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Prostatic Artery Embolization is Similarly Efficacious to Transurethral Resection of the Prostate (TURP) with a Better Safety Outcome: A Systematic Review and Meta-Analysis

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ABSTRACT

Benign prostatic hyperplasia (BPH) is a prevalent condition affecting over 50% of men aged 60 years and older, often leading to lower urinary tract symptoms (LUTS) that significantly reduce quality of life. Transurethral resection of the prostate (TURP) remains the standard treatment for moderate to severe BPH; however, it is associated with notable complications. Prostatic artery embolization (PAE) has emerged as a minimally invasive alternative with potential advantages in safety and recovery. This study aims to evaluate and compare the safety and efficacy of PAE and TURP in treating BPH, focusing on symptom improvement, prostate volume reduction, hospital stay duration, and adverse events. A systematic review and meta-analysis were conducted following PRISMA guidelines. Literature searches were performed in PubMed, the Cochrane Library, and ScienceDirect up to May 3, 2025. Studies comparing PAE and TURP reporting outcomes such as IPSS, prostate volume, length of stay, and adverse events were included. Data extraction and quality assessment were conducted using the RoB-2 tool, while statistical analysis was performed using Review Manager version 5.4. The findings revealed a non-significant trend favoring PAE in improving IPSS scores (mean difference -2.71, p=0.12) and reducing prostate volume (mean difference -9.62 mL, p=0.08). However, PAE significantly reduced hospital stay duration (mean difference -1.52 days, p<0.0001) and showed a lower risk of severe adverse events (relative risk 0.37, p=0.05) compared to TURP. In conclusion, PAE demonstrates comparable effectiveness to TURP with improved safety and shorter hospitalization, making it a promising minimally invasive alternative.

INTRODUCTION

Benign prostatic hyperplasia (BPH) is a common condition that impacts over 50% of men aged 60 and older (Levy & Samraj, 2007). In certain individuals, the disease's clinical presentation may include symptoms of the lower urinary tract, including an interrupted and feeble urinary stream, nocturia, urgency, and leaking, as well as sexual dysfunction. Medical waiting, minimally invasive approaches, alpha-1-blockers, or surgical therapies are frequently employed as treatment options for BPH. The use of 5-reductase inhibitors, which have been deemed the first-line treatment, has been demonstrated to reduce prostate volumes by over 30 ml (Eckhardt et al., 2001; Sarma & Wei, 2012). In the event of unsuccessful medical management, surgical interventions (transurethral resection of the prostate or open surgery) are implemented. The gold standard of treatment for males with prostate volumes of 30–80 ml is transurethral resection of the prostate (TURP), which is also appropriate for those with prostate volumes exceeding 80 ml (Bachmann et al., 2013; Oelke et al., 2013). Nevertheless, the

complications of TURP include retrograde ejaculation, postoperative hemorrhage, continent urinary retention, TURP syndrome, and urinary stricture (Joshi et al., 2015; Pasha et al., 2015; Pavone et al., 2015). Prostatic artery embolization (PAE) has been proposed as a minimally invasive interventional radiological procedure (Abt et al., 2018). In PAE, the bilateral or unilateral injection of microspheres or small particulates or directly into the prostatic arteries may lead to ischemia or an enlarged prostate. Michlle et al. were the first to report that the embolization of hypogastric arteries (PAE) could be employed to manage extensive prostate hemorrhage caused by BPH (Lin et al., 2016; Mitchell et al., 1976).

Transurethral resection of the prostate (TURP) remains the standard treatment for cases characterized by moderate to severe symptoms of the lower urinary tract. Nevertheless, the procedure is associated with a substantial complication rate and is restricted to prostates that are smaller than 60-80 ml (Reich et al., 2008; Sun et al., 2008). The cumulative short-term morbidity rate is approximately 11%, and the need for surgical revision is as high as 6%. Transurethral resection syndrome and bleeding necessitating transfusions pose potentially severe risks to elderly and debilitated patients. Prostatic artery embolization (PAE) has been recommended as a minimally invasive alternative procedure that can be performed in an ambulatory setting, resulting in rapid recovery and low morbidity (DeMeritt et al., 2000; Jeon et al., 2009; Lang et al., 1979).

In 1979, Lang et al. introduced PAE as a treatment option for intractable proteogenic hemorrhage.15 In recent decades, technical advancements have enabled PAE to become a safe and effective treatment. DeMeritt et al. were the first to report on the relief of BPH-related bladder outlet obstruction after trans arterial polyvinyl alcohol prostate embolization in 2000, using PAE for this purpose.

The first publication on the intentional treatment of BPH by PAE was in 2008. Consequently, patients with symptomatic BPH who were refractory to medical treatment could demonstrate optimistic short- and medium-term outcomes: A reduction in prostate volume and post-void residual urine, as well as a significant improvement in the International Prostate Symptom Score (IPSS) and maximal urinary flow rate, were reported in numerous studies (Carnevale et al., 2010, 2013; Kurbatov et al., 2014; Rio Tinto et al., 2012). The methods and techniques for performing PAE are well-established and have been detailed in numerous publications (Bilhim et al., 2013; Martins Pisco et al., 2012). In meticulously selected patients, PAE was demonstrated to be a secure procedure with minimal morbidity.

The clinical outcomes and safety of TURP and PAE have been compared in numerous studies. Schreuder et al. conducted a systematic review of the efficacy of TURP and PAE in the treatment of BPH. A recent observational study conducted by Ray et al. compared the safety and efficacy of PAE and TURP in the treatment of BPH. Feng et al. conducted a meta-analysis of 20 studies that investigated the efficacy of PAE in the treatment of BPH. Nevertheless, no meta-analysis has been conducted to compare the clinical efficacy and safety of TURP and PAE.

