Comparison on the efficacy and safety of bipolar transurethral vaporization of the prostate (B-TUVP) with bipolar transurethral resection of the prostate (B-TURP) for benign prostatic hyperplasia (BPH): a systematic review and meta-analysis of randomized controlled trial

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Original Article

INTRODUCTION

Benign prostatic hyperplasia (BPH) is a prevalent urological disorder among aging males.1 It involves the proliferation of prostatic tissue, which may result in lower urinary tract symptoms (LUTS) such as weak urine flow, hesitancy, and urgency.2 The management of BPH depend on various factors, including symptom severity, prostate size, and comorbidities.

Conservative and pharmacological interventions may improve symptoms by smooth muscle tone and reducing prostate size.3 However, surgical intervention may be indicated if medical therapy fails.

Several surgical modalities for BPH exist, with different degrees of invasiveness. The current modalities that considered as gold standard is Transurethral Resection of the Prostate (TURP).4 TURP can be performed using either monopolar or bipolar energy sources. Bipolar TURP (B-TURP) has some advantages over monopolar TURP (M-TURP), such as lower risk of TUR syndrome and no restriction on operative duration.5 However, TURP is not the only option for BPH surgery. One of the emerging alternatives is Bipolar Transurethral Vaporization of the Prostate (B-TUV).
difference between them is not significant. The only difference is in the design of the electrode. B-TUVP uses a hemispherical shape while B-TURP uses a loop shape. The hemispherical electrode produces a thin layer of ionized particles and forms a plasma field that causes vaporization of the prostate tissue. B-TURP is a newer modality for BPH that offers technical simplicity, short operative time, and minimal intraoperative hemorrhage.6 However, despite these benefits, it has not gained much popularity among urologists. The reasons for this are unclear. Previous studies have shown inconsistent outcomes when comparing B-TUVP to B-TURP. Moreover, no previous meta-analysis have directly compared the efficacy and complications of B-TUVP and B-TURP. Therefore, this study aims to compare the efficacy and complication between these two modalities for BPH treatment.

METHODS

Protocol registration
The protocol of this systematic review and meta-analysis is registered at PROSPERO (CRD42023395453).

Search strategy and study selection
The Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines provided the basis for both the planning stages and the actual execution of this study. This review topic was determined by applying the PICOS framework method, which consists of Population, Intervention, Comparison, Outcome and Study Design. The inclusion criteria for studies were: (P): BPH patients who underwent surgery; (I): B-TUVP; (C): B-TURP; (O): efficacy and complications; (S): randomized controlled trial. Studies that were case reports, conference abstracts, reviews, editorials letters, as well as non-English studies were excluded. The systematic search was conducted in six databases, namely PubMed, Web of Science, ProQuest, Cochrane Central Register of Controlled Trials (CENTRAL) and ClinicalTrials.gov. The keywords used to search the studies in each database are shown in Table 1. Two authors (M.A.W. and D.P.A.) independently screened the search results. Conflicts between them were resolved and disagreements were settled by the senior author (L.H.).

Quality assessment and data extraction
The same two authors who screened abstracts and full articles also performed data extraction and risk of bias assessment. The extracted data included study subjects’ baseline characteristics, such as age and prostate volume, as well as sample size, country of study, number of surgeons involved, International Prostate Symptom Score (IPSS), Quality of Life (QoL) score, Post-void Residual (PVR), maximum flow rate (Qmax), mean operative time, hemoglobin drop, catheterization period, hospital stay and complications. The Cochrane Risk of Bias Tools for Randomized Trials version 2 (RoB 2) was used to analyze the risk of bias in the study.8

Statistical analysis
The statistical analysis is based on the type of data that can be extracted. Continuous data will be analyzed using Standardized Mean Differences (SMD) and dichotomous data will be analyzed using Pooled Odds Ratio, with 95% confidence intervals. Assessment of heterogeneity in the study will be assessed based on the I2 statistic. A fixed-effects model will be used if heterogeneity is low (I2 < 50%), if heterogeneity is high (I2 ≥ 50% and p < 0.05) then a random-effects model will be used. Statistical analysis will be performed using Review Manager5.4 for Windows software (Cochrane Collaboration, Oxford, UK). Sensitivity analysis will be carried out using the leave-one-out method by excluding studies one by one with the aim of testing the stability of the results and looking for studies that could potentially be a source of heterogeneity.

