Arab Journal of Urology (2016) **14**, 147–155

Arab Journal of Urology
(Official Journal of the Arab Association of Urology)

www.sciencedirect.com

PROSTATIC DISORDERS
ORIGINAL ARTICLE

Prostate tissue retrieval after holmium laser enucleation of the prostate; assessment of non-morcellation approaches

Ahmed M. Elshal *, **Yasser Eldemerdash, Ramy Mekkawy, Diaa-Eldin Taha, Mahmoud Laymon, Ahmed R. El-Nahas, Ahmed El-Assmy**

Prostate Unit, Urology and Nephrology Center, Mansoura University, Mansoura, Egypt

Received 6 December 2015, Received in revised form 23 January 2016, Accepted 13 February 2016
Available online 17 March 2016

KEYWORDS

Prostate;
Laser;
Morcellation;
TURP;
Enucleation

ABBREVIATIONS

Q_{max}, maximum urinary flow rate;
HoLEP, holmium laser enucleation of the prostate;
PVR, post-void residual urine volume;
TUR, transurethral resection

Abstract ***Objectives:*** To review non-morcellation approaches for tissue retrieval after holmium laser enucleation of the prostate (HoLEP) and whether these approaches demolish the advantages of the HoLEP procedure.

Patients and methods: We reviewed our prospectively maintained laser prostate database for HoLEP procedures where non-morcellation approaches were used for retrieval of the enucleated adenoma. Non-morcellation approaches were adopted in cases of morcellator malfunction or whenever concomitant pathology indicated laparotomy. Patients were stratified into the laparotomy group (Group I) or the transurethral resection (TUR) group (Group II). Safety and efficacy of each approach were assessed and compared.

Results: Between August 2012 and July 2015, of 392 HoLEP procedures non-morcellation approaches were used for tissue retrieval in 37 (9.4%). In 19 procedures a laparotomy approach was adopted (17 mini-laparotomies and two conventional laparotomies for concomitant diverticulectomy). TUR of the enucleated adenoma was adopted in 18 patients. Baseline demographic data and indications for surgery were comparable between the groups. However, significantly larger prostates were treated in Group I. There were no significant differences between the groups for tissue retrieval time, histopathological findings of retrieved tissue, and peri-procedure biochemical changes. However, significantly more tissue was retrieved (median tissue

* Corresponding author. Tel.: +20 502202222.
E-mail address: elshalam@hotmail.com (A.M. Elshal).

Peer review under responsibility of Arab Association of Urology.

Production and hosting by Elsevier

http://dx.doi.org/10.1016/j.aju.2016.02.003

weight 115 vs 38 g) and at a faster rate (4.6 vs 1.09 g/min) in Group I. The median hospital stay was similar in both groups, but the median time to catheter removal was longer in Group I (5 vs 2 days). Minimal and similar peri-procedure complications were reported in both groups and in both groups there was a significant and comparable improvement in all urinary outcome measures.

Conclusion: In the absence or malfunction of a tissue morcellator, or whenever concomitant pathology indicates laparotomy, non-morcellation tissue retrieval approaches are feasible options for endourologists practicing transurethral enucleation of prostate adenoma. These approaches are valid alternatives retaining most of the advantages of the transurethral prostate enucleation procedure.

Introduction

For over two decades transurethral enucleation of prostate adenoma using a holmium laser (HoLEP) has been extensively studied. HoLEP was promoted as a size independent procedure [1], being a cost-effective alternative to open prostatectomy [2] with the advantages of being safe in patients with bleeding disorders, reducing hospital stay and catheter time, and minimising the need for blood transfusion. The procedure has stood the test of time well [3]. Furthermore, the feasibility of HoLEP with concomitant urological procedures has been proven [4]. However, the acknowledged limitation of this procedure remains the tissue retrieval approach after transurethral enucleation [5].

Today, transurethral morcellation of the intravesical prostate adenoma is the standard tissue retrieval approach; however, transurethral morcellation of a completely enucleated intravesical adenoma is time consuming and tedious, and is associated with extra costs for the morcellator machine and its re-usables [5]. Occasionally, impaired visibility through the indirect nephroscope after enucleation may force the surgeon to stage the procedure resulting in another session of morcellation [6].

Non-morcellation approaches entail *in situ* resection of partially enucleated adenomas [7] and open cystostomy for extraction of intravesical adenomas [8].

The objective of the present study was to review our experience of non-morcellation approaches used for tissue retrieval after HoLEP and to assess whether these approaches compromise the acknowledged advantages of the HoLEP procedure.

