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Research Article

Effects of Prostatic Arterial Embolization With α-Blocker for Advanced Age Benign Prostatic Hyperplasia

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Abstract

Background and Objective: There is no universally accepted understanding of the complex pathogenesis of Benign Prostatic Hyperplasia (BPH). Precision prostate artery embolization (PPAE) is performed under the guidance of digital subtraction angiography and can alleviate clinical symptoms caused by BPH. This research assessed the effectiveness of PPAE combined with highly specific α1 blockers for elderly BPH patients. **Materials and Methods**: The 144 elderly BPH patients were split into two groups: 80 for observation and 64 for control. The study treated all participants with α1 blockers, while the observation group additionally received precise prostatic artery embolization (PPAE). Changes in clinical symptoms before and after therapy were monitored.The statistical assessment was done by SPSS 22.00. Count data were reported as a percentage (%), while data were expressed as the Mean $\pm$ Standard Deviation (SD). The threshold of significance was $p < 0.05$. **Results**: The treatment led to a significantly greater overall effective rate in the observation group than in the control group ($p < 0.05$). Both groups had lower international prognostic scoring system (IPSS) and urinary symptom distress (BS) levels than before therapy ($p < 0.05$), with the observation group also having lower scores. After 2 weeks, 1 month, 6 months and 1 year of therapy, both groups saw substantial increases in Q_{max}, while the fraction of residual urine volume (RU), prostate volume (PV) and ischemia were reduced. The observation group improved more significantly than the control group. The observation group was considerably lower than the control group ($p < 0.05$). **Conclusion**: High selectivity α1-receptor blockers have good feasibility in the treatment of elderly BPH and combined with precise PAE can improve the treatment effect, with good safety and reliability.

Keywords: precision prostatic artery embolization; benign prostatic hyperplasia; α-receptor blocker; pathogenesis; urinary symptom distress

1. Introduction

The etiology of Benign Prostatic Hyperplasia (BPH) is intricate and a definitive agreement has not been achieved. Modern studies have shown that the occurrence of BPH is affected by adjacent organ lesions, physical and chemical factors, immunological factors, pathogen infection and other factors [1]. Due to the deep location of the prostate and the special structure of its lipid envelope, it has special anatomical and physiological characteristics, which makes it difficult to deliver drugs deep into the lesion and easy to relapse [2]. However, α1A adrenoceptors, which are mainly distributed in the human prostate, bladder neck, bladder base, prostatic urethra and prostatic bursa, can act selectively on prostate α1 receptor and thereby treating BPH without affecting other systems [3]. As a novel highly selective α1A receptor blocker, cellodoxin is significantly more selective against prostate tissue than blood vessels and has an obvious diastolic effect on the smooth muscle of the lower urinary tract [4].

The precision prostate artery embolization (PPAE) is performed under the guidance of digital subtraction angiography, which can achieve necrosis and atrophy of prostate tissue, thereby alleviating clinical symptoms caused by BPH [5]. Its clinical application is a minimally invasive treatment technology that can directly reach the lesion with a high absorption rate, obvious therapeutic effect, minimal trauma, low side effects, fast patient recovery and fewer complications which is especially suitable for elderly BPH patients who are not suitable for surgical treatment [6].

This research aimed to assess the effectiveness of PPAE in combination with silodosin for treating elderly individuals with benign prostatic hyperplasia (BPH), and to evaluate the clinical outcomes of different treatment approaches.

2. Materials and Methods

2.1 Study Subjects

The current investigation used a retrospective study design to assess 144 senior individuals with elderly BPH

Table 1. Comparison of the two groups of general data.