METHOD

Search strategy

The Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) criteria were adhered to in the conduct and reporting of this meta-analysis. A comprehensive literature search was conducted using PubMed, the Cochrane Library, and ScienceDirect up to May 3, 2025. The literature search was conducted using the following keywords: "benign prostate hyperplasia AND (Transurethral Resection of the prostate OR TURP) AND Artery embolization. Articles with pertinent titles and abstracts would be incorporated into this process to facilitate their comprehensive evaluation and subsequent qualitative and quantitative analysis.

Inclusion and exclusion criteria

The studies were evaluated based on the following inclusion criteria: (1) studies that involved BPH patients; (2) studies that compared PAE with TURP; and (3) studies that reported IPSS, prostate volume, length-of-stay, and adverse events as their final outcomes. As a result, the subsequent exclusion criteria were established: 1) Irretrievable full-text articles and 2) studies that are inappropriate in terms of their design, intervention, or outcome. FIGURE 1 illustrates the specifics of the study search strategy.

Data extraction and risk of bias assessment

Subsequently, we extracted data from our selected articles. Articles were also assessed in terms of quality by using RoB-2 Tool provided by Cochrane. Quality assessment was done collaboratively by all reviewers until consensus was reached.

Statistical Analysis

Meta-analysis was implemented with Review Manager ver. 5.4 (Copenhagen: The Nordic Cochrane Centre. The Cochrane Collaboration). The odds ratio (OR) and Mean Difference (MD) along with its 95% confidence interval (CI) were identified as common measures. In anticipation of clinical heterogeneity, random-effects models were implemented to aggregate effect sizes. The analysis result is deemed significant if the p-value is less than

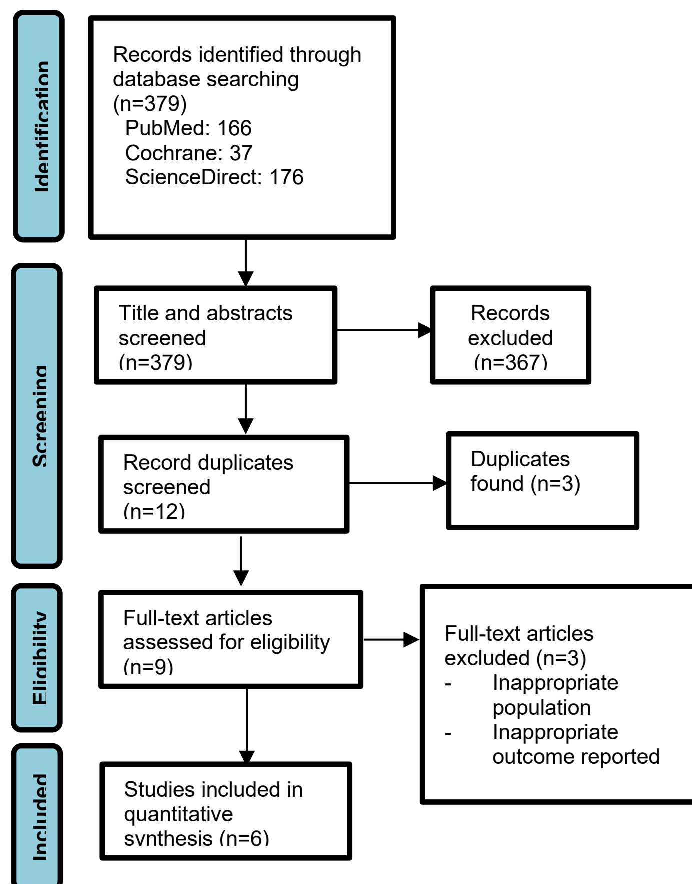
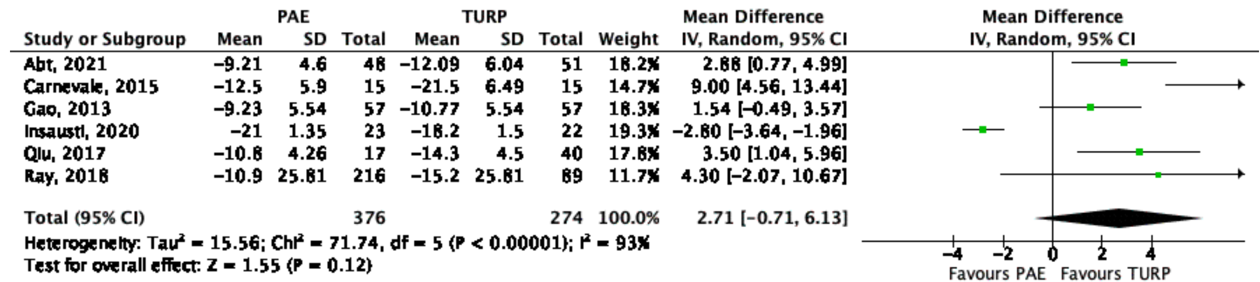


Figure 1. Diagram flow of literature search strategy for this meta-analysis

0.05. Investigation of heterogeneity was conducted using the Higgins I-squared (I2) statistical model. The heterogeneity test results were classified as negligible (0-25%), low (25%-50%), moderate (50-75%), or high (<75%).

