Balancing clinical outcomes and quality of life aspects in the treatment of LUTS/BPH
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Clinical utility of “blind placement” prostatic stent in patients with benign prostatic obstruction: a prospective study

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INTRODUCTION

In a significant number of patients, temporary urinary retention is observed after minimally invasive treatment of benign prostatic obstruction. To avoid drainage with a permanent indwelling catheter, the use of temporary prostatic stents has received increasing attention. The ideal prostatic stent should be easy to insert and remove under local anesthesia and should allow immediate voiding after insertion and cause minimal complications.

The polyurethane stents such as the Nissenkorn intraurethral catheter and the Trestle stent are examples of stents designed for temporary use. These stents seem to provide simple insertion and removal. The initial results using these stents were encouraging. However, the insertion and removal of these stents are still not as simple as using an indwelling Foley catheter. Regarding complications, these stents have been reported to have a migration rate of 5.6% to 21%. Several types of temporary prostatic stents have been investigated to overcome the migration. However, the most recently reported stent, the hourglass-shaped nitinol prostatic stent, still had a high migration rate.

To resolve these problems, an intraurethral catheter (Boston Scientific Corporation) has been developed, the blind placement stent (BPS). To the best of our knowledge, no studies of this type of temporary stent have been reported. Therefore, our prospective trial was conducted to determine the feasibility and effectiveness of the BPS system for temporary relief of symptoms from benign prostatic obstruction.

MATERIAL AND METHODS

The study was designed as a prospective, randomized controlled trial, and the ethical committee of the hospital approved the protocol.

Patients

The inclusion criteria for this trial were lower urinary tract symptoms, an International Prostate Symptom Score (IPSS) greater than 12 owing to benign prostatic obstruction, age 40 years or older, and a prostatic urethra 35 to 55 mm long.

The exclusion criteria were a history of prostate or bladder surgery, any malignancies of the urinary tract, gross hematuria, neurogenic bladder, urethral stricture, concurrent treatment with an investigational drug or device, urinary tract infection, pelvic irradiation, and an allergy to silicone. The patients were randomized into two groups for insertion of one of the two BPS designs.

The pretreatment evaluation included transrectal ultrasonography to determine the prostate volume and length of the prostatic urethra, uroflowmetry to measure the maximal urinary flow rate (Qmax), and ultrasonography of the bladder to assess the
postvoid residual urine volume. Symptom scores were determined using the IPSS questionnaire, including the quality-of-life (QOL) item. Follow-up evaluations of voiding parameters and symptom scores were performed shortly after stent placement and at 14 and 28 days after insertion.

**Prostatic stent**

The BPS system is a disposable stent consisting of a soft silicone stent, retrieval line, and delivery device. Two different BPS designs were investigated in this study. The first version of the BPS – BPS-1 (Figure 1A) – contains one segment of a 22F silicone stent with stainless steel coiled wire reinforcement, a coude tip, and an extruded Malecot section. The device is preloaded on a delivery system, and a retrieval suture is attached to the stent for device removal. After stent placement, the 4-cm prostatic urethral segment should be located above the external striated sphincter in the prostate.

![Figure 1: (A) BPS-1. (B) BPS-2. (C) Prostatic urethral segment of BPS-2 located above external striated sphincter in prostate. Bulbar urethral segment of BPS-2 located below external striated sphincter and connecting suture bridges sphincter, securing normal functioning of sphincter.](image-url)
The second version of the BPS – BPS-2 (Figure 1B) – comprises two segments. It contains all the elements of BPS-1, as well as an additional 2-cm bulbar segment to prevent migration. The junction zone of the two segments is connected by a 3-cm suture. This bulbar urethral segment is located below the external striated sphincter and the connecting suture bridges the sphincter, securing normal functioning of the sphincter and consequently ensuring micturition control (Figure 1C). Only one size is available in both stent designs.