Group	n	Age (year)	BMI (kg/m^2)	Degree of proliferation (degree I/II/III)	Complicated diseases (hypertension/diabetes/hyperlipidemia)	Prostate volume (mL)	Course of disease (years)
Observation group	80	68.22 ± 3.09	22.23 ± 2.44	40/28/12	16/12/14	76.22 ± 6.79	7.18 ± 0.32
Control group	64	68.11 ± 3.11	22.89 ± 3.19	36/20/8	12/8/12	76.03 ± 7.14	7.23 ± 0.45
t or χ^2		0.212	1.407	0.573	0.346	0.163	0.778
p-value		0.832	0.162	0.751	0.951	0.870	0.438

who were diagnosed at the General Hospital of Huabei Petroleum Administration Bureau between January, 2021 and January, 2022.

The inclusion criteria of patients were (1) Age $\geq$65 years old, 80 patients were enrolled; (2) Patients who fulfilled the diagnostic requirements for BPH [4] and had symptoms such as middle urinary flow, increased nocturia, dysuria, frequent urination and urine weakness; (3) Digital anal examination and ultrasound examination confirmed BPH (4) Diagnostic criteria: TCM diagnosis of blood stasis and damp-heat syndrome BPH; (5) Patient signed the informed consent voluntary; (6) Normal bladder residual urine volume (RU) 6–10 mL and (7) Disease duration for 3 months. The exclusion criteria of patients are (1) Patients without comprehensive clinical information; (2) Individuals suffering from severe cardiovascular, renal and hepatic conditions; (3) Patients with urinary stricture and urinary tract infection and (4) Patients who have previously taken medicine for BPH.

2.2 Treatment Methods

The control group (64 patients) received α-blockers alone, while the observation group (80 patients) received α-blockers combined with precise prostate artery embolization (PPAE). Oral α-blocker drug treatment: Oral silodosin capsules (Daiichi Sankyo (Beijing) Pharmaceutical Co., Ltd., China; Approval Number: H20110100), 4 mg, twice daily. The PPAE treatment: With the femoral artery as the puncture site, after visualization of the prostate artery vessels under image-guided conditions, the F4 Cobra catheter was used to deliver embolic particles. After embolization, angiography confirmed that the prostatic feeding artery was blocked, the catheter and arterial sheath were removed and the puncture site was locally pressurized. Both groups had treatment and were monitored for 4 weeks and then followed up for 12 months.

2.3 Observed Indicators

The efficacy evaluation criteria were determined as per the Guiding Principles for Clinical Research of New Traditional Chinese Medicine: Markedly effective: International Prognostic Scoring System (IPSS) score $\leq$7 points and Q_{max} $\geq$18 mL/s; Effective: IPSS score $\leq$15 points and Q_{max} $\geq$18 mL/s; Invalid: Those that do not meet effective standards:

$$\text{Total effective rate } (\%) = \frac{\text{Effective } + \text{ Significant}}{\text{Total cases}} \times 100$$

All patients underwent IPSS and urinary symptom distress (BS) scores before and after treatment, with a total score of 0–35 for both IPSS and BS. As the score increases, the severity of the overall symptoms or urine distress also increases. Before and after treatment, ultrasound was used to measure RU and urinary flow rate was checked for Q_{max}, prostate volume and ischemic ratio. Follow up and observe the changes in various indicators at different times within 1 year after surgery.

2.4 Statistical Methods

The statistical assessment was done by SPSS 22.00 (IBM Corporation, Armonk, NY, USA). Count data were reported as a percentage (%), while data was expressed as the Mean $\pm$ Standard Deviation (SD). The assessment of groups was done using the χ^2 test and the *t*-test. The threshold of significance was $p < 0.05$.

3. Results

3.1 Clinical Information

The clinical information of all patients was summarized in Table 1. There was no statistically significant difference in clinical information between the two groups of patients ($p > 0.05$)

3.2 Embolization Effect

All patients completed embolization without any serious complications during the surgery. The embolization surgery time was 65.4 $\pm$ 13.23 min and the hospital stay was 9.49 $\pm$ 1.42 days.

