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ORIGINAL ARTICLE

Surgical treatment of large volume prostates: a matched pair analysis comparing the open, endoscopic (ThuVEP) and robotic approach

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Abstract

Objective To compare open simple prostatectomy, endoscopic enucleation and laparoscopic, robot-assisted enucleation of high-volume prostate in terms of operation time, blood loss, transfusion and complication rates and early continence rates.

Material and methods Patients with BPH treated endoscopically (ThuVEP, Hamburg and Hannover) or robotically (Mainz) were evaluated prospectively for prostate size, free flow and validated questionnaires (IPSS, QoL). 35 patients were matched to patients after open prostatectomy (Mainz) for age, prostate size, IPSS and QoL scores. Operation time was noted from the first cut to the last suture; blood loss was estimated by the drop of haemoglobin preoperatively and one day after surgery. Transfusion rates were documented. Early continence was estimated by pad use over the first 24 h after catheter removal. Statistical analysis was performed with SPSS 22.0.

Results No significant differences in prostate size, age and preoperative questionnaires were found ($p > 0.3$). Postoperative flow and the results of the questionnaires were significantly improved (all $p < 0.05$), without difference between the approaches ($p > 0.8$). Endoscopic surgery showed superiority in operation time (both $p < 0.05$); blood loss and transfusion rates were significantly lower compared to open surgery (both $p < 0.01$) and lower than in robotic surgery without reaching significance ($p = 0.18$, $p = 0.36$). Similar results were seen in early continence rates.

Conclusion Due to our results, endoscopic surgery should be considered as first-line therapy unless there are comorbidities like diverticula and/or bladder calculi that can be easily treated simultaneously by robotic surgery. Against the background of these findings, indications favouring open surgery are getting sparse.

Keywords Bladder outlet obstruction · BPH · BPS · Laser enucleation · Robotic enucleation · Simple prostatectomy

Introduction

Open simple prostatectomy (OSP) has been considered gold standard for surgical therapy of prostates larger than 80 ccm for decades [1], but with the implementation of endoscopic laser surgery, new methods have evolved and been taken on as new gold standard besides OSP [1]. The surgery technique of Millin [2] or Freyer [3] have stood the test of time in terms of efficiently removing infravesical obstruction and improving lower urinary tract symptoms. They are known for their short operating time and low re-operation rates, but are also associated with considerable morbidity, especially bleeding, clot retention and the need for blood transfusion [4–6]. Furthermore, urinary incontinence may be encountered in up to 8.8% [7, 8] and bladder neck strictures have been described in up to 5.7% [7].

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Therefore, over the last decade, open simple prostatectomy has been challenged by endoscopic surgery. For large prostates, transurethral resection of the prostate (TUR-P), even after establishing bipolar resection, has been shown to be no proper alternative due to increasing morbidity rate with increasing prostate volume [9]. In contrast, transurethral laser enucleation of the adenoma by holmium laser (HoLEP) or thulium laser (ThuVEP) have shown to be a safe and effective way of treatment [10, 11]. Large-scale studies have described only a minor blood loss [11] and good functional results in long-term follow-up after four years [12]. Therefore, laser enucleations are now considered equal to OSP and have been taken on as gold standard for surgical therapy of high-volume prostates as well [1]

With robotics emerging in urologic surgery, robotic simple prostatectomy (RASP) as an alternative to OSP has been carried out as well [13]. RASP has the benefit of a low surgical access trauma, low intraoperative blood loss and low postoperative pain levels [13] with a steep learning curve for experienced robotic surgeons [14]. Blood loss has been described to be low comparable to endoscopic surgery [15].

Several attempts to compare the different approaches have been undertaken [16–19], but these studies neither were matched-pair comparisons nor compared all three techniques.

Therefore, we conducted a matched-pair, multicentre analysis to compare open, endoscopic and robotic surgery for large-volume prostates in terms of operation time, blood loss, transfusion rate and early continence rates.

Materials and methods

All patients being treated for benign prostate enlargement (BPE) due to prostates larger than 80 ccm estimated with transrectal ultrasound (TRUS) were evaluated prospectively with the following parameters: age, prostate size per TRUS, free flow and validated questionnaires (IPSS, QoL). Only patients with complete data sets were included in this study. We recruited the first 35 patients operated robotically in Mainz between 2012 and 2014 and matched these patients (1:1:1) for the above-mentioned parameters to patients operated with the standard open approach (operation after Millin [2]) between 2005 and 2012 in Mainz and the endoscopic approach (ThuVEP) which has been performed in Hamburg-Harburg and Hannover between 2009 and 2013 out of existing databases in the corresponding hospitals. These databases consisted of 390 open simple prostatectomies in Mainz and 937 endoscopic operations in Hamburg-Harburg and Hannover, respectively. All robotic and endoscopic operations were performed by experienced surgeons, whereas open simple prostatectomy was partly performed by experienced surgeons as well, but also by residents with an experience of less than 25 operations. Coagulation in robotic surgery was performed by monopolar and bipolar forceps, in OSP by careful bipolar coagulation as well as suturing in all cases. Power of the thullium laser was 90 W over the whole study period.