RESULT AND DISCUSSION



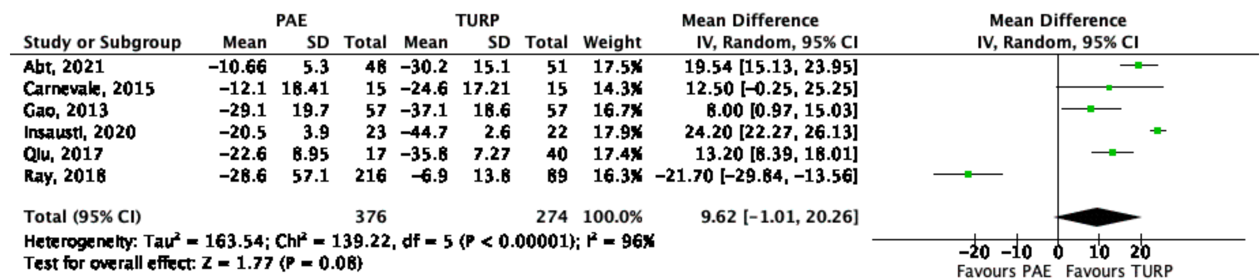
Study or Subgroup	PAE Mean	PAE SD	PAE Total	TURP Mean	TURP SD	TURP Total	Weight	Mean Difference IV, Random, 95% CI
Abt, 2021	−9.21	4.6	48	−12.09	6.04	51	18.2%	2.88 [0.77, 4.99]
Carnevale, 2015	−12.5	5.9	15	−21.5	6.49	15	14.7%	9.00 [4.56, 13.44]
Gao, 2013	−9.23	5.54	57	−10.77	5.54	57	18.3%	1.54 [−0.49, 3.57]
Insausti, 2020	−21	1.35	23	−18.2	1.5	22	19.3%	−2.80 [−3.64, −1.96]
Qiu, 2017	−10.8	4.26	17	−14.3	4.5	40	17.8%	3.50 [1.04, 5.96]
Ray, 2018	−10.9	25.81	216	−15.2	25.81	89	11.7%	4.30 [−2.07, 10.67]
Total (95% CI)			376			274	100.0%	2.71 [−0.71, 6.13]

Heterogeneity: $Tau^2 = 15.56; Chi^2 = 71.74, df = 5 (P < 0.00001); I^2 = 93\%$
Test for overall effect: Z = 1.55 (P = 0.12)

Figure 2. Pooled results on the reduction IPSS score between PAE and TURP

For the treatment of benign prostatic hyperplasia (BPH), the systematic review and meta-analysis demonstrated a mean difference of -2.71 points in the reduction of the International Prostate Symptom Score (IPSS) between prostatic artery embolization (PAE) and the gold-standard transurethral resection of the prostate (TURP). The p-value of 0.12 indicates that the difference is not statistically significant, and the confidence interval ranged from -0.71 to 6.13. This suggests that, although PAE may decrease the IPSS score, the evidence does not conclusively establish a superior benefit over TURP in terms of symptom relief.

Prostate volume



Study or Subgroup	PAE Mean	PAE SD	PAE Total	TURP Mean	TURP SD	TURP Total	Weight	Mean Difference IV, Random, 95% CI
Abt, 2021	−10.66	5.3	48	−30.2	15.1	51	17.5%	19.54 [15.13, 23.95]
Carnevale, 2015	−12.1	18.41	15	−24.6	17.21	15	14.3%	12.50 [−0.25, 25.25]
Gao, 2013	−29.1	19.7	57	−37.1	18.6	57	16.7%	8.00 [0.97, 15.03]
Insausti, 2020	−20.5	3.9	23	−44.7	2.6	22	17.9%	24.20 [22.27, 26.13]
Qiu, 2017	−22.6	8.95	17	−35.8	7.27	40	17.4%	13.20 [8.39, 18.01]
Ray, 2018	−28.6	57.1	216	−6.9	13.8	89	16.3%	−21.70 [−29.84, −13.56]
Total (95% CI)			376			274	100.0%	9.62 [−1.01, 20.26]

Heterogeneity: $Tau^2 = 163.54; Chi^2 = 139.22, df = 5 (P < 0.00001); I^2 = 96\%$
Test for overall effect: Z = 1.77 (P = 0.08)

Figure 3. Pooled results on the reduction prostate volume between PAE and TURP

The analysis revealed a mean difference of -9.62 mL in the reduction of prostate volume between PAE and TURP. The p-value was 0.08, and the 95% confidence interval encompassed the values of -1.01 and 20.26. While there is a trend in favor of PAE in reducing prostate volume, the result is not statistically significant, indicating that additional research may be necessary to provide a more definitive conclusion regarding the efficacy of PAE in reducing prostate size in comparison to TURP.

Length-of-stay

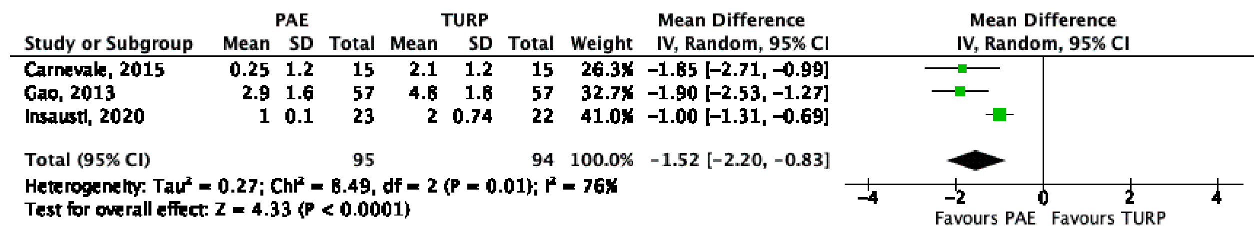


Figure 4. Pooled results on the length-of-stay between PAE and TURP

The mean difference in the length of hospital stay between PAE and TURP was -1.52 days, with a highly significant p-value of less than 0.0001 and a 95% confidence interval ranging from -2.2 to -0.83. The results of this study suggest that patients who underwent PAE experienced a statistically significant decrease in the duration of their hospital stays. This underscores the potential benefits of PAE in terms of healthcare resource utilization and patient recovery periods.

