5	1.04	15	-3.7	1.22	15	1.9%	1.20 [0.39, 2.01]					
Gao2014	-2.9	3.13	54	-2.8	2.96	53	0.9%	-0.10 [-1.25, 1.05]					
Hou2016	-2.38	1.28	31	-2.67	1.5	39	2.9%	0.29 [-0.36, 0.94]					
Insausti2020	-3.78	1.28	23	-3.09	1.41	22	0.0%	-0.69 [-1.48, 0.10]					
Qlu2017	-2	0.7	17	-2.4	0.6	40	8.5%	0.40 [0.02, 0.78]					
Rav2018	-2.6	1.1	216	-3.4	1.1	89	0.0%	0.80 [0.53, 1.07]					
Tan2018	-2.9	1.25	47	-2.85	1.79	47	3.2%	-0.05 [-0.67, 0.57]					
Zhu2018	-2.92	1.28	20	-2.83	1.3	20	1.9%	-0.09 [-0.89, 0.71]					
Subtotal (95% CI)			232			265	24.5%	0.43 [0.20, 0.65]	•				
Heterogeneity: Chi <sup>2</sup> =	11.31,	df = 6	(P = 0.	08); P	- 47%								
Test for overall effect:	Z = 3.7	4 (P =	0.000	2)									
		-											
2.1.4 24m													
Abt2021	-2.29	1.5	48	-3.28	2.13	51	2.4%	0.99 [0.27, 1.71]					
Gao2014	-3.2	3.13	54	-3.2	2.72	53	1.0%	0.00 [-1.11, 1.11]					
Hou2016	-2.31	1.34	31	-2.67	3.19	39	1.0%	0.36 [-0.75, 1.47]					
Subtotal (95% CI)			133			143	4.4%	0.62 [0.09, 1.15]	-				
Heterogeneity: Chi <sup>2</sup> =	2.42, d	F = 2 (I	P = 0.3	0); l² =	17%								
Test for overall effect:	Z = 2.2	8 (P =	0.02)										
Total (95% CI)			1231			1086	100.0%	0.43 [0.31, 0.54]	•				
Heterogeneity: Chi <sup>2</sup> =	23.94,	df = 23	3 (P = 0	).41); l <sup>2</sup>	= 4%			-					
Test for overall effect:	Z = 7.5	0 (P <	0.000	01)					Favours (PAE) Favours (TURP)				
Test for subgroup diff	erences:	Chi <sup>2</sup> =	0.55,	df = 3	(P = 0)	91), r²	- 0%						
							DOI:	10.12998/wjcc.v10.i32	2.11812 <b>Copyright</b> ©The Author(s) 2022.				

Figure 3 Forest plot about quality of life score changes at postoperative 3 mo, 6 mo, 12 mo and 24 mo between the prostate artery embolization group and the transurethral resection of the prostate group.

Four studies[11,12,15,16] involving 249 participants were enrolled to analyze postoperative erectile dysfunction. The forest plot demonstrated that the difference between the PAE group and the TURP group was not statistically significant (MD 0.33; 95%CI: 0.10 to 1.05; P = 0.06) (Figure 8B).

Four studies[11,12,15,16] involving 249 participants were enrolled to analyze postoperative retrograde ejaculation. The forest plot demonstrated that the difference between the PAE group and the TURP group was statistically significant (MD 0.10; 95%CI: 0.02 to 0.43; P = 0.002) (Figure 8C).

#### Safety

**Procedure time:** Five studies [7-9,12,16] involving 404 participants were enrolled to analyze the procedure time. The forest plot demonstrated that the difference between the PAE group and the TURP group was not statistically significant (MD 35.53; 95%CI: -0.28 to 71.35; P = 0.05) (Figure 9A).

#### Hospital stay

Five studies[7,9,12,15,16] involving 468 participants were enrolled for an analysis of the hospital stay. The forest plot demonstrated that the difference between the PAE group and TURP group was statistically significant (MD -2.23; 95% CI: -3.80 to -0.67; P = 0.005) (Figure 9B).