3.3 Total Efficiency Comparison

Table 2 presented a comparison of the overall effective rates between the two groups. Following the administration of the therapy, the observation group exhibited a total effective rate of 98.75%, while the control group exhibited a total effective rate of 84.4% ($p < 0.05$).

Table 2. Comparison of total effective rates between two groups (n).

Group	Total (n)	Markedly effective (n)	Effective (n)	Invalid (n)	Total effective rate
Observation group	80	72	7	1	79 (98.75%)
Control group	64	41	13	10	54 (84.38%)
χ^2					3.885
p-value					<0.001

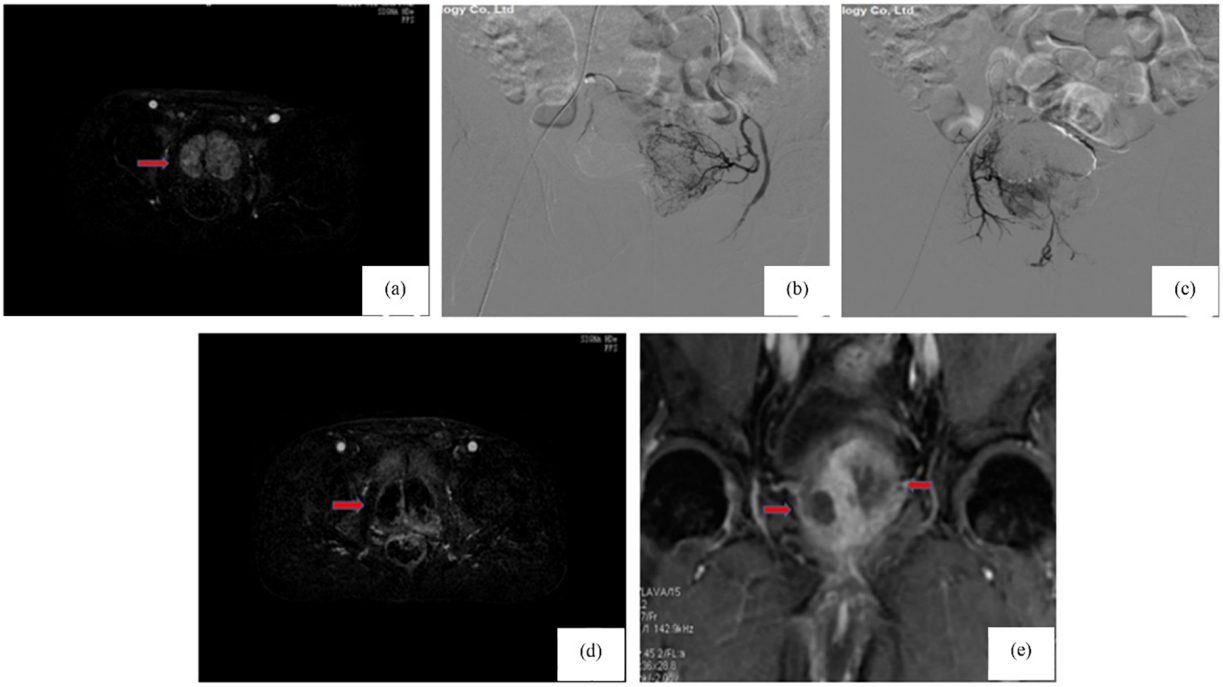

Fig. 1. Changes in the prostate gland's magnetic resonance imaging before and after treatment in the observation group. (a) Preoperative MRI shows prostate enlargement with marked heterogeneous enhancement (arrow); (b) Left prostatic artery; (c) Right prostatic artery; (d) Day 7 post-op: reduced prostate volume and diminished enhancement (arrow), indicating early ischemic necrosis. (e) One year post-op: further shrinkage and patchy non-enhancing areas in the central lobe (arrow), consistent with ischemic necrosis.