Adverse events (Clavin ≥3)

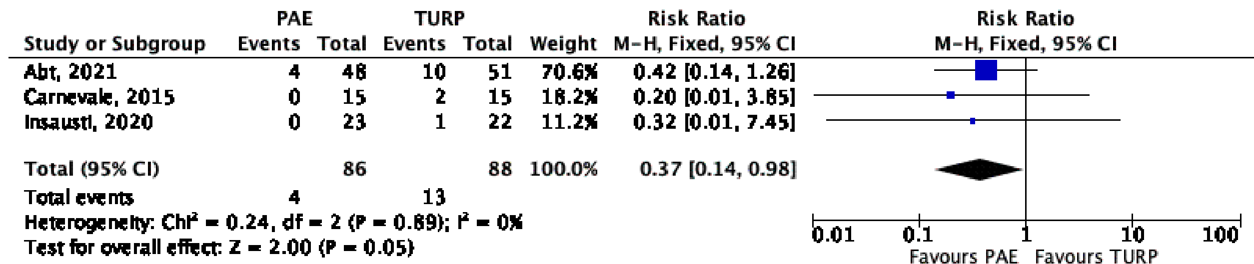


Figure 5. Pooled results on the adverse events between PAE and TURP

The relative risk of severe adverse events associated with PAE was determined to be 0.37 in comparison to TURP, with a confidence interval of 0.14 to 0.98 and a p-value of 0.05. This suggests that PAE may be a safer alternative to TURP in terms of adverse event profiles, as it has a statistically significant reduction in the risk of severe sequelae. These results indicate that PAE may provide a more favorable safety profile, potentially rendering it an appealing alternative for patients who are at a higher risk of complications.

The results of this systematic review and meta-analysis offer valuable insights into the comparative efficacy and safety of transurethral resection of the prostate (TURP) and prostatic artery embolization (PAE) in the treatment of benign prostatic hyperplasia (BPH). Although the International Prostate Symptom Score (IPSS) showed a mean improvement in PAE compared to TURP, the absence of statistical significance in the reduction of IPSS suggests that both procedures may provide comparable symptom relief. This result emphasizes the necessity of additional research to investigate whether specific patient populations may experience higher levels of symptom management from one procedure than from the other.

The analysis suggested a trend in favor of PAE in terms of prostate volume reduction, albeit without statistical significance. This finding emphasizes the potential of PAE to reduce prostate size; however, the extensive confidence interval implies that the data is subject to variability and uncertainty. In order to gain a more comprehensive understanding of the long-term effects of PAE on prostate volume and whether it can consistently match or exceed the efficacy of TURP, future studies with larger sample sizes and extended follow-up periods are required (Bilhim, Costa, et al., 2022; Carnevale & Antunes, 2013; J. A. Pereira et al., 2012; Schreuder et al., 2014).

The statistically significant reduction in hospital stay associated with PAE is a significant finding from this study. This result implies that PAE may provide logistical and economic benefits over TURP by minimizing hospital resources and reducing patient recovery times. The shorter duration of stay is a critical factor for healthcare systems that are striving to enhance patient throughput and efficiency, as well as for patients who prioritize a faster recovery and return to daily activities (Bilhim et al., 2016; Malling, Røder, Brasso, et al., 2019; Uflacker et al., 2016).

Ultimately, the analysis demonstrated a statistically significant decrease in the likelihood of severe adverse events with PAE when contrasted with TURP. This discovery is especially pertinent for patients who are at a higher risk of complications or who may not be the most suitable candidates for more invasive surgical procedures. The reduced relative risk of adverse events, which is indicative of PAE's enhanced safety profile, renders it an appealing alternative for specific patient populations. Nevertheless, additional research is necessary to verify these safety benefits across a variety of populations and to assess long-term results. In general, this investigation contributes to the expanding body of evidence that bolsters the use of PAE as a viable alternative in the treatment of BPH, with a particular emphasis on safety and recovery.