Patients and methods

After obtaining Institutional Review Board approval, we reviewed our prospectively maintained laser prostate database for HoLEP procedures that were completed using a non-morcellation tissue retrieval approach. One surgeon (A.M.E.), who had passed the learning curve for HoLEP, performed or supervised all procedures. Patients were admitted for BPH surgery whenever they had refractory LUTS with failed medical treatment, an indwelling catheter due to urinary retention, and failed trial of voiding without catheter, or refractory haematuria of prostatic origin.

Intervention

A 100 W holmium:yttrium-aluminium-garnet (YAG) laser (Versapulse, Lumenis Inc., Santa Clara, CA, USA) with a 550-μm end-firing flexible fibre (SlimLine™ 550, Lumenis Inc.) was used. A continuous flow 26-F resectoscope (Karl Storz, Tuebingen, Germany) was used for all procedures.

The enucleation phase of HoLEP was performed as previously described [9]. After prostate enucleation, adenoma retrieval was routinely performed using a tissue morcellator [2]; however, in the absence of morcellator cutting blades or morcellator device malfunction, non-morcellation approaches were used. Moreover, if there was concomitant urological pathology this might also be an indication to change our surgical plan regarding the tissue retrieval approach.

Retrieval of the prostate adenoma was performed as follows:

Laparotomy approach (Group I)

For adenomas that were judged significantly large by the surgeon and/or in the presence of concomitant pathology (large bladder stones/bladder diverticulum) the enucleated adenomas were completely detached to the bladder followed by meticulous haemostasis. Then, a 22-F three-way catheter was inserted and continuous bladder irrigation was instituted. Clamping of the catheter outflow was done just before cystostomy and bladder irrigation was reinstituted immediately after bladder closure.

- *Mini-laparotomy approach*, unless bladder diverticulectomy was indicated; in the same lithotomy position, a transverse 3-cm lower abdominal incision deep to the anterior rectus sheath was made and the two recti separated, followed by a transverse incision in the anterior bladder wall with stay

sutures, extraction of the intravesical adenoma followed by a water-tight closure of the bladder wall and anatomical closure without drains was performed Fig. 1a–c.

- *Conventional laparotomy approach*, after transurethral enucleation; in the supine position, a classic midline subumbilical extraperitoneal incision was made. Cystostomy was classically performed for extraction of the adenoma and any bladder stones. Then, bladder diverticulectomy was performed as indicated Fig. 1d.

TUR approach (Group II)

For adenomas that were judged by the surgeon as resectable within a reasonable time.

- '*Mushroom technique*', in which adenomas were left attached at the bladder neck between the 3 and 5 o'clock positions for the left lobe, and the 7 and 9 o'clock positions for the right lobe followed by bipolar TUR of the partially detached adenoma Fig. 2a–c.
- *TUR of intravesical completely enucleated adenoma*, in cases of non-intentional separation of relatively small adenomas to the bladder. The resection of the freely detached adenoma inside the bladder is relatively difficult and associated with risk of bladder injury. So, in these instances insertion of a suprapubic 5-mm transvesical laparoscopic port with the introduction of a tissue grasper to hold the adenoma during TUR was performed Fig. 2d–f. The port was removed at the end of the procedure and a three-way 22-F urethral catheter inserted.

Outcome measures

Intraoperative and peri-procedure parameters were monitored and reported. The efficacy of each approach was assessed by tissue retrieval time, weight of tissue retrieved, and tissue retrieval rate. For open extraction, the retrieval time was counted from skin incision to closure. For the TUR approach, the retrieval time was counted after the introduction of the resection loop until catheter insertion. The rate of tissue retrieval was calculated by dividing the weight of the prostate specimen by the time needed for retrieval.

The safety of each approach was assessed and compared. Peri-procedure complications, hospital stay and catheter time were reported and compared. Peri-procedure haemoglobin and haematocrit values deficits

Figure 1 (a) Mini-laparotomy, adenoma extraction. (b) Mini-laparotomy, 3-cm wound. (c) Mini-laparotomy, 163.8 g extracted adenoma. (d) Conventional laparotomy, bladder diverticulum specimen and extracted enucleated adenoma and vesical stone.