RESULTS

Study characteristics
A systematic search using predetermined keywords found a total of 3150 studies. After checking for duplication, 423 duplicate studies were removed. Then, 663 studies were selected by reading titles and abstracts, and 74 articles met the criteria and were further selected by reading the full text. Sixty-one studies had full text available, and six studies met the inclusion criteria and proceed to the analysis. Figure 1 shows the PRISMA flow diagram of study selection procedure.9-14 There were a total of 940 samples from the six studies that met the inclusion criteria. The baseline characteristics of studies are shown in Table 2. The mean age of the samples in all studies ranged from 51 to 70 years. In five of the six studies, the samples’ prostate volumes are below 80 cc.9,11-14 Only in one study, assessed the efficacy and complications of B-TUVP and B-TURP in patients with large prostate volumes (>120 cc).15

Risk of bias in studies
The risk of bias in the studies was analyzed using the RoB 2 (Figure 2). The risk of bias assessment showed that most of the studies had moderate risk or some concerns, especially in domain 1 (randomization process) and domain 5 (selection of the reported result). Four studies only described ‘The randomization process briefly, without explaining how they concealed it.’11-14 Only two studies by Geavlete et al. reported using sealed envelopes to hide the allocation order.9,10 Most studies did not provide or register a protocol before conducting the research. A protocol for randomized clinical trials is important to ensure consistency and avoid bias in the selection of outcomes.8 Two studies had a high risk of bias. Abdelwahab et al. did not report the incidence of urethral stricture complications at month 9 follow-up, only at month 6 follow-up, meanwhile the other outcomes were reported at both follow-ups.13 Geavlete et al. did not report the reasons for losing some samples during follow-up.10

Efficacy B-TUVP vs. B-TURP
The efficacy of surgical outcome in this meta-analysis was assessed using IPSS, QoL score, PVR, Qmax and operative time, hemoglobin drop, catheterization period and hospital stay (Figure 3). The IPSS, PVR, Qmax and mean operative time were not significantly different, while QoL score (SMD = -0.64; 95%CI = -1.09 – -0.18; I2 = 86%), hemoglobin drop (SMD = -2.05; 95%CI = -2.78 – -1.31; I2 = 95%), catheterization period (SMD = -1.11; 95%CI = -1.30 – -0.92; I2 = 60%) and hospital stay (SMD = -0.72; 95%CI =
Table 1. Keywords used in each database

<table>
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<th>Database</th>
<th>Keywords</th>
</tr>
</thead>
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<td>Scopus</td>
<td>TITLE-ABS-KEY (“prostatic hyperplasia” OR “benign prostatic hyperplasia” OR “benign prostatic enlargement”) AND TITLE-ABS-KEY (“bipolar transurethral vaporization” OR “bipolar plasma vaporization” OR “bipolar vaporization” OR “plasmakinetic vaporization” OR “BIVAP” OR “B-TUVP”)</td>
</tr>
<tr>
<td>Web of Science</td>
<td>((ALL=(prostatic hyperplasia)) OR ALL=(benign prostatic hyperplasia)) OR ALL=(benign prostatic enlargement) AND (((((ALL=(bipolar transurethral vaporization)) OR ALL=(bipolar plasma vaporization)) OR ALL=(bipolar vaporization)) OR ALL=(plasmakinetic vaporization)) OR ALL=(BIVAP)) OR ALL=(B-TUVP)</td>
</tr>
<tr>
<td>ProQuest</td>
<td>noft(prostatic hyperplasia OR benign prostatic hyperplasia OR benign prostatic enlargement) AND noft(bipolar transurethral vaporization OR bipolar plasma vaporization OR bipolar vaporization OR plasmakinetic vaporization OR BIVAP OR B-TUVP)</td>
</tr>
</tbody>
</table>
| Cochrane Central Register of Controlled Trials (CENTRAL) | #1 MeSH descriptor: [Prostatic Hyperplasia] explode all trees  
#2 (benign prostatic hyperplasia):ti,ab,kw OR (benign prostatic enlargement):ti,ab,kw  
#3 #1 OR #2  
#4 MeSH descriptor: [Transurethral Resection of Prostate] explode all trees  
#5 (bipolar transurethral vaporization):ti,ab,kw OR (bipolar plasma vaporization):ti,ab,kw OR (bipolar vaporization):ti,ab,kw OR (plasmakinetic vaporization):ti,ab,kw OR (BIVAP OR B-TUVP):ti,ab,kw  
#6 #4 OR #5  
#7 #3 AND #6 |
| ClinicalTrials.gov     | Condition or disease: benign prostatic hypertrophy OR benign prostatic hyperplasia Intervention/treatment: B-TURP OR B-TUVP OR plasma OR bipolar OR vaporization OR resection |

Figure 1. PRISMA flow diagram of study selection procedure.