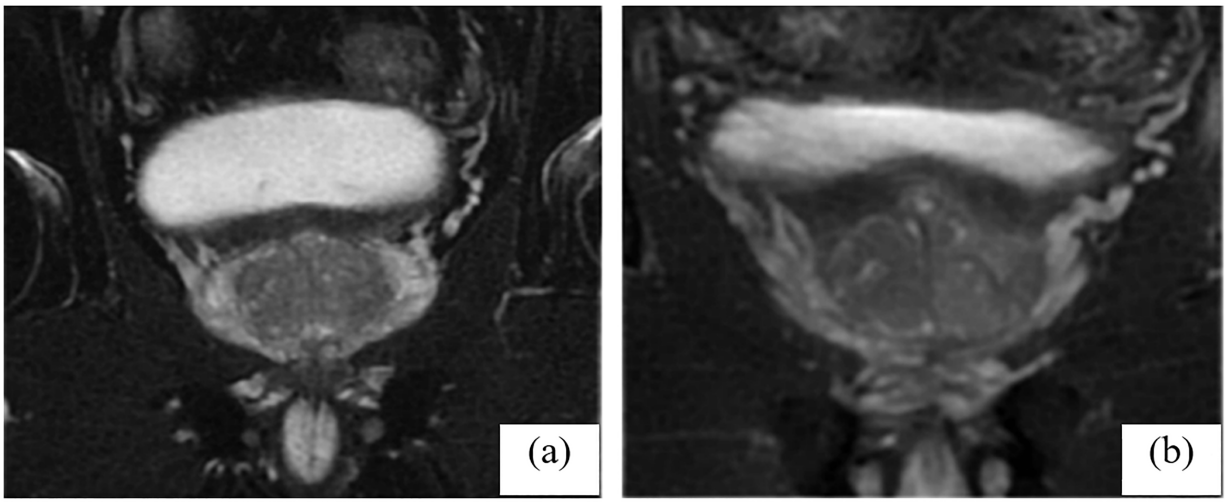

Fig. 2. Dimensions of the prostate's magnetic resonance imaging before and after treatment in the observation group. (a) Prostate's dimensions before therapy and (b) Prostate's dimensions and an uneven signal in the central lobe after therapy.

Table 3. Comparison of changes in international prognostic scoring system (IPSS) and urinary symptom distress (BS) scores between the two groups before and after treatment (scores, $\bar{x} \pm s$).

		IPSS					BS				
Group	n	Before treatment	2 weeks after treatment	1 month after treatment	6 months after treatment	1 year after treatment	After treatment	2 weeks after treatment	1 month after treatment	6 months after treatment	1 year after treatment
Observation group	80	21.49 ± 3.29	14.29 ± 4.53*	10.51 ± 3.88*	6.03 ± 1.77*	3.29 ± 0.76*	22.77 ± 5.11	13.98 ± 5.86*	7.84 ± 4.90*	3.92 ± 3.92*	0.98 ± 0.51*
Control group	64	22.88 ± 4.19	18.49 ± 5.19*	15.51 ± 5.02*	9.32 ± 2.43*	5.86 ± 1.69*	22.19 ± 4.98	17.02 ± 4.11*	10.03 ± 6.05*	5.27 ± 4.11*	1.48 ± 0.66*
t		2.230	5.181	6.742	9.392	12.160	0.685	3.515	2.400	2.010	5.128
p		0.027	<0.001	<0.001	<0.001	<0.001	0.495	0.0006	0.018	0.046	<0.001

Compared to before treatment, *$p < 0.05$.

Table 4. Comparison of RU and Q_{max} changes before and after treatment in the two groups (score, $\bar{x} \pm s$).