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		PAE			TURP			Mean Difference	Mean Difference			
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV. Random, 95% CI	IV. Random, 95% CI			
3.1.1 Qmax-3m								,	,			
Ah+2021	55	5 12	AR	15 3	12 33	51	3.1%	-9 80 [-13 48 -6 12]				
Cao2014	9.5	11 04	54	14 1	15.01	53	2.34	-4 60 [-9 75 0 55]				
10402014	5.1	3 23	21	7 23	3 7	20	4 5 8	-1 82 [-3 45 -0 10]				
02017	3.41	3.23	22	C 08	7 51	22	3.2%	-7.02 [-3.43, -0.15]				
QUU2017	4.55	3.07	17	0.50	2.02	40	3.27	-2.35 [-3.50, 1.12]				
T==2018	3.7	3.0	216	10 44	5.52	40	4.17	-7.30 [-9.46, -3.12]				
1412010	4.0	4.72	210	10.44	0.3	09	4.07	-3.04 [-7.09, -4.19]				
Wang2016	5.27	2.59	4/	7.13	2.95	4/	4./7	-1.60 [-2.96, -0.74]	~			
ZnuZU15	11.39	2.62	407	11.64	2.79	402	21.2%	-0.25 [-1.24, 0.74]				
Subtotal (95% CI)			497			403	31.3%	-3.97 [-6.05, -1.89]	-			
Heterogenery: $ a_{1}r  = 7.32$ ; $Chr = 74.09$ , $df = 7 (P < 0.00001)$ ; $r = 91\%$												
Test for overall effect: Z = 3.74 (P = 0.0002)												
2120												
3.1.2 Qmax-6m		-										
Abt2021	5.9	7.19	48	12.4	11.12	51	3.2%	-6.50 [-10.17, -2.83]				
Gao2014	13.7	13.38	54	16.4	10.58	53	2.6%	-2.70 [-7.27, 1.87]				
Gu2018	12.4	2.4	50	8.3	2.59	50	0.0%	4.10 [3.12, 5.08]				
Hou2016	8.7	2.95	31	8.76	2.9	39	4.6%	-0.06 [-1.44, 1.32]	+			
Insausti2020	5.83	3.46	23	6.29	6.66	22	3.5%	-0.46 [-3.58, 2.66]	<del></del>			
Qlu2017	6.9	4.16	17	14.4	3.57	40	4.1%	-7.50 [-9.77, -5.23]	<u> </u>			
Tan2018	8.43	3.05	47	8.82	3.14	47	4.7%	-0.39 [-1.64, 0.86]	-+			
Zhu2018	8.43	3.03	20	8.71	2.99	20	4.3%	-0.28 [-2.15, 1.59]	-			
Subtotal (95% CI)			240	•		272	26.9%	-2.36 [-4.53, -0.19]	•			
Heteropeneity: Tau <sup>2</sup> =	6.80: C	$hf^2 = 43$	3.39. di	F = 6 (P	< 0.000	001): P	= 86%		-			
Test for overall effect:	Z = 2.1	3 (P = 0	.03)	•••			•••					
3.1.3 Qmax-12m												
Abt2021	5.8	8.2	48	10.5	9.15	51	3.3%	-4.70 [-8.12, -1.28]	<u> </u>			
Carnevale2016	3.1	5.64	15	17.4	7.55	15	0.0%	-14 30 [-19 07 -9 53]				
Can2014	14.3	11 38	54	15.8	10 54	£3	2.0%	_1 50 [_5 66 2 66]				
Heu2016	8 11	3.00	31	8 07	3 46	30	4 5 8	-0.86 [-2.40, 0.68]				
1002010	614	3.05	22	0.57	0.40	22	2.74	-3 51 (-8 00 0 08)				
nisaus(izuzu	12.2	4.00	23	9.05	9.02	22	2.57	-3.51 [-0.00, 0.50]				
QU02017	12.3	3.97	11	14.9	3.44	40	4.17	-2.60 [-4.77, -0.43]				
Kay2016	5.3	4.72	210	11.94	0.3	69	4.07	-0.04 [-0.09, -5.19]	-			
Tan2016	6.64	3.28	47	6.99	2.75	47	4.7%	-0.15 [-1.37, 1.07]	Ť			
Zhu2018	6.62	3.15	20	6.99	3.13	20	4.3%	-0.17 [-2.13, 1.79]				
Subtotal (95% CI)			450			361	31.0%	-2.45 [-4.52, -0.38]				
Heterogeneity: Tau* =	7.16; C	:h <b>r =</b> 5€	6.36, di	f = 7 (P	< 0.000	001); r	- 66%					
Test for overall effect:	Z = 2.3	2 (P = 0	).02)									
3.1.4 Omax-24m												
Ah+2021	4 1	5 19	AR	10.7	0.00	51	3.7%	-6 60 [-9 49 -3 71]				
Cae2014	13.7	11 62	54	14.8	11 14	53	2.8%	-1 10 [-5 41 3 21]				
Uau2014	13.7	2 72	21	0.51	2 72	20	2.0/	-0.81 [-3.55 0.04]				
Subtotal (95% CI)	0.7	3.72	133	9.51	3.72	143	10.8%	-2.85 [-6.82 1 11]				
Hatanaanaha T2	0 86. 0	LB2	1.22	- 2/2	- 0.000	175	10.0%	2.05 [-0.02, 1.11]				
Test for overall effect:	9.00; C Z = 1.4	.nr = 1) 1 (P = 0	1.34, 01 ).16}	- 2 (*	= 0.003	у; г <b>=</b>	037					
Total (95% CI)			1326			1179	100.0%	-2.92 [-4.00, -1.85]	•			
Heterogeneity: Tau" =	6.08; C	hr = 19	1.62, (	df = 25	(P < 0.0	00001)	; = 67%	i	-20 -10 0 10 20			
Test for overall effect:	Z = 5.3	2 (P < 0	0.00001	1)					Favours (PAE) Favours (TURP)			
Test for subgroup diff	erences:	$Cht^2 = 1$	1.43, d	f = 3 (P	= 0.70	), ř = (	)% DO	I: 10.12998/wicc.v10 i3	32.11812 <b>Copyright</b> ©The Author(s) 2022			