-0.95 – -0.50; I^2 = 61%) were significantly lower in B-TUVP (p < 0.05). The study by Geavlete 2011 was excluded from the hospital stay analysis because it was a source of high heterogeneity obtained from the leave-one-out analysis (Before leave-one-out, I^2 = 98%, p < 0.00001; after leave-one-out, I^2 = 61%, p = 0.08).

Complications B-TUVP vs. B-TURP

The meta-analysis revealed 2.09% and 1.43% incidence of complications for B-TUVP and B-TURP respectively. The complications assessed in this study included postoperative hematuria, clot retention, bladder neck sclerosis, urethral stricture, rehospitalization, catheter reinsertion, reoperation, urinary tract infection, urinary incontinence and postoperative irritative symptoms. The forest plot analysis indicated no significant difference in complication rates between the B-TUVP and B-TURP groups (Figure 4).

DISCUSSION

Surgical therapy for BPH is still a topic of debate among urologists. TURP is
considered to be the standard surgery for BPH, but it is still associated with significant perioperative morbidity. The morbidity includes bleeding, clot retention, urinary tract infection, and TUR syndrome.\textsuperscript{15} It is a question of whether TURP will continue to have a role as the standard tool in prostate management, or whether alternatives to TURP should be sought. The alternative should be easily accessible and safe for the patient.\textsuperscript{16} Along with technological advances, many innovations have emerged to find operative BPH management that is safer for patients, one of which is B-TUVP, which uses almost identical equipment like B-TURP except for the electrode.\textsuperscript{17} However, there are contradictory reports on the efficacy and complications caused by B-TUVP and B-TURP. Some studies conclude that B-TUVP has the same efficacy as B-TURP, with a better perioperative and complication profile, so it is considered to be a superior surgical technique compared to B-TURP.\textsuperscript{9,11,12} However, a study by Abdelwahab et al. stated that, although B-TUVP is a rapid surgical modality with minimal intraoperative bleeding, it is associated with increased complications such as postoperative irritation symptoms and a high incidence of urethral strictures.\textsuperscript{13}

To the best of our knowledge, this is the first meta-analysis of randomized controlled trials that directly compared the bipolar energy sources for B-TUVP and B-TURP. In the analysis of the efficacy, no significant differences were found in IPSS, PVR and Qmax, consistent with previous studies.\textsuperscript{18–20} These studies compared the two modalities using retrospective designs and reported comparable efficacy outcomes. However, this meta-analysis found a significant difference in QoL score between the two groups, with B-TUVP group having significantly lower score than B-TURP group. Lower QoL score indicate better subjective quality of life as reported by the patients.

The catheterization period and hospital stay were significantly shorter in B-TUVP group than in B-TURP group, which may explain the better QoL score in B-TUVP group. Prolonged catheterization can cause discomfort, pain and increased risk of complications such as UTI, as