**Insertion and Removal**

Stent insertion was performed in an outpatient setting under local anesthesia without a special instrument. Tension on the stent was achieved by pulling the retrieval suture and locking it into the delivery system, causing the Malecot section to collapse. The delivery system includes a balloon at the tip, the position of which corresponds to the Malecot section of the stent. With the patient in the lithotomy position, the stent was advanced through the urethra until the tip of the prostatic urethral segment was positioned in the bladder, as confirmed by the flow of urine from the distal end of the delivery system. Next, the balloon was inflated with 10 mL of air, causing the Malecot section to stretch out. To confirm that the Malecot section of the stent was positioned at the bladder neck, the stent, together with the delivery system, was pulled back until resistance was encountered. After balloon deflation, the retrieval suture was relieved, and the delivery system was retracted from the urethra. The retrieval suture was cut off just inside the meatus. To confirm proper positioning, abdominal ultrasonography or cystoscopy was performed. Removal of the stent was achieved by pulling the retrieval suture until the stent was completely retracted. However, if stent removal was not possible with the suture, assisting instruments were used.

**Statistical Analysis**

The data were analyzed using the Statistical Package for Social Sciences for Windows, version 11.5.1 (SPSS, Chicago, Ill). To evaluate the pretreatment data and baseline variables between the two BPS stents, the independent sample $t$ test or Wilcoxon rank sum test was used. The Wilcoxon signed-rank test or paired $t$ test was used for longitudinal changes in voiding parameters and symptom scores. Adverse events were compared between the two groups using the chi-square test or Fisher’s exact test, as appropriate. Significant $P$ values were set at 0.05 or less. The effect of the BPS-2 versus the BPS-1 on the various outcomes and follow-up course was evaluated using model-based estimates, in which the outcomes were assumed to have normal errors and constant covariance between individual patient measurements.
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Kaplan-Meier survival analysis was performed to assess stent survival. In this analysis, the terminal event was defined as stent removal; patients in whom stent placement was not accomplished were not included.

RESULTS

Patients
A total of 55 men were included in the study from February to April 2002. After randomization of the first 28 patients, migration of the BPS-1 occurred in 84.6% of the patients after a median of 4 days. In contrast, 13.3% of the BPS-2 patients reported migration. The decision was made to stop trial insertion of the BPS-1, and the trial was continued with the BPS-2.

The pretreatment patient data are summarized in Table 1. No statistically significant differences were found in mean age, prostate volume, voiding parameters, or IPSS between the patients receiving the BPS-1 and BPS-2. Only the mean baseline QOL score differed significantly ($P = 0.039$). The differences in the urethral length did not have any effect on the outcomes of the BPS-1 and BPS-2.

Placement
The stents were successfully placed in 13 (92.9%) of 14 BPS-1 patients and in 39 (95.1%) of 41 BPS-2 patients ($P = 0.999$). The mean number of placement attempts was 1.6 ± 1.0 for the BPS-1 and 1.5 ± 1.1 for the BPS-2 ($P = 0.520$). The difficulties in passing the device were not due to device malfunction. All stents were inserted “blindly”; however, the proper position of the stent was confirmed using ultrasonography or cystoscopy. The device had to be repositioned after confirming the position in 7 (53.9%) of BPS-1 and 22 (56.4%) of BPS-2 patients during the placement procedure ($P = 0.683$).

Voiding Function
Spontaneous voiding was achieved in all patients immediately after stent insertion. The results of the voiding parameters before and after stent placement are shown in Table 1. The Qmax improved significantly after stent placement for the BPS-2 but decreased shortly thereafter. The Qmax dropped to less than the baseline values for BPS-1; however, it was still greater than at baseline for the BPS-2 until 14 days of placement. As seen in Table 1 (model-based estimates), the BPS-2 tended to be superior to BPS-1 in voiding outcomes. However, only the Qmax reached statistical significance.
Table 1: Pretreatment data, voiding parameters, and symptom scores before and after stent placement, including effect of BPS-2 versus BPS-1 on various outcomes