Overall, 35 matching patients per group were included, and the follow-up of at least 12 months was obtained. Patients with disorders that might have an impact on bladder function, e.g., diabetes or neurogenic bladder were excluded.

The following functional outcome parameters were analysed for all groups: operation time was noted from the first cut to the last suture; in robotics therefore docking time was included. Blood loss was estimated by the drop of haemoglobin between preoperative levels and 1 day after surgery. Transfusion rates were documented during the complete hospital stay and the first four weeks afterwards. Early continence was estimated by pad use over the first 24 h after catheter removal. Statistics were evaluated with SPSS 22.0.

Results

In each group, 35 patients were included. Median age at time of operation was 70.6 years in the group of OSP, median prostate size 95 g in histology. Mean IPSS score in OSP preoperatively was 23, mean QoL score was 5. No significant differences were seen between all groups (all $p > 0.2$, see Table 1).

ThuVep showed a median operation time of 83 min and was therefore significantly faster than OSP with 130 min ($p = 0.004$) and RASP needing 182 min ($p < 0.001$). Comparing OSP to RASP, the open approach was significantly faster ($p < 0.001$).

Table 1 Patient characteristics

	Open simple prostatectomy $n = 35$	Robotic simple prostatectomy $n = 35$	Thulium vapoenucleation $n = 35$	p value overall
Age (years) median	70.6	70.9	71.2	0.92
IQR	66.1–74.3	66.5–73.1	65.1–74.8	
Prostate size (g) median by TRUS	95	94.5	90.8	0.41
IQR	84–132	82–136	73–121	
IPSS median	23	23	20	0.5
IQR	21–25	20–25	18–23	
QoL median	5	5	4.2	0.27
IQR	5–6	4–6	3–5	

Blood loss in OSP was significantly higher compared to the minimal invasive approaches ($p < 0.001$ or both). In open surgery, the haemoglobin level dropped about 3 g/dl over the first 24 h, in ThuVEP 1.2 g/dl and in robotic surgery 1.5 g/dl. Between endoscopic and robotic surgery, no significant difference could be seen ($p = 0.18$).

Similar results were seen in transfusion rate. Again, no difference was noted between the minimal invasive approaches ($p = 0.36$), but again significantly higher results compared to open surgery ($p < 0.001$ for ThuVep, $p = 0.017$ for RASP).

Only five patients needed one pad during the first 24 h after ThuVEP, so median pad use was 0 in ThuVEP. After RASP, 26 patients reported no incontinence, of the remaining nine patients six patients needed one pad, two patients two pads and one patient three pads per day. Median therefore was 0 as well and no significant difference could be described. When comparing the mean values, ThuVEP had 0.12 and RASP 0.46, without reaching statistical significance ($p = 0.53$). In OSP, median pad use was 1 and mean pad use was 1.23, but overall 28 patients needed pads, 14 patients one pad, 12 patients two pads and two patients three pads. Mean as well as median pad use were significantly higher in OSP compared to the minimal invasive approaches ($p \leq 0.001$) (Tables 2, 3).

Complications according to the Clavien-Dindo classification

In the OSP group in 15 patients complications occurred (42.8%). This is mainly due to the above-mentioned transfusion rates ($n = 12$). In two patients, wound infection occurred and was treated by opening the wound and secondary healing. Surgical revision was not necessary (grade I; 5.7%). One patient suffered from prolonged gross hematuria (grade I).

Table 3 Peri- and postoperative complications classified after Clavien-Dindo

	Open simple prostatectomy $n = 35$	Robotic simple prostatectomy $n = 35$	Thulium vapoenucleation $n = 35$
Grade I	3	3	–
Grade II	12	5	–
Grade IIIa	–	1	1
Grade IIIB	–	–	–
Grade IV	–	–	–

No re-operations were necessary. In the ThuVEP group, one patient had to be revised due to bleeding (Grade IIIA), in the robotic group three patients showed a prolonged hematuria (Grade I), three patients received blood packs and two patients presented with urinary retention after removal of the catheter (Grade II).One patient had to be revised due to bleeding (Grade IIIA).

Discussion

The main recommendation for therapy of high-volume BPH in the guidelines has changed in the last years. Besides open surgery, endoscopic enucleation has become the equal gold standard for surgical therapy of high-volume BPH. Nevertheless, to our knowledge, up to now no study has compared the different approaches (i.e., open vs robotically assisted vs endoscopic thulium laser) of adenoma enucleation in a matched-pair study.

In our study, we showed significant advantages for the minimal invasive approaches compared to open surgery concerning blood loss, transfusion rates and early continence.