Figure 4 Forest plot about peak urine flow rate changes at postoperative 3 mo, 6 mo, 12 mo and 24 mo between the prostate artery embolization group and the transurethral resection of the prostate group.

#### Complications

The TURP group experienced more complications (80.8%, P < 0.00001); however, the differences in the rates of major events (Clavien-Dindo grade  $\geq$  3) between the two groups were not statistically significant (P = 0.23), such as blood transfusion and sepsis in the TURP group (3.35%) or groin hematoma and bladder ischemia in the PAE group (2.12%). Participant deaths did not occur in either group (Table 2).

Urinary irritation or local pain was the main complication in both groups, but the difference between the PAE group (39.29%) and the TURP group (33.26%) was not statistically significant (P = 0.05). A higher proportion of hematuria (19.64%), urinary incontinence (4.02%) and urinary stricture (3.13%) was identified in the TURP group (*P* < 0.00001, *P* = 0.001 and *P* = 0.005) (Table 2).

#### DISCUSSION

In the early 1970s, PAE was primarily used to treat refractory hematuria. The treatment of LUTS/BPH with PAE was gradually introduced into clinical practice until 2000[18]. This meta-analysis presented changes in different outcomes at 3, 6, 12 and 24 mo postoperatively and a summary of the latest comparisons between PAE and TURP in patients with LUTS/BPH.



Table 2 Complications reported in the eligible studies												
Complications	Haematuria	Irritation or pain	Urinary retention	Urinary incontinence	Urinary tract infection	Urinary stricture	Major events (clavien ≥ 3)	Total				
PAE	46 (8.14%)	222 (39.29%)	27 (4.78%)	2 (0.35%)	30 (5.31%)	1 (0.18%)	12 (2.12%)	349 (61.77%)				
TURP	88 (19.64%)	149 (33.26%)	15 (3.35%)	18 (4.02%)	35 (7.81%)	14 (3.13%)	15 (3.35%)	362 (80.8%)				
P value	< 0.00001	0.05	0.26	0.001	0.11	0.005	0.23	< 0.00001				

PAE: Prostate artery embolization; TURP: Transurethral resection of the prostate.