The rate of unilateral PAE has decreased from 14% to 7% in the past decade as microcatheter and microwire technology has improved (Knight et al., 2021). We recently conducted a review of our unilateral PAE rate from 2019–2022, which was subsequently reduced to 2%. Unilateral PAE has been demonstrated to be a predictor of clinical failure (Zumstein et al., 2019). Consequently, it is crucial to embolize both sides of the prostate organ. In patients with benign prostatic hyperplasia (BPH), PAE is employed to alleviate symptoms of the lower urinary tract. Systematic evaluations and meta-analyses have demonstrated its safety and efficacy (Rink et al., 2022; Wu et al., 2022). In addition, there is a substantial body of evidence that compares PAE to surgery, with systematic reviews and meta-analyses demonstrating that the relief of symptoms in the lower urinary tract is comparable (Bilhim, Betschart, et al., 2022; Foster et al., 2019). Nevertheless, surgery resulted in a greater improvement in objective parameters, such as prostate volume and maximal urinary flow rate. In contrast, PAE is more secure and has shorter recovery times than surgery (Bilhim, 2022; K. Pereira et al., 2016). The cost-effectiveness of PAE has also been demonstrated (Chen et al., 2017; Tian et al., 2019). The minimally invasive nature of PAE is significantly distinct from that of other minimally invasive urologic alternatives.34 Nevertheless, it is imperative to demonstrate long-term, sustained clinical relief in order to establish its value in current urology guidelines and to elucidate its position among BPH treatment options. Despite the fact that PAE is only recommended in clinical trials for the North American Urology Society, the European Urology Guidelines have adopted it as an experimental treatment option (Ayyagari et al., 2020; Malling, Røder, Lindh, et al., 2019). The role of PAE in the management of patients with BPH is becoming more apparent, and it is probable that long-term studies will be conducted (Bhatia et al., 2018). Re-intervention rates are higher after PAE than after surgery, with a 20% rate in the first five years and up to 60% after 10 years. Nevertheless, the procedure's minimally invasive nature, safety profile, recuperation process, and potential for repetition render it an extremely appealing alternative for a high number of patients with BPH. It is crucial to employ a multidisciplinary approach that encompasses both interventional radiologists and urologists in order to provide patients with guidance and determine the most suitable treatment for men with BPH.

Refractory hematuria of prostatic origin (RHPO) caused by prostate cancer or BPH may be managed with PAE. It is imperative to conduct a comprehensive urologic examination and consultation in order to rule out any other potential causes of hematuria. Prostatic hematuria caused by prostate cancer is a difficult condition to manage clinically, and it is frequently

initially treated with continuous bladder irrigation. Cystoscopy transurethral interventions may be required in cases that are more advanced. Nine prostate cancer patients who had previously undergone bladder irrigation and cystoscopy intervention were assessed for refractory hematuria in a single study. The hematuria of six out of nine patients (67%) was resolved as a result of PAE. Twenty patients with hematuria caused by BPH underwent PAE in an additional study. This indicated that the hematuria was resolved in 85% of patients at 3 months and in 80% of patients at 12 months. In a separate study that assessed extensive hematuria in BPH patients, 34 out of 37 (92%) patients were hematuria-free 483 ± 137 days after undergoing PAE (Rampoldi et al., 2017).

PAE may also serve as a palliative treatment for patients with prostate cancer who have catheter-dependent urinary retention or LUTS. In a small study of advanced prostate cancer patients with significant LUTS who were not surgical candidates, PAE was efficacious in reducing their International Prostate Symptom Score (IPSS) by a mean of 12.2 points in 5 patients.

Patients who have chronic indwelling catheters as a result of BPH may also benefit from PAE. Surgical treatment options may be restricted for a significant number of these patients, as they are not suitable candidates for surgery. The quality of life and activities of daily living of a patient are substantially impacted by the long-term use of an indwelling catheter. PAE has been demonstrated to be a safe and effective treatment for catheter-dependent BPH, including a substantial enhancement in quality of life in numerous studies. catheter-dependent patients who were not surgical candidates following PAE were assessed in a single study. Thirty-three patients (81%) underwent catheter removal. The results of another study were comparable, with 80% of catheter-dependent patients becoming catheter-free three months after undergoing PAE. Another study yielded comparable findings, demonstrating that 33 out of 38 (87%) catheter-dependent patients were capable of becoming catheter-free after three months (Tapping & Boardman, 2019).

A rare complication of TURP or urologic intervention is iatrogenic hemorrhage. Conservative management is the initial treatment for iatrogenic hemorrhage following surgery. PAE has been shown to be a reasonable and effective alternative in patients who have failed initial conservative medical management. This may be particularly true when the source is prevented from being adequately visualized during cystoscopy due to excessive hemorrhage (Kably et al., 2016).

Lastly, prostate artery embolization is a viable treatment option for patients who have previously failed transurethral interventions for BPH. Three patients who initially failed transurethral intervention experienced positive outcomes three months after prostate artery embolization in a single study. The prostate organ size was reduced by approximately 32%, and the IPSS score was reduced by a mean of 13.7 in these patients. PAE may continue to be administered subsequent to urologic therapies.

CONCLUSION

In summary, this systematic review and meta-analysis offer a thorough comparison of transurethral resection of the prostate (TURP) and prostatic artery embolization (PAE) for the treatment of benign prostatic hyperplasia (BPH). Despite the fact that PAE is a prospective alternative to TURP, particularly in terms of a reduced hospital stay and a lower risk of severe adverse events, the results indicate that it does not exhibit a statistically significant advantage in symptom relief or prostate volume reduction. PAE is an alluring alternative for patients who are unsuitable for surgery or at a higher risk of complications due to its minimally invasive nature and favorable safety profile. Nevertheless, the urgent need for additional research to determine the definitive efficacy and safety of PAE in comparison to TURP is underscored by the variability in data and the necessity of long-term studies. This study emphasizes the

significance of a multidisciplinary approach in determining the most appropriate treatment for BPH, taking into account both patient-specific factors and the utilization of healthcare resources.