		RU (mL)					Q_{max} (mL/sec)				
Group	n	Before treatment	2 weeks after treatment	1 month after treatment	6 months after treatment	1 year after treatment	After treatment	2 weeks after treatment	1 month after treatment	6 months after treatment	1 year after treatment
Observation group	80	36.44 ± 8.22	22.19 ± 5.62*	17.53 ± 5.02*	15.45 ± 4.97*	12.93 ± 3.30*	9.78 ± 1.49	13.39 ± 2.19*	15.12 ± 2.31*	18.58 ± 3.11*	20.51 ± 3.50*
Control group	64	36.10 ± 7.29	27.44 ± 4.44*	21.68 ± 4.01*	18.08 ± 3.90*	20.92 ± 3.53*	9.89 ± 1.22	12.48 ± 2.11*	13.93 ± 2.38*	16.29 ± 2.96*	17.77 ± 2.74*
t		0.259	6.102	5.380	3.464	14.000	0.476	2.518	3.031	4.485	5.129
p		0.796	0.000	0.000	0.000	0.000	0.635	0.013	0.003	0.000	0.000

Compared to before treatment, *$p < 0.05$.

Table 5. Comparison of prostate volume (PV) and ischemia ratio between two groups before and after treatment ($\bar{x} \pm s$).

		PV (mL)					Ischemic ratio (%)				
Group	n	Before treatment	2 weeks after treatment	1 month after treatment	6 months after treatment	1 year after treatment	After treatment (%)	2 weeks after treatment (%)	1 month after treatment (%)	6 months after treatment (%)	1 year after treatment (%)
Observation group	80	116.23 ± 18.57	93.47 ± 16.64*	80.52 ± 14.91*	73.10 ± 12.55*	70.53 ± 12.04*	50.53 ± 10.23	41.90 ± 9.28*	40.90 ± 9.42 *	38.89 ± 11.35*	35.23 ± 11.34*
Control group	64	114.27 ± 18.33	99.01 ± 17.94*	93.19 ± 17.22*	88.26 ± 13.91*	80.17 ± 12.97*	52.34 ± 9.12	46.24 ± 13.12*	44.45 ± 8.43*	43.89 ± 9.25*	38.53 ± 10.43*
t		0.633	1.917	4.729	6.863	4.613	1.107	2.321	2.354	2.847	2.343
p		0.528	0.057	0.000	0.000	0.000	0.270	0.022	0.020	0.005	0.021

Compared to before treatment, *$p < 0.05$.

3.4 Assessment of Changes in IPSS and BS Scores

Table 3 illustrated a comparison of the changes in the IPSS and urinary symptom distress (BS) ratings between the two groups before and after therapy. Following therapy, both groups saw a substantial decrease in their IPSS and BS ratings compared to before treatment ($p < 0.05$). Additionally, the observation group had considerably reduced scores than the control group ($p < 0.05$).

3.5 Comparison of Changes in RU and Q_{max}

Table 4 presented a comparison of the changes in RU and Q_{max} before and after therapy in the two groups. Both groups exhibited a noteworthy rise in Q_{max} and a notable decrease in RU at various time points after the therapy ($p < 0.05$) (Table 4).

3.6 Assessment of Prostate Volume (PV) and Ischemia Ratio (1, 6 and 12 Months)

Table 5 illustrated a comparison of prostate volume (PV) and ischemia ratio between the two groups before and after therapy. At the 2 week, 1 month, 6 month and 1 year follow-up intervals after treatment, there was a substantial reduction in the proportion of ischemia and PV in both groups compared to before treatment. Furthermore, the observation group exhibited a considerably greater drop than the control group ($p < 0.05$).

3.7 Special Instructions and Follow-up Results of Recurrence and Adverse Reactions

This study specifically states that the duration of treatment in two groups was 4 weeks. In the observation group, there was no recurrence within 1 month after treatment. However, 1 case had a recurrence within 3 months, 3 cases experienced a recurrence within 6 months and 5 cases experienced a recurrence within 12 months. In the control group, there were 10 cases of recurrence within 1 month after treatment, 13 cases within 3 months and 23 cases within 12 months. Recurrent patients were followed up with the study group's treatment method and the treatment effect was the same in the study group. All patients in this study did not experience serious complications, only mild complications such as low fever, burning sensation at the urethral opening, hematospermia, transient hematuria and mild pain in the pubic region. The incidence rate in the observation group was much lower than that in the control group and that variation was statistically noteworthy ($p < 0.05$). The imaging findings in the observation group before, during and at follow-up showed a good prognosis (Fig. 1a–e).