		PAE			TURP			Mean Difference	Mean Difference		
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Fixed, 95% CI	IV, Fixed, 95% CI		
4.1.1 PVR-3m											
Abt2021	-98.2	153.62	48	-197	189.77	51	0.0%	98.80 [30.97, 166,63]			
Gan2014	-70.1	220.9	54	-82.2	221.21	53	0.0%	12.10 [-71.67.95.87]			
Hou2016	-82 3	14 53	31	-84.2	15 46	39	3.14	1 90 [-5 15 8 95]	-		
Insausti2020	-61.2	179 18	23	-59.7	182.05	22	0.04	-1 50 [-107 09 104 09]			
Raus(12020	-35.4	126 4	216	-174 8	202.03	80	0.04	120 40 102 58 185 221			
T	-35.4	139.4	210	-1/4.0	8 5 3	47	12 64	139.40 [93.30, 103.22]			
Tan2010	-00.40	15.34	4/	-04.03	0.34	47	13.37	3.33 [0.13, 0.95]	Ľ		
wang2016	-197.92	15.34	01	-201.25	12.9	02	5.17	3.33 [-2.19, 6.65]	Γ		
ZNUZUIS	-60.41	<b>5.4</b> 1	20	-64.05	6.57	20	27 5%	3.07 [-1.59, 6.93]	T		
Subtotal (95% CI)			230			245	27.5%	5.55 [0.96, 5.75]	ľ		
Heterogeneity: Chi <sup>+</sup> = 0.24, df = 5 (P = 1.00); i <sup>+</sup> = 0%											
Test for overall effect:	Z = 2.75 (	(P = 0.00)	6)								
4.1.2 PVR-6m											
Abt2021	-107.8	154.06	48	-200	187.81	51	0.0%	92.20 [24.70, 159.70]			
Gao2014	-87.7	220.85	54	-84.5	220.05	53	0.0%	-3.20 [-86.74, 80.34]			
Gu2018	-147.3	5.92	50	-149	6.15	50	28.0X	1.70 [-0.67, 4.07]	+		
Hou2016	-88	14.48	31	-88.1	15.5	39	3.2%	0.10 [-6.95, 7.15]	+		
Insausti2020	-67.2	182.53	23	-63.4	179.23	22	0.0%	-3.80 [-109.51, 101.91]			
Tan2018	-88.08	9	47	-88.22	8.74	47	12.2%	0.14 [-3.45, 3.73]	+		
Zhu2018	-87.86	9.1	20	-88.3	8.66	20	5.2%	0.44 [-5.07. 5.95]	+		
Subtotal (95% CI)			225			231	48.5%	1.07 [-0.73, 2.86]	•		
Heteropeneity: Chi <sup>2</sup> =	0.67. df =	5(P = 0)	.98): P	- 0%				. , ,			
Test for overall effect:	7 = 1 16	P = 0 24	1	- •/-							
rest for overall energy.	1.19	0.24	,								
4.1.3 PVR-12m											
46+2021	116	164 6		-207.1	100.24	E 1	0.01	02 10 122 00 160 211			
	-115	134.3	40	-207.1	190.34	10	0.07	5 20 [ 50 04 63 54]			
Carnevale2016	-04.2	09.04	15	-/0	00.13	13	0.07	5.60 [-50.94, 62.54]			
0402014	-99.6	223.74	24	-93.1	220.13	33	0.07	-0.50 [-91.75, 76.75]			
Houzule	-67.77	14.45	31	-67.61	15.45	39	3.27	-0.16 [-7.19, 6.67]	Ť		
Insausti2020	-20.2	68.45	23	-44.7	67.1	22	0.1%	24.50 [-15.11, 64.11]			
Ray2018	-32	136.4	216	-183	202.4	89	0.0%	151.00 [105.18, 196.82]			
Tan2018	-88	9.03	47	-88.19	8.67	47	12.27	0.19 [-3.39, 3.77]	<u>†</u>		
Zhu2018	-87.82	9.08	20	-88.09	8.63	20	5.2%	0.27 [-5.22, 5.76]	+		
Subtotal (95% CI)			190			196	20.8%	0.28 [-2.47, 3.03]	•		
Heterogeneity: Chi <sup>2</sup> =	1.51, df =	5 (P = 0	.91); r²	- 0%							
Test for overall effect:	Z = 0.20 (	P = 0.84	}								
4.1.4 PVR-24m											
Abt2021	-76.9	164.13	48	-202.6	186.52	51	0.0%	125.70 [56.59, 194.81]			
Gao2014	-107.5	231.75	54	-100.2	230.99	53	0.0%	-7.30 [-94.98, 80.38]			
Hou2016	-87.62	14.48	31	-87.1	15.05	39	3.2%	-0.52 [-7.47, 6.43]	+		
Subtotal (95% CI)			85			92	3.3%	-0.56 [-7.49, 6.37]			
Heterogeneity: Chi <sup>2</sup> =	0.02. df =	1(P = 0)	.88): 12	- 0%				electroner - entroner	1		
Test for overall effect:	Z = 0.16	P = 0.87	}								
		0.07	,								
Total (95% CI)			736			762	100.0%	1.48 [0.23, 2.73]	)		
Heterogeneity: Chi <sup>2</sup> =	6.08, df =	19 (P =	1.00);	² = 0%				-			
Test for overall effect:	Z = 2.32 (	P = 0.02	)						Favours (PAF) Favours (TUPP)		
Test for subgroup diffe	erences: C	hl <sup>2</sup> = 3.63	3, df =	3 (P = 0.3	$(), f^2 = 1$	7.4%					
							DOI:	10.12998/wjcc.v10.i32.1	1812 Copyright ©The Author(s) 2022.		