<table>
<thead>
<tr>
<th>No.</th>
<th>Author</th>
<th>Year</th>
<th>Country</th>
<th>Group</th>
<th>N</th>
<th>Age (yr)</th>
<th>Prostate Volume (ml)</th>
<th>IPSS pre op</th>
<th>Qmax pre op (ml/s)</th>
<th>Follow-up (mo)</th>
<th>Bipolar Generator</th>
<th>No of surgeons</th>
<th>Qmax post op</th>
<th>QoL score</th>
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<tr>
<td>1.</td>
<td>Geavlete</td>
<td>2011</td>
<td>Romania</td>
<td>B-TUVP</td>
<td>170</td>
<td>67 ± 5.28</td>
<td>5413 ± 8.77</td>
<td>25 ± 1.39</td>
<td>6.75 ± 1.63</td>
<td>Not reported</td>
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<td>3</td>
<td>1, 3, 6, 12</td>
<td></td>
</tr>
<tr>
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<td>Falahatkar</td>
<td>2014</td>
<td>Iran</td>
<td>B-TUVP</td>
<td>49</td>
<td>70.97 ± 3.79</td>
<td>46.92 ± 4.67</td>
<td>26.36 ± 1.96</td>
<td>8.48 ± 1.04</td>
<td>3</td>
<td>Olympus bipolar generator</td>
<td>1</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Karadag</td>
<td>2014</td>
<td>Turkey</td>
<td>B-TUVP</td>
<td>39</td>
<td>69.14 ± 4.09</td>
<td>47.14 ± 4.44</td>
<td>26.04 ± 3.02</td>
<td>8.22 ± 1.21</td>
<td>1</td>
<td>Olympus SuperPulse</td>
<td>1</td>
<td>1, 3, 6, 12</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Geavlete</td>
<td>2015</td>
<td>Romania</td>
<td>B-TUVP</td>
<td>87</td>
<td>67.98 ± 6.07</td>
<td>50.9 ± 16.5</td>
<td>21.46 ± 5.68</td>
<td>6.57 ± 2.73</td>
<td>1</td>
<td>Olympus SuperPulse</td>
<td>1</td>
<td>1, 3, 9</td>
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<td>5.</td>
<td>Abdelwahab</td>
<td>2019</td>
<td>Egypt</td>
<td>B-TUVP</td>
<td>44</td>
<td>51.7 ± 11.2</td>
<td>59.4 ± 13.9</td>
<td>24.1 ± 3.1</td>
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<td>6.</td>
<td>Abuelazayem</td>
<td>2019</td>
<td>Egypt</td>
<td>B-TUVP</td>
<td>40</td>
<td>69.20 ± 5.40</td>
<td>57.98 ± 9.11</td>
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<td>Storz bipolar generator</td>
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</table>
Figure 2. RoB 2 assessment of the included studies.

Figure 3. Forest plot comparing the efficacy of B-TUVP and B-TURP groups.
than B-TURP (1.2% vs 7.1%). B-TUVP also had significantly shorter hospital stay, which was directly proportional to catheterization period.

This meta-analysis showed slightly higher incidence of complication in B-TURP than B-TUVP. However, the forest plot analysis indicated no significant difference in both groups. This meta-analysis did not support the result that B-TUVP has higher complications than B-TURP, especially postoperative irritative symptoms and urethral stricture events, which limits its popularity. Abdelwahab et al.'s study suggested that most complications were related to longer operative time. For BPH surgeries such as TURP and B-TUVP, it is recommended to complete within 90-100 minutes to reduce the risk of complications. B-TUVP surgery has similar short- and medium-term efficacy and complications to B-TURP, with better QoL score, lower hemorrhagic drop, shorter catheterization and hospital stay. Geavlete et al.'s eight-year follow-up study on B-TUVP, B-TURP and M-TURP patients concluded that B-TUVP is a good alternative for moderate BPH, with better surgical safety, lower bleeding risk and faster postoperative recovery.

Long-term efficacy and complications were similar to B-TURP and M-TURP modalities. The limitation of this study is the high heterogeneity of most analysis results. This may be due to different follow-up periods reported by each study. Follow-up periods affect reported outcomes. Most studies only followed up for 1-18 months, long-term efficacy and complications of B-TUVP could not be evaluated. Surgeons' experience may also cause outcome differences. Higher operation volume of surgeons may provide better outcomes.

CONCLUSION

B-TUVP is a viable alternative to B-TURP in BPH patients because it has similar short- to medium-term efficacy and complications to B-TURP, with the benefits of B-TUVP being better in QoL score, lower hemorrhagic drop, shorter catheterization and hospital stay than B-TURP.

CONFLICT OF INTEREST

The author reports no conflicts of interest in this work.

FUNDING

The authors declared that no financial support or funding was obtained for this study.

ETHICS COMMITTEE APPROVAL

This systematic review and meta-analysis do not require ethical approval.

AUTHOR CONTRIBUTION

- Made Adi Wiratama (M.A.W.): Concepts, design, literature search, data acquisition, data analysis, statistical analysis, manuscript preparation, manuscript editing.
- Dimas Panca Andhika (D.P.A.): Literature search, data acquisition, data analysis, statistical analysis, manuscript editing, manuscript review.
- Chi-Fai Ng (C-F.N.): Definition of intellectual content, data analysis, statistical analysis, manuscript editing, manuscript review.
- Lukman Hakim (L.M.): Definition of intellectual content, data analysis, statistical analysis, manuscript editing, manuscript review, guarantor.

Figure 4. Forest plot comparing the complications of B-TUVP and B-TURP groups.
REFERENCES