<table>
<thead>
<tr>
<th>Variable</th>
<th>BPS-1</th>
<th></th>
<th>BPS-2</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretreatment data</td>
<td>Mean ± SD n</td>
<td></td>
<td>Mean ± SD n</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (yr)</td>
<td>66.4 ± 8.3</td>
<td>14</td>
<td>65.9 ± 9.0</td>
<td>41</td>
<td>0.834</td>
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<tr>
<td>Prostate volume (cm³)</td>
<td>54.9 ± 23.4</td>
<td>14</td>
<td>55.0 ± 16.5</td>
<td>41</td>
<td>0.980</td>
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<tr>
<td>Prostatic urethral length (mm)</td>
<td>45.9 ± 6.3</td>
<td>14</td>
<td>47.4 ± 5.5</td>
<td>41</td>
<td>0.403</td>
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<tr>
<td>Qmax (mL/s)†</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Baseline</td>
<td>10.1 ± 4.2</td>
<td>14</td>
<td>8.5 ± 3.5</td>
<td>39</td>
<td>0.174</td>
</tr>
<tr>
<td>After insertion</td>
<td>12.0 ± 5.4</td>
<td>13</td>
<td>14.9 ± 6.0</td>
<td>39</td>
<td>0.002</td>
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<tr>
<td>At 14 days</td>
<td>6.0 ± 2.5</td>
<td>5</td>
<td>10.5 ± 4.1</td>
<td>24</td>
<td></td>
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<tr>
<td>At 28 days</td>
<td>6.3 ± 1.2</td>
<td>4</td>
<td>8.0 ± 2.8</td>
<td>23</td>
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<td>PVR (mL)§</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Baseline</td>
<td>96.0 ± 105.3</td>
<td>14</td>
<td>115.9 ± 168.8</td>
<td>39</td>
<td>0.984</td>
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<td>After insertion</td>
<td>21.5 ± 77.7</td>
<td>13</td>
<td>42.0 ± 148.4</td>
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<tr>
<td>At 14 days</td>
<td>35.0 ± 31.7</td>
<td>5</td>
<td>11.6 ± 25.8</td>
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<tr>
<td>At 28 days</td>
<td>120.5 ± 141.1</td>
<td>4</td>
<td>32.4 ± 64.4</td>
<td>23</td>
<td>0.676</td>
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<td>IPSS</td>
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<td>Baseline</td>
<td>22.2 ± 6.5</td>
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<td>20.4 ± 5.8</td>
<td>39</td>
<td>0.321</td>
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<td>At 14 days</td>
<td>17.6 ± 6.1</td>
<td>7</td>
<td>16.0 ± 6.5</td>
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<td></td>
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<tr>
<td>At 28 days</td>
<td>14.8 ± 8.7</td>
<td>4</td>
<td>14.0 ± 7.6</td>
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<td>0.246</td>
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<td>QOL score¶</td>
<td></td>
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<td></td>
<td></td>
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<td>Baseline</td>
<td>4.1 ± 1.1</td>
<td>14</td>
<td>3.3 ± 1.2</td>
<td>38</td>
<td>0.039</td>
</tr>
<tr>
<td>At 14 days</td>
<td>3.7 ± 1.1</td>
<td>7</td>
<td>3.0 ± 1.4</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>At 28 days</td>
<td>2.8 ± 2.2</td>
<td>4</td>
<td>2.7 ± 1.4</td>
<td>22</td>
<td>0.586</td>
</tr>
</tbody>
</table>

Key: BPS = blind placement stent; Qmax = maximal urinary flow rate; PVR = postvoid residual urine volume; IPSS = International Prostate Symptom Score; QOL = quality of life. Data in parentheses are medians, with range in brackets.

* P value between BPS-1 and BPS-2; Wilcoxon rank sum test, independent sample t test, and model-based estimates test used as appropriate; estimates for effect of stent on outcomes adjusted for baseline differences and effect of age, prostatic urethral length, prostate volume, and different follow-up points (the covariates).