Figure 5 Forest plot about postvoid residual volume changes at postoperative 3 mo, 6 mo, 12 mo and 24 mo between the prostate artery embolization group and the transurethral resection of the prostate group.

> In the present study, we observed more significant changes in IPSS, Qmax, PVR, PV and PSA in the TURP group at 3, 6 and 12 mo postoperatively than in the PAE group, although both groups achieved comparable results at 24 mo postoperatively. Thus, no differences were observed at 24 mo postoperatively, suggesting that PAE eventually achieves similar clinical efficacy during long-term follow-up, although the results of this procedure are slow to emerge.

> This delay may be caused by the different mechanisms of these two procedures. The mechanical obstruction of the urinary tract in prostatic hyperplasia is mainly due to the enlargement of the prostate volume and the protruding prostatic tissue, which in turn obstructs the urethra[19]. The direct removal



		PAE			TURP			Mean Difference	Mean Difference		
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Random, 95% CI	IV, Random, 95% CI		
5.1.1 PV-3m											
Abt2021	-12.1	28.02	48	-29.4	26.12	51	3.5%	17.30 [6.61, 27.99]			
Gao2014	-21.3	68.39	54	-36.2	59.66	53	1.3×	14.90 [-9.40, 39.20]			
Hou2016	-19.24	6.05	31	-16.38	6.3	39	5.3%	-2.86 [-5.77. 0.05]			
Insausti2020	-19.9	18.42	23	-41.2	19.74	22	3.3%	21.30 [10.13, 32.47]			
Olu2017	-12.3	8.87	17	-38.8	7.97	40	4.9%	26.50 [21.61. 31.39]			
Rav2018	-29.1	57.1	216	-6.9	31.5	89	3.6%	-22.20 [-32.24, -12.16]			
Tan2018	-14.58	6.23	47	-21.74	6.14	47	5.4%	7.16 [4.66. 9.66]	-		
Zhu2018	-13.72	6.54	20	-21.61	6.32	20	5.1%	7.89 [3.90, 11.88]			
Subtotal (95% CI)			456			361	32.6%	8.32 [0.01, 16.64]	-		
Heterogeneity: Tau <sup>2</sup> =	121.38:	$Cht^2 = 1$	47.28	df = 7	P < 0.0	0001):	r <sup>2</sup> = 95%		-		
Test for overall effect: $Z = 1.96 (P = 0.05)$											
			,								
5.1.2 PV-6m											
Gao2014	-28.4	63.56	54	-36.7	58.95	53	1.4%	8.30 [-14.92, 31.52]			
Gu2018	-63.8	10.42	50	-60.1	11.33	50	5.1%	-3.70 [-7.97, 0.57]			
Hou2016	-31.2	5.53	31	-30.18	6.96	39	5.3%	-1.02 [-3.95, 1.91]	-+		
Insausti2020	-22.3	18.13	23	-43	19.56	22	3.4%	20.70 [9.67, 31.73]			