Pre-operative enhanced magnetic resonance imaging of the prostate shows (Fig. 1a) approximately 7.2 × 6.2 × 6.8 cm (RL × AP × SI), dynamic enhancement shows significant unevenness and strength of the prostate gland. Intraoperative digital subtraction angiography (DSA) imaging shows (Fig. 1b) that the left prostatic artery is narrow and tortuous and iodine staining of the left prostate is visible. Intraoperative DSA angiography shows (Fig. 1c) that the right prostatic artery is thin and tortuous and iodine staining of the right prostate is visible. On the 7th day after the operation, the re-examination of the enhanced MRI showed (Fig. 1d) the prostate size was approximately 6.7 × 6.3 × 5.7 cm (RL × AP × SI), which was smaller than before the operation and the degree of central glandular enhancement was weaker than before the operation. There was no obvious area of enhancement. Ischemic necrosis was considered. One year after the operation, the re-examination of the enhanced MRI showed (Fig. 1e) that the size of the prostate was approximately 6.6 × 5.6 × 5.3 cm (RL × AP × SI), which was smaller than 2 years ago and multiple patchy nonenhanced areas were seen in the central lobe. Ischemic necrotic changes were considered. Fig. 2a illustrated that the dimensions of the prostate were around 5.7 × 3.6 × 3.2 cm (right-left × anterior-posterior × superior-inferior) and there was an abnormal signal in the central lobe before therapy. Fig. 2b displayed the dimensions of the prostate, which are about 5.7 × 3.7 × 3.2 cm (right-left × anterior-posterior × superior-inferior), along with an uneven signal in the central lobe after the therapy.

4. Discussion

The research found that the observation group had a considerably greater effective rate compared to the control group. After therapy, both groups showed a substantial decrease in their IPSS and BS levels compared to prior therapy. Additionally, the observation group had lower scores than the control group. The occurrence of negative responses and complications in the observation group was drastically reduced compared to the control group. This study demonstrated that following therapy, there was a significant increase in the Q_{max} and a significant decrease in the resistance to RU in both groups ($p < 0.05$). Additionally, the PV and the ratio of ischemic events in the bladder were significantly reduced at 2 weeks, 1 month, 6 months and 1 year after treatment compared to before treatment. Furthermore, the observation group exhibited significant changes compared to the control group.

Finally, follow-up revealed no recurrence in the observation group. Then 1 month after treatment, 1 case recurred in 3 months, 3 cases recurred in 6 months and 5 cases recurred in 12 months. In the control group, 10 cases recurred 1 month after treatment, 13 cases recurred 3 months after treatment and 23 cases recurred 12 months after treatment. Patients with recurrence were treated with follow-up treatment in the study group and the treatment effect was the same in the study group. All patients in this study had no serious complications, only mild complications such as low-grade fever, burning sensation at the urethral orifice, blood in the urine, transient hematuria, mild pain in the pubic region and so on. The occurrence rate in the observation group was considerably reduced compared to the control group and the imaging results of the observation

group indicated a favourable prognosis before, during and after follow-up. This further illustrates that precise prostatic artery embolization combined with high selectivity $\alpha 1$ receptor blockers have good efficacy and high safety in the treatment of BPH in the elderly.

The BPH is more prevalent in older men and its incidence has been increasing in recent years as the population gets older. The purpose of BPH treatment is to prevent and delay the progression of hyperplasia to alleviate symptoms and improve quality of life [7]. However, as organs age and various physiological functions deteriorate, the tolerance of many patients to surgery is significantly reduced. The BPH is often accompanied by increased blood supply to the prostate, which provides an important theoretical basis for the treatment of precise prostatic artery embolization [8].