REFERENCE

Abt, D., Hechelhammer, L., Müllhaupt, G., Markart, S., Güsewell, S., Kessler, T. M., & al., et. (2018). Comparison of prostatic artery embolisation (PAE) versus transurethral resection of the prostate (TURP) for benign prostatic hyperplasia: randomised, open label, non-inferiority trial. *BMJ*, k2338. https://doi.org/10.1136/bmj.k2338

Ayyagari, R., Powell, T., Staib, L., Chapiro, J., Perez-Lozada, J. C., Bhatia, S., & al., et. (2020). Prostatic Artery Embolization in Nonindex Benign Prostatic Hyperplasia Patients: Single-center Outcomes for Urinary Retention and Gross Prostatic Hematuria. *Urology*, *136*, 212–217. https://doi.org/10.1016/j.urology.2019.10.018

Bachmann, A., Muir, G. H., Wyler, S. F., & Rieken, M. (2013). Surgical Benign Prostatic Hyperplasia Trials: The Future is Now! *European Urology*, *63*(4), 677–679. https://doi.org/10.1016/j.eururo.2012.10.039

Bhatia, S., Sinha, V. K., Kava, B. R., Gomez, C., Harward, S., Punnen, S., & al., et. (2018). Efficacy of Prostatic Artery Embolization for Catheter-Dependent Patients with Large Prostate Sizes and High Comorbidity Scores. *Journal of Vascular and Interventional Radiology*, *29*(1), 78–84. https://doi.org/10.1016/j.jvir.2017.08.028

Bilhim, T. (2022). Long-Term PAE Results: What Do We Know. *Seminars in Interventional Radiology*, *39*(6), 577–580. https://doi.org/10.1055/s-0042-1758720

Bilhim, T., Betschart, P., Lyatoshinsky, P., Müllhaupt, G., & Abt, D. (2022). Minimally Invasive Therapies for Benign Prostatic Obstruction: A Review of Currently Available Techniques Including Prostatic Artery Embolization, Water Vapor Thermal Therapy, Prostatic Urethral Lift, Temporary Implantable Nitinol Device and Aquablation. *Cardiovascular and Interventional Radiology*, *45*(4), 415–424. https://doi.org/10.1007/s00270-021-03040-2

Bilhim, T., Costa, N. V, Torres, D., Pinheiro, L. C., & Spaepen, E. (2022). Long-Term Outcome of Prostatic Artery Embolization for Patients with Benign Prostatic Hyperplasia: Single-Centre Retrospective Study in 1072 Patients Over a 10-Year Period. *Cardiovascular and Interventional Radiology*, *45*(9), 1324–1336. https://doi.org/10.1007/s00270-022-03209-z

Bilhim, T., Pisco, J., Campos Pinheiro, L., Rio Tinto, H., Fernandes, L., Pereira, J. A., & al., et. (2013). Does Polyvinyl Alcohol Particle Size Change the Outcome of Prostatic Arterial Embolization for Benign Prostatic Hyperplasia? Results from a Single-Center Randomized Prospective Study. *Journal of Vascular and Interventional Radiology*, *24*(11), 1595–1602. https://doi.org/10.1016/j.jvir.2013.07.010

Bilhim, T., Pisco, J., Pereira, J. A., Costa, N. V, Fernandes, L., Campos Pinheiro, L., & al., et. (2016). Predictors of Clinical Outcome after Prostate Artery Embolization with Spherical and Nonspherical Polyvinyl Alcohol Particles in Patients with Benign Prostatic Hyperplasia. *Radiology*, *281*(1), 289–300. https://doi.org/10.1148/radiol.2016151202

Carnevale, F. C., & Antunes, A. A. (2013). Prostatic Artery Embolization for Enlarged Prostates Due to Benign Prostatic Hyperplasia. How I Do It. *Cardiovascular and Interventional Radiology*, *36*(6), 1452–1463. https://doi.org/10.1007/s00270-013-0787-2

Carnevale, F. C., Antunes, A. A., da Motta Leal Filho, J. M., de Oliveira Cerri, L. M., Baroni, R. H., Marcelino, A. S. Z., & al., et. (2010). Prostatic Artery Embolization as a Primary Treatment for Benign Prostatic Hyperplasia: Preliminary Results in Two Patients. *Cardiovascular and Interventional Radiology*, *33*(2), 355–361.