† BPS-1: baseline versus after insertion, P = 0.302; baseline versus 14 days, P = 0.554; baseline versus 28 days, P = 0.319; BPS-2: baseline versus after insertion, P = 0.000; baseline versus 14 days, P = 0.014; baseline versus 28 days, P = 0.442.

‡ Model-based P value.

§ BPS-1: baseline versus after insertion, P = 0.022; baseline versus 14 days, P = 0.043; baseline versus 28 days, P = 0.465; BPS-2: baseline versus after insertion, P = 0.000; baseline versus 14 days, P = 0.000; baseline versus 28 days, P = 0.001; paired t test or Wilcoxon signed rank test.

|| BPS-1: baseline versus 14 days, P = 0.106; baseline versus 28 days, P = 0.432; BPS-2: baseline versus 14 days, P = 0.044; baseline versus 28 days, P = 0.001; paired t test or Wilcoxon signed rank test.

¶ BPS-1: baseline versus 14 days, P = 0.631; baseline versus 28 days, P = 0.664; BPS-2: baseline versus 14 days, P = 0.137; baseline versus 28 days, P = 0.044; paired t test or Wilcoxon signed rank test.

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Symptoms
The IPSS and QOL scores are summarized in Table 1. The IPSS and QOL scores improved compared with baseline at days 14 and 28 for both groups. Using the model-based estimates, BPS-2 proved superior in symptom scores than the BPS-1, but without statistical significance.

Adverse Events
Stent migration into the bladder occurred in 11 of BPS-1 patients (84.6%) and 2 of BPS-2 patients (5.1%; \( P < 0.001 \)). On removal, the bulbar part of the BPS-2 stent was entangled in the urethra up against the sphincter in 59% of the patients (bulbar impaction). Irritative symptoms were experienced by 3 (23.1%) and 11 (28.2%) patients in the BPS-1 and BPS-2 groups \( (P = 0.999) \), respectively. None of the BPS-1 patients and 7 (18.0%) of the BPS-2 patients complained of pain after stent insertion \( (P = 0.171) \). None of the BPS-1 patients reported a urinary tract infection, and 5 BPS-2 patients (12.8%) developed a urinary tract infection that was treated with antibiotics without stent removal. Hematuria was not encountered in any of the BPS-1 patients but was in 2 BPS-2 patients (5.1%).

Stent Removal
The main indication for BPS-1 removal was stent migration. The main indication for BPS-2 removal was pain from bulbar impaction. The BPS-1 stents were removed by pulling the retrieval suture or using cystoscopic assistance (84.6%). In 1 BPS-2 patient, attempted removal failed when the suture broke close to the stent. Subsequently, the stent was removed during transurethral resection of the prostate. During this procedure, the stent was found to be totally encrusted and attached to the bladder neck, requiring removal of the stent in pieces. The median stent indwelling time was 16 days (range 2 to 44) and 38 days (range 1 to 90) for the BPS-1 and BPS-2, respectively and was not significantly different (log-rank \( P = 0.154 \)).