Silodosin for α-receptor blockers can relax the smooth muscle of the posterior urethra, prostate and bladder neck and have the advantages of convenient administration. However, the curative effect of some patients is not ideal and they have certain adverse reactions [9]. Although the mechanism of prostatic artery embolization is not yet fully understood, the short and medium-term results of many studies show that clinical parameters routinely used to quantify BPH-related lower urinary tract symptoms have been significantly improved [10]. The clinical efficacy of prostatic artery embolization, combined with the generally low incidence of minor complications, makes it more suitable for the treatment of older patients [11]. Prior research has demonstrated that the clinical success percentage of BPH after transprostatic arterial embolization is 79.1–85.7%, while the short to medium-term success rate is 72.1–98%, which is derived from the statistically significant improvement in all outcome parameters, supporting the role of PAE as an effective alternative to standard operation urological treatment, especially in patients who are not candidates for operation [12]. Precise prostatic artery embolization may be performed under local anesthesia and does not harm the central nervous system, which may explain the reason for its effectiveness [13,14]. It can obstruct the blood flow to the prostatic artery, leading to the shrinkage of the prostatic artery, a notable improvement in clinical symptoms [15], low damage to the surrounding tissue, faster recovery after surgery, a substantial therapeutic benefit and few negative side effects [16,17].

Increased blood supply is the basic condition of BPH and the arterial source of the prostate is abundant [18]. Under the condition of cutting off the blood supply and nutrition of the tumor, the local tumor will atrophy or necrosis, which provides a theoretical basis for embolization treatment. Silodosin is a prostate $\alpha 1$ receptor blocker, which has the function of relaxing the smooth muscle of the prostate, stopping congestion and improving clinical symptoms [19]. It is suggested that embolization combined with silodosin can effectively relieve the adverse symptoms of elderly patients with BPH and the current studies show that precise prostatic artery embolization can also reduce sympathetic nerve excitability, relieve pelvic floor muscle spasms, relieve congestion and reduce pain [20–22]. In summary, PPAE and highly selective $\alpha 1$ receptor blockers can relieve clinical symptoms and improve urinary function in elderly benign prostatic hyperplasia patients, making it a promising clinical treatment.

5. Conclusion

Overall, this study demonstrates that precise prostatic artery embolization combined with highly selective $\alpha 1$ receptor blockers is highly effective and safe in treating elderly patients with BPH. The observation group showed superior treatment outcomes, symptom improvement, lower recurrence rates and fewer complications compared to the control group. This method effectively alleviates clinical symptoms, improves urinary function and holds promising clinical application prospects.

6. Significance Statement

This study demonstrates that precise prostatic artery embolization combined with highly selective $\alpha 1$ receptor blockers shows significant efficacy and high safety in treating elderly patients with benign prostatic hyperplasia (BPH). The observation group outperformed the control group in overall effective rates, IPSS and BS scores, changes in Q_{max} and residual urine (RU), as well as reductions in prostate volume and ischemia ratio, with a lower incidence of complications. This approach significantly improves clinical symptoms and quality of life, providing an effective alternative treatment option for elderly patients who are not suitable candidates for surgery.

Availability of Data and Materials

The datasets used or analyzed during the current study are available from the corresponding author on reasonable request.

Author Contributions

QW and HZ designed and supervised the research and WH drafted the initial version of the article. KY, JZ and JL examined unprocessed data. YB, LZ, FG, WH, JC and FL conducted statistical and bioinformatics analysis. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

The Ethics Committee of the General Hospital of Huabei Petroleum Administration Bureau is approved the probe (Reg No: 2023/BPH/345). Informed consent was obtained from all participants prior to enrollment. This

manuscript describes a clinical intervention involving human subjects and was conducted in full accordance with the ethical principles set forth in the Declaration of Helsinki.

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Conflict of Interest

The authors declare no conflict of interest.

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