https://doi.org/10.1007/s00270-009-9727-z
Carnevale, F. C., da Motta-Leal-Filho, J. M., Antunes, A. A., Baroni, R. H., Marcelino, A. S. Z., Cerri, L. M. O., & al., et. (2013). Quality of Life and Clinical Symptom Improvement Support Prostatic Artery Embolization for Patients with Acute Urinary Retention Caused by Benign Prostatic Hyperplasia. *Journal of Vascular and Interventional Radiology*, *24*(4), 535–542. https://doi.org/10.1016/j.jvir.2012.12.019
Chen, J. W., Shin, J. H., Tsao, T. F., Ko, H. G., Yoon, H. K., Han, K. C., & al., et. (2017). Prostatic Arterial Embolization for Control of Hematuria in Patients with Advanced Prostate Cancer. *Journal of Vascular and Interventional Radiology*, *28*(2), 295–301. https://doi.org/10.1016/j.jvir.2016.10.016
DeMeritt, J. S., Elmasri, F. F., Esposito, M. P., & Rosenberg, G. S. (2000). Relief of Benign Prostatic Hyperplasia-related Bladder Outlet Obstruction after Transarterial Polyvinyl Alcohol Prostate Embolization. *Journal of Vascular and Interventional Radiology*, *11*(6), 767–770. https://doi.org/10.1016/S1051-0443(07)61538-2
Eckhardt, M. D., Van Venrooij, G. E. P. M., Van Melick, H. H. E., & Boon, T. A. (2001). Prevalence and bothersomeness of lower urinary tract symptoms in benign prostatic hyperplasia and their impact on well-being. *Journal of Urology*, *166*(2), 563–568.
Foster, H. E., Dahm, P., Kohler, T. S., Lerner, L. B., Parsons, J. K., Wilt, T. J., & al., et. (2019). Surgical Management of Lower Urinary Tract Symptoms Attributed to Benign Prostatic Hyperplasia: AUA Guideline Amendment 2019. *Journal of Urology*, *202*(3), 592–598. https://doi.org/10.1097/JU.0000000000000319
Jeon, G. S., Won, J. H., Lee, B. M., Kim, J. H., Ahn, H. S., Lee, E. J., & al., et. (2009). The Effect of Transarterial Prostate Embolization in Hormone-induced Benign Prostatic Hyperplasia in Dogs: A Pilot Study. *Journal of Vascular and Interventional Radiology*, *20*(3), 384–390. https://doi.org/10.1016/j.jvir.2008.11.015
Joshi, H., De Jong, I., Karmacharya, R., Shrestha, B., & Shrestha, R. (2015). Outcomes of Transurethral Resection of the Prostate in Benign Prostatic Hyperplasia Comparing Prostate Size of more than 80 Grams to Prostate Size less than 80 Grams. *Kathmandu University Medical Journal*, *12*(3), 163–167.
Kably, I., Pereira, K., Chong, W., & Bhatia, S. (2016). Prostate Artery Embolization (PAE) in the Management of Refractory Hematuria of Prostatic Origin Secondary to Iatrogenic Urological Trauma: A Safe and Effective Technique. *Urology*, *88*, 218–221. https://doi.org/10.1016/j.urology.2015.11.010
Knight, G. M., Talwar, A., Salem, R., & Mouli, S. (2021). Systematic Review and Meta-analysis Comparing Prostatic Artery Embolization to Gold-Standard Transurethral Resection of the Prostate for Benign Prostatic Hyperplasia. *Cardiovascular and Interventional Radiology*, *44*(2), 183–193. https://doi.org/10.1007/s00270-020-02669-z
Kurbatov, D., Russo, G. I., Lepetukhin, A., Dubsky, S., Sitkin, I., Morgia, G., & al., et. (2014). Prostatic Artery Embolization for Prostate Volume Greater Than 80 cm3: Results From a Single-center Prospective Study. *Urology*, *84*(2), 400–404. https://doi.org/10.1016/j.urology.2014.04.022
Lang, E. K., Deutsch, J. S., Goodman, J. R., Barnett, T. F., Lanasa, J. A., & Duplessis, G. H. (1979). Transcatheter Embolization Of Hypogastric Branch Arteries in the Management of Intractable Bladder Hemorrhage. *Journal of Urology*, *121*(1), 30–36. https://doi.org/10.1016/S0022-5347(17)56632-1
Levy, A., & Samraj, G. P. (2007). Benign prostatic hyperplasia: when to "watch and wait," when and how to treat. *Cleveland Clinic Journal of Medicine*, *74*(Suppl_3), S15.
Lin, Y. T., Amouyal, G., Correas, J. M., Pereira, H., Pellerin, O., Del Giudice, C., & al., et. (2016). Can prostatic arterial embolisation (PAE) reduce the volume of the peripheral zone? MRI evaluation of zonal anatomy and infarction after PAE. *European Radiology*,

26(10), 3466–3473. https://doi.org/10.1007/s00330-015-4191-6

Malling, B., Røder, M. A., Brasso, K., Forman, J., Taudorf, M., & Lönn, L. (2019). Prostate artery embolisation for benign prostatic hyperplasia: a systematic review and meta-analysis. *European Radiology*, *29*(1), 287–298. https://doi.org/10.1007/s00330-018-5564-8

Malling, B., Røder, M. A., Lindh, M., Frevert, S., Brasso, K., & Lönn, L. (2019). Palliative Prostate Artery Embolization for Prostate Cancer: A Case Series. *Cardiovascular and Interventional Radiology*, *42*(10), 1405–1412. https://doi.org/10.1007/s00270-019-02275-0

Martins Pisco, J., Pereira, J., Rio Tinto, H., Fernandes, L., & Bilhim, T. (2012). How to Perform Prostatic Arterial Embolization. *Techniques in Vascular and Interventional Radiology*, *15*(4), 286–289. https://doi.org/10.1053/j.tvir.2012.09.006

Mitchell, M. E., Waltman, A. C., Athanasoulis, C. A., Kerr, W. S., & Dretler, S. P. (1976). Control of Massive Prostatic Bleeding with Angiographic Techniques. *Journal of Urology*, *115*(6), 692–695. https://doi.org/10.1016/S0022-5347(17)59302-0

Oelke, M., Bachmann, A., Descazeaud, A., Emberton, M., Gravas, S., Michel, M. C., & al., et. (2013). EAU Guidelines on the Treatment and Follow-up of Non-neurogenic Male Lower Urinary Tract Symptoms Including Benign Prostatic Obstruction. *European Urology*, *64*(1), 118–140. https://doi.org/10.1016/j.eururo.2013.03.004

Pasha, M. T., Khan, M. A., Jamal, Y., Wahab, F., & Naeemullah. (2015). Postoperative Complications with Glycine and Sterile Distilled Water after Transurethral Resection of Prostate. *Journal of Ayub Medical College Abbottabad*, *27*(1), 135–139.