Qlu2017	-19.4	8.87	17	-37.9	7.99	40	4.9%	18.50 [13.61, 23.39]			
Tan2018	-26.45	5.84	47	-31.86	5.96	47	5.4%	5.41 [3.02, 7.80]	-		
Zhu2018	-25.73	5.87	20	-31.96	6.02	20	5.2%	6.23 [2.55, 9.91]			
Subtotal (95% CI)			242			271	30.8%	6.81 [1.13, 12.49]	◆		
Heterogeneity: Tau <sup>2</sup> =	45.98; 0	hr² = 69	9.09, di	f = 6 (P +	< 0.000	01); r ·	91%		-		
Test for overall effect:	Z = 2.35	(P = 0.	02)								
5.1.3 PV-12m											
Carnevale2016	-12.1	18.43	15	-24.6	18.63	15	2.9%	12.50 [-0.76, 25.76]			
Gao2014	-29.1	63.46	54	-37.1	58.57	53	1.4%	8.00 [-15.13, 31.13]			
Hou2016	-28.62	6.43	31	-28.85	7.18	39	5.3%	0.23 [-2.96, 3.42]	+		
Insausti2020	-20.5	47.41	23	-44.7	23.23	22	1.6%	24.20 [2.53, 45.87]			
Qlu2017	-22.6	9.15	17	-35.8	7.97	40	4.9%	13.20 [8.20, 18.20]			
Tan2018	-26.34	5.92	47	-31.62	5.86	47	5.4%	5.28 [2.90, 7.66]	-		
Zhu2018	-24.82	5.94	20	-31.6	6.09	20	5.2%	6.78 [3.05, 10.51]			
Subtotal (95% CI)			207			236	26.7%	7.14 [3.02, 11.27]	◆		
Heterogeneity: Tau <sup>2</sup> =	16.96; 0	.hl² = 23	3.97, di	f = 6 (P -	0.000	5); P =	75%				
Test for overall effect:	Z = 3.40	$\langle P=0.$	0007)								
$514 PV_{-}24m$											
5.1.4 FV-24III		33 60	40	20.4	20.00		2.1-	20 20 19 26 22 24			
ADTZUZI	-0.1	33.59	46	-20.4	20.90	51	3.17	20.30 [6.26, 32.34]			
Gao2014	-29.8	64.09	54	-36.9	58.53	53	1.4%	7.10 [-16.15, 30.35]			
HQU2016 Subtotal (95% CI)	-28.21	<b>6.</b> 04	122	-27.35	<b>Ģ.</b> 71	142	5.37				
Subtotal (95% CI)	100.00	CL12	122	15	0.00	143	9.9%	0.20 [-7.30, 24.12]			
Test for overall effect:	z = 1.02	$\langle P = 0. \rangle$	31)	ar = 2 (P	= 0.00	3); =	6374				
Total (95% CI)			1038			1011	100.0%	7.62 [4.39, 10.84]	•		
Heterogeneity: Tau <sup>2</sup> =	48.62; (	;hľ² = 2€	64.28, 6	df = 24 (	P < 0.0	0001);	r <sup>2</sup> = 91%				
Test for overall effect:	Z = 4.62	(P < 0.	00001)						Favours (PAF) Favours (TUPP)		
Test for subgroup diff	erences: (	$Cht^2 = 0$	.11, df	= 3 (P =	0.99),	<sup>2</sup> = 0%	DOT	10 12008/wies v10 22 1	1912 Comprise Market @The Author(=) 2022		
-								T0'T5330/MICC'AT0'I25'T			

Figure 6 Forest plot about prostate volume changes at postoperative 3 mo, 6 mo, 12 mo and 24 mo between the prostate artery embolization group and the transurethral resection of the prostate group.