COMMENT
Both permanent and temporary application of prostatic stents has been investigated during the past decade.\(^6\)\(^-\)\(^10\) However, considerable problems with insertion and removal, migration, encrustation, and irritative symptoms were encountered. Although our study was performed in an elective setting, most of the patients in this trial were not suitable candidates for surgery, had refused the proposed surgical treatment, or were awaiting surgical therapy.
BPS placement was performed blindly, without the use of a cystoscope. However, the proper stent position had to be adjusted after using ultrasonography or cystoscopy for confirmation. Djavan et al.\textsuperscript{2} reported insertion of the first-model Trestle stent blindly and using ultrasonography and/or urethroscopy for placement confirmation. Next, Traxer et al.\textsuperscript{4} reported the placement technique for the second-model Trestle stent under cystoscopy. Although Djavan and colleagues\textsuperscript{2} noted that it was not clear whether these imaging techniques would be necessary for routine clinical placement of the stent, they did not report the rate of proper stent positioning after imaging confirmation. Our data have demonstrated that more than one half of both stents required repositioning after blind placement, even in patients who were able to void. This might have been due to the softness of the BPS, especially the Malecot segment, which might not be firm enough to prevent distal disposition during the removal of the delivery system. In the BPS-2, adjustments of the bulbar segment position were also necessary. Corica et al.\textsuperscript{11} recently described the Spanner stent, which has a placement technique similar to that of the Foley catheter. In their series, only 3.3\% of the stents needed repositioning after confirmation of the position. The Spanner stent has a balloon, similar to the Foley catheter, to prevent distal displacement. The firmness of the balloon might provide more resistance than the Malecot section of the BPS, which might be why the Spanner had to be repositioned less often after placement than did the BPS. Nevertheless, balloon malfunction, such as leakage, rupture, or an inability to deflate, could occur. Most of the stents were easily removed from the patients without migration or bulbar impaction; however, removal was difficult in 1 patient with a BPS-2 because of severe encrustation; the stent was removed later by transurethral resection of the prostate. The presence of urinary tract infection and prolonged stenting are two factors predisposing to stent encrustation reported by several investigators.\textsuperscript{6, 12-14}

Although the Nissenkorn and Trestle stents had a low migration rate,\textsuperscript{1, 2, 4} the designs of these two stents are not alike. The Nissenkorn stent only has a prostatic segment, and the Trestle stent has a prostatic and bulbar part. To our knowledge, a study to assess whether the bulbar segment of the stent is necessary to prevent migration has not been previously published. The results of the present trial have shown that the BPS-1 has a significantly greater migration rate compared with the BPS-2. These results indicate that the bulbar segment of the stent might prevent stent migration. This is supported by the fact that none of the Spanner stents, which have a bulbar segment similar to that of the BPS-2, were reported to have migrated.\textsuperscript{11} However, several problems related to the bulbar part of the BPS-2 were encountered in this trial. The pain and the irritative symptoms which were the two main reasons for removal of BPS-2 might have been caused by the bulbar impaction.

The results of this study have confirmed that insertion of the BPS-2 causes immediate relief of outlet obstruction. The mean Qmax improved after insertion and at 14 days of follow-up and decreased close to baseline after 28 days of follow-up. In our study,
as in previous stent trials, a tendency toward a decrease in Qmax during follow-up was observed. The possible causes mentioned in these studies included severe encrustation on the stent, bullous edema obstructing the stent, and preterm degradation in the case of biodegradable stents. Nevertheless, these phenomena were found in only 1 case of severe encrustation of the BPS-2. For the BPS-1, the Qmax was lower than at baseline during the follow-up period. This might have been a result of the high rate of migration of the BPS-1; consequently, only a small number of patients of the BPS-1 group are available for follow up. The decrease in voiding function during the follow-up period of the BPS-2 might have been a result of the bulbar impaction of the stents. The other voiding parameters were comparable with those of other intraurethral stents.

In the present trial, both IPSS and QOL scores improved during the clinical course, as previously described by several investigators. However, it was not significant for the BPS-1 group, which may have been because of the small number of patients in that group. Finally, the infection rate was lower than previously reported when using a Foley catheter.

CONCLUSIONS

The insertion of the BPS cannot be performed totally blindly; cystoscopy or ultrasonography is needed to confirm proper stent placement. Because of the high migration rate, the BPS-1 is not suitable for clinical practice. The BPS-2 migrated less often than the BPS-1, which might have been because of additional bulbar segment. However, the bulbar part of the BPS-2 may cause pain and discomfort to the patient. In addition, the voiding parameters and symptom scores of the BPS-2 were minimally improved. Therefore, BPS-2 is also not a useful stent for clinical practice. To improve the placement technique and minimize stent displacement, advanced adjustments in stent design and additional studies are indispensable.
REFERENCES