Pavone, C., Abbadessa, D., Scaduto, G., Caruana, G., Scalici Gesolfo, C., Fontana, D., & al., et. (2015). Sexual dysfunctions after transurethral resection of the prostate (TURP): evidence from a retrospective study on 264 patients. *Archivio Italiano Di Urologia e Andrologia*, *87*(1), 8. https://doi.org/10.4081/aiua.2015.1.8

Pereira, J. A., Bilhim, T., Duarte, M., Rio Tinto, H., Fernandes, L., & Martins Pisco, J. (2012). Patient Selection and Counseling before Prostatic Arterial Embolization. *Techniques in Vascular and Interventional Radiology*, *15*(4), 270–275. https://doi.org/10.1053/j.tvir.2012.09.004

Pereira, K., Halpern, J. A., McClure, T. D., Lewis, N. A., Kably, I., Bhatia, S., & al., et. (2016). Role of prostate artery embolization in the management of refractory haematuria of prostatic origin. *BJU International*, *118*(3), 359–365. https://doi.org/10.1111/bju.13430

Rampoldi, A., Barbosa, F., Secco, S., Migliorisi, C., Galfano, A., Prestini, G., & al., et. (2017). Prostatic Artery Embolization as an Alternative to Indwelling Bladder Catheterization to Manage Benign Prostatic Hyperplasia in Poor Surgical Candidates. *Cardiovascular and Interventional Radiology*, *40*(4), 530–536. https://doi.org/10.1007/s00270-016-1545-6

Reich, O., Gratzke, C., Bachmann, A., Seitz, M., Schlenker, B., Hermanek, P., & al., et. (2008). Morbidity, Mortality and Early Outcome of Transurethral Resection of the Prostate: A Prospective Multicenter Evaluation of 10,654 Patients. *Journal of Urology*, *180*(1), 246–249. https://doi.org/10.1016/j.juro.2008.03.058

Rink, J. S., Froelich, M. F., McWilliams, J. P., Gratzke, C., Huber, T., Gresser, E., & al., et. (2022). Prostatic Artery Embolization for Treatment of Lower Urinary Tract Symptoms: A Markov Model–Based Cost-Effectiveness Analysis. *Journal of the American College of Radiology*, *19*(6), 733–743. https://doi.org/10.1016/j.jacr.2022.01.019

Rio Tinto, H., Martins Pisco, J., Bilhim, T., Duarte, M., Fernandes, L., Pereira, J., & al., et. (2012). Prostatic Artery Embolization in the Treatment of Benign Prostatic Hyperplasia: Short and Medium Follow-up. *Techniques in Vascular and Interventional Radiology*, *15*(4), 290–293. https://doi.org/10.1053/j.tvir.2012.09.007

Sarma, A. V, & Wei, J. T. (2012). Benign Prostatic Hyperplasia and Lower Urinary Tract

Symptoms. *New England Journal of Medicine*, *367*(3), 248–257. https://doi.org/10.1056/NEJMcp1106637

Schreuder, S. M., Scholtens, A. E., Reekers, J. A., & Bipat, S. (2014). The Role of Prostatic Arterial Embolization in Patients with Benign Prostatic Hyperplasia: A Systematic Review. *Cardiovascular and Interventional Radiology*, *37*(5), 1198–1219. https://doi.org/10.1007/s00270-014-0949-3

Sun, F., Sánchez, F. M., Crisóstomo, V., Lima, J. R., Luis, L., García-Martínez, V., & al., et. (2008). Benign Prostatic Hyperplasia: Transcatheter Arterial Embolization as Potential Treatment—Preliminary Study in Pigs. *Radiology*, *246*(3), 783–789. https://doi.org/10.1148/radiol.2463070347

Tapping, C. R., & Boardman, P. (2019). Prostatic artery embolization (PAE) in catheter-dependent patients with large prostatic (BPH) glands (>90 cc): early intervention essential. *Acta Radiologica*, *60*(11), 1562–1565. https://doi.org/10.1177/0284185119828617

Tian, W., Zhou, C., Leng, B., Shi, H., & Liu, S. (2019). Prostatic Artery Embolization for Control of Gross Hematuria in Patients with Benign Prostatic Hyperplasia: A Single-Center Retrospective Study in 20 Patients. *Journal of Vascular and Interventional Radiology*, *30*(5), 661–667. https://doi.org/10.1016/j.jvir.2018.11.013

Uflacker, A., Haskal, Z. J., Bilhim, T., Patrie, J., Huber, T., & Pisco, J. M. (2016). Meta-Analysis of Prostatic Artery Embolization for Benign Prostatic Hyperplasia. *Journal of Vascular and Interventional Radiology*, *27*(11), 1686–1697. https://doi.org/10.1016/j.jvir.2016.08.002

Wu, X., Zhou, A., Heller, M., & Kohlbrenner, R. (2022). Prostatic Artery Embolization Versus Transurethral Resection of the Prostate for Benign Prostatic Hyperplasia: A Cost-Effectiveness Analysis. *Journal of Vascular and Interventional Radiology*, *33*(12), 1605–1615. https://doi.org/10.1016/j.jvir.2022.08.019

Zumstein, V., Betschart, P., Vetterlein, M. W., Kluth, L. A., Hechelhammer, L., Mordasini, L., & al., et. (2019). Prostatic Artery Embolization versus Standard Surgical Treatment for Lower Urinary Tract Symptoms Secondary to Benign Prostatic Hyperplasia: A Systematic Review and Meta-analysis. *European Urology Focus*, *5*(6), 1091–1100. https://doi.org/10.1016/j.euf.2018.11.008