> of pathologically enlarged prostate tissue provides immediate relief of mechanical obstruction of the urethra with satisfactory urodynamic results. PAE does not significantly reduce PV in a short period of time and takes a long time to obtain histopathologic changes after the disruption of the blood supply to the prostate [20]. PAE disrupts the vasculature of the prostate and takes several months to complete the complex histopathologic changes.

> In addition, two types of PAE, unilateral and bilateral embolization, have been employed. For PAE, bilateral embolization has been reported to be more effective than unilateral embolization[21]. Combined bilateral necrosis results in better overall shrinkage and lower regeneration rates. The size of the embolization particles and the embolization route are also important factors in the outcome of the procedure, and the appropriate embolization route and material should be selected intraoperatively [22].

> QoL scores supported a greater improvement in the TURP group than in the PAE group at all followup time points. We reviewed the included trials and found that the inclusion criteria for these studies varied. Thus, patient selection bias is a possible cause of heterogeneity. For example, the baseline data for IPSS scores in Gu's study were no less than 25, whereas they were no less than 8 in Abt's study and Gao's study.

> The preservation of sexual function is an important point for many patients with BPH and should be preserved as much as possible during treatment. Epidemiological evidence suggests a clear and clinically meaningful association between LUTS and sexual dysfunction that is independent of age and comorbidity<sup>[23]</sup>. Continued improvement in LUTS was accompanied by the beginning of an increase in IIEF-5 scores. Regarding changes in sexual function, we assessed 3 indicators, including IIEF-5 scores, erectile dysfunction and retrograde ejaculation. For both groups, the degree of improvement in IIEF-5 scores and the incidence of erectile dysfunction postoperatively did not significantly differ, but the incidence of retrograde ejaculation was significantly higher in the TURP group than in the PAE group.





Figure 7 Forest plot about prostate-specific antigen changes at postoperative 3 mo, 6 mo, 12 mo and 24 mo between the prostate artery embolization group and the transurethral resection of the prostate group.

> Several studies have explained that postoperative erectile dysfunction is closely associated with injury to the prostatic capsule through which the cavernous nerve passes and the heating effect of the electrode occurs during TURP[24]. However, penile artery weakness may be the direct cause of erectile dysfunction after nontargeted embolization with PAE[25]. The main pathogenic mechanism of retrograde ejaculation is related to the removal of the bladder neck (internal sphincter) that occurs during TURP[26].

> PAE uses endovascular surgery rather than transurethral surgery and does not cause urethral injury or necessitate bladder irrigation. Thus, the risk of transurethral resection syndrome, urethral stricture and bladder neck contracture is eliminated<sup>[27]</sup>. For anesthesia, prostate embolization is performed under local anesthesia. Local anesthesia is a safer form of anesthesia for frail patients, and it reduces the risks associated with general anesthesia. Therefore, the PAE group had fewer complications and shorter hospital stays than the TURP group. However, we found that the operation time in the PAE group was similar to that in the TURP group. The longer procedure duration of PAE was often due to difficult anatomy, including tortuosity and atherosclerotic changes of the iliac arteries[28].

> The disadvantages of PAE include radiation exposure and a lack of tissue sampling for histopathological analysis[29]. Due to a lack of data, PAE radiation exposure was not evaluated in our analysis. Laborda described a case of radiation dermatitis in an obese patient after 72 minutes and 8023949 mGy cm<sup>2</sup> of fluoroscopy exposure during a PAE procedure[30]. The radiation dose was usually decreased after approximately 10 cases were performed by interventional radiologists. In addition, the use of conebeam CT (CBCT) reduces the risk of nontargeted embolism[31].