Table 2 Perioperative parameters

	Open simple prostatectomy $n = 35$	Robotic simple prostatectomy $n = 35$	Thulium vapoenucleation $n = 35$
Operation time (min) median	130	182	83
IQR	109–172	150–210	60–105
Resected adenoma from histopathologic examination (g)	82	77	72
IQR	59–121	52–120	53–109
Blood loss (g/dl) median	3	1.5	1.2
IQR	2.3–3.6	1–1.8	0.6–2.3
Transfusion rate (%) median	34.4	9.4	0
Catheteriziation (days)	7	5	2
IQR	7–7	5–5	2–3
Hospitalization (days)	8	5	2
IQR	8–10	5–6	2–3

Between the minimal invasive approaches, endoscopic surgery showed better results, but could not reach significance levels. The only exception was operation time, where robotic surgery due to long preparation in terms of applying the ports and docking the robot showed significant longer duration compared to endoscopic and open surgery. The same results are described in the current literature [19], even though operation time in our study proved to be shorter in all approaches [19].

Our study shows some limitations due to its retrospective design and the long time period in which patients were recruited. Blood loss was compared by the drop of haemoglobin pre- and postoperatively. In nine years of surgery and three different hospitals, different perioperative hydration regimens were used by our anaesthesiologic colleagues. This may have affected the outcome in the evaluation of the drop of haemoglobin, but cannot be outcounted in our retrospective analysis. Similarly, the transfusion rate must be interpreted. Retrospectively, the indications for transfusion can only partly be comprehended. The postoperative transfusions were executed according to the contemporary guidelines by urologists, but the intraoperative transfusions were indicated by the anaesthesiologists according to their perioperative regimen and can therefore not easily be compared. Depending on the regimen using adrenalin or blood transfusions for maintaining blood pressure, the transfusion rate may be influenced, especially in OSP.

Moreover, the results in robotics may be underestimated. In our study, the cases were consecutive, whereas the open and endoscopic surgeries were matched from large databases. Furthermore, the robotic enucleations contained the whole learning curve from the first operation performed in our centre [14]; in contrast open and endoscopic cases were screened out of a large database. Therefore, there may be a bias in all parameters, but especially in operation time and complication rates. Nevertheless, it has been shown, that operation time does decrease significantly after the first fifteen operations in robotic enucleation [14], but even then, operation time remained significantly longer. All other parameters did not significantly differ from endoscopic surgery.

Besides the measurable data, personal satisfaction is an important parameter and seems to be triggered mainly by continence rate in a medium follow-up. Whereas pad use in between the first six weeks was tolerated without making patients unsatisfied, later on, patients complained if pad use was larger than one per day. Therefore, patients' satisfaction in endoscopic and robotic surgery was higher than in OSP. Nevertheless, no patient regretted his decision for operation without regard to the different approaches.

Besides this, nowadays costs have become an issue. Especially with robotic surgery emerging, high costs are caused due to single use instruments. Here OSP leads the series with lowest costs per operation followed by endoscopic and then robotic surgery. Nevertheless, costs should not judge the modus operandi, especially since all the minimal invasive operations show major advantages in all other parameters.

Concerning these results, endoscopic surgery seems to be the most effective and safe way for treatment of high-volume BPH in a high-volume centre and should be considered the first choice. Robotic surgery is an interesting alternative, but costs and operation time make this approach at least debatable. It may be reserved for patients with concomitant bladder stones of considerable size or diverticula, which can be treated simultaneously by robotic surgery. But since the learning curve requires at least fifteen operations in minimal invasive approaches until stable and good results can be achieved [12, 14, 20–22], the question remains whether open surgery still might keep its standing in centres with limited case load. Teaching in minimal invasive surgery, whether robotic or endoscopic. is time consuming and has a long learning curve [20, 21]. If the caseload of high-volume BPH per centre is less than 10–15, it is debatable whether to implement any kind of minimal invasive surgery at this department.

Conclusions

The endoscopic approach showed excellent results for prostates larger than 80 g concerning blood loss, transfusion and early continence rates. Robotic surgery offers a reasonable alternative approach with the only significant disadvantage in operation time. Endoscopic surgery should be considered as first-line therapy at least in high-volume centres unless there are comorbidities like diverticula and/or bladder calculi that can be easily treated simultaneously by robotic surgery. Against the background of these findings, indications favouring open surgery are getting sparse.

Author contributions SN: Project development, Data Collection, Data analysis, Manuscript writing. TB: Project development Manuscript editing Data Collection. TH: Project development Manuscript editing. SJ: Data Collection. FCR: Manuscript editing. CH: Manuscript editing. JWT: Manuscript editing. CT: Data analysis, Manuscript editing. AN: Project development, Data analysis, Manuscript editing.

Compliance with ethical standards

Conflict of interest The authors were not compensated and retained the control over the content of the manuscript.

Research involving human participants The study was performed in accordance with the ethical standards of the institutional research committee of each hospital.

Informed consent Informed consent was obtained from all patients at time of follow-up.

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