> In the UK Register of Prostate Embolization study, PAE had a reoperation rate of 19.9% within 2 years, whereas only 5% of men who had undergone an initial TURP procedure needed repeat surgery [32]. Furthermore, patients with suboptimal outcomes after PAE were more likely to receive escalation, such as resective techniques, whereas patients were more likely to receive pharmacological treatment after TURP[33]. PAE may fill a therapeutic gap between pharmacological and surgical treatment in the treatment pathway of patients with LUTS/BPH or even replace pharmacological treatment in selected





Figure 8 Forest plot about postoperative changes in sexual function between the prostate artery embolization group and the transurethral resection of the prostate group. A: changes in International Index of Erectile Function score; B: changes in erectile dysfunction; C: changes in retrograde ejaculation

patients.

Nevertheless, our study had some limitations. The main limitation was the heterogeneity generated by different participant selections, embolization patterns, and embolization materials. Subgroup analysis, sensitivity analysis, or the use of random-effects models may reduce this heterogeneity but cannot eliminate it. In addition, the small sample sizes of some of the included studies and the absence of long-term follow-up studies added to the bias.

#### CONCLUSION

In our conclusion, PAE can be performed on an outpatient basis with local anesthesia as an alternative to medication and surgery. It may be an appropriate option for elderly patients, patients who are not candidates for surgery, and patients who do not want to risk the potential adverse effects of TURP, such as urinary incontinence, urinary stricture or retrograde ejaculation. Studies with large numbers of cases and long follow-up times are needed to validate the results.

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Figure 9 Forest plot about procedure time and the hospital stay between the prostate artery embolization group and the transurethral resection of the prostate group. A: Procedure time; B: The hospital stay.

# **ARTICLE HIGHLIGHTS**

#### Research background

Prostate artery embolization (PAE) is a promising minimally invasive therapy that improves lower urinary tract symptoms (LUTS) related to benign prostatic hyperplasia (BPH). Transurethral resection of the prostate (TURP) is the gold standard therapy for LUTS/BPH.

#### **Research motivation**

Although PAE is considered a therapeutic option for LUTS/BPH in the European Association of Urology guidelines and National Institute for Health and Care Excellence, controversy persists regarding PAE in the treatment of LUTS/BPH.

#### **Research objectives**

A literature review was performed to identify all published articles on PAE *vs* TURP for LUTS/BPH. Sources included PubMed, Embase, Cochrane library databases, and Chinese databases before June 2022. A systematic review and meta-analysis were conducted.

#### Research methods

Therefore, we performed a meta-analysis to evaluate the efficacy and safety of PAE compared with TURP, which may help urologists make better choices.

#### **Research results**

Eleven studies involving 1070 participants were included. Compared with the TURP group, the PAE group had a similar effect on the International Index of Erectile Function (IPSS) score, Peak urinary flow rate (Qmax), postvoid residual volume (PVR), Prostate volume (PV), prostatic specific antigen (PSA), The International Index of Erectile Function short form (IIEF-5) scores, and erectile dysfunction during 24 mo follow-up. Lower quality of life (QoL) score, lower rate of retrograde ejaculation and shorter hospital stay in the PAE group. A higher proportion of haematuria, urinary incontinence and urinary stricture was identified in the TURP group.

#### **Research conclusions**

PAE may be an appropriate option for elderly patients, patients who are not candidates for surgery, and patients who do not want to risk the potential adverse effects of TURP.

#### **Research perspectives**

Studies with large cases and long follow-up time are needed to validate results.

#### FOOTNOTES

Author contributions: Wang XY and Chai YM contributed equally to this work; Wang XY, Chai YM and Zhang Y designed the research study; Wang XY and Chai YM performed the research; Huang WH contributed analytic tools; Wang XY, Chai YM and Huang WH analyzed the data, Wang XY and Chai YM wrote the manuscript; all authors have read and approve the final manuscript.

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