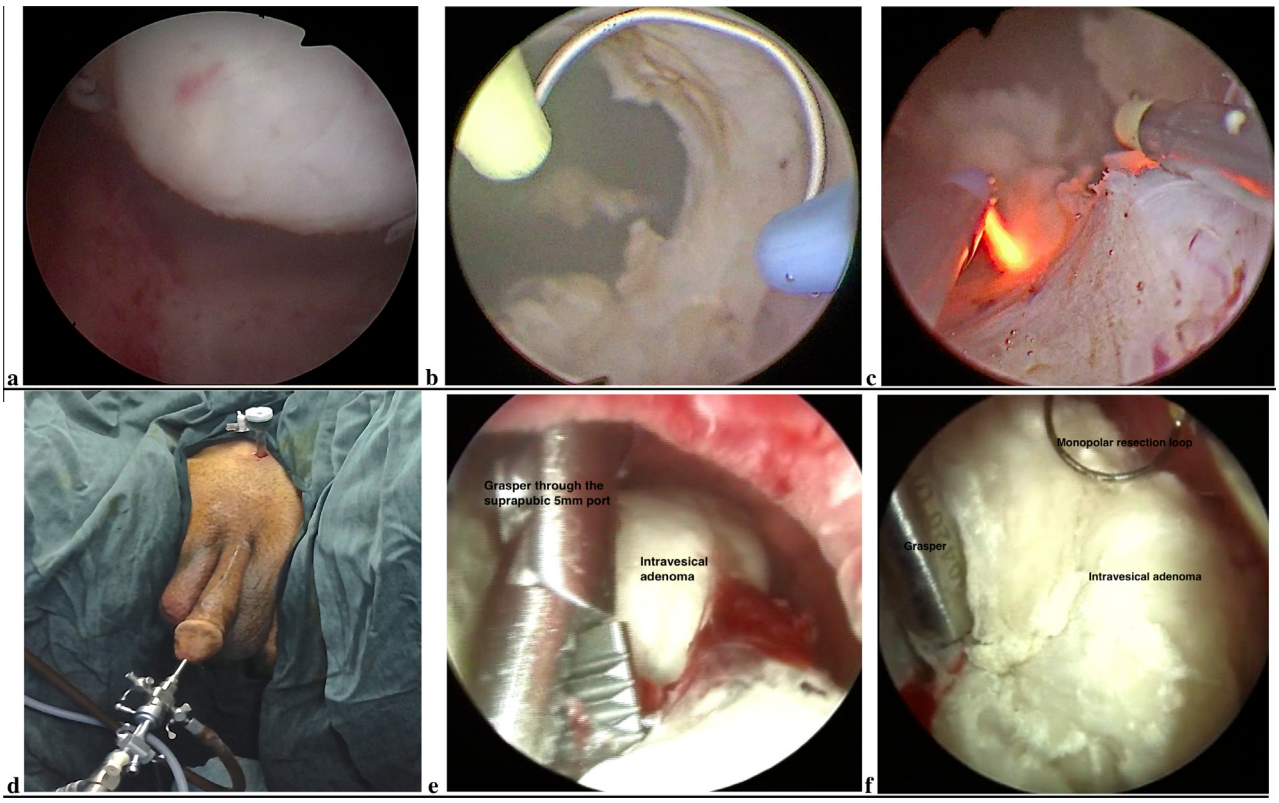

Figure 2 (a) Enucleated partially detached adenoma. (b–c) 'Mushroom technique' using bipolar resection loop for resection of partially detached adenoma. (d) Suprapubic intravesical 5-mm port insertion under cystoscopic guidance. (e) Suprapubic grasper holding the intravesical adenoma. (f) Resection loop in action with grasped intravesical adenoma.

Table 1 Baseline data.

Variable	Post HoLEP extraction of prostatic adenoma		
	Laparotomy, Group I [mini-laparotomy (n = 17), conventional laparotomy (n = 2)]	TUR, Group II ['mushroom technique' (n = 16), TUR of intravesical adenoma (n = 2)]	P
Mean (SD):			
Age, years	66.4 (5.7)	68 (7.9)	0.5
BMI, kg/m^2	29.6 (5.1)	30.7 (3.4)	0.4
TRUS estimated prostate size, g	176 (30)	96.5 (26)	<0.001
N (%):			
Patients with ASA score of III	2 (10.5)	3 (16.6)	0.5
Patients with diabetes mellitus	4 (21)	6 (33.3)	0.66
Indications of surgery			0.2
Indwelling urinary catheter, urine retention, and failed TOV	4 (21)	5 (27.5)	
LUTs refractory to medical treatment	13 (68.5)	12 (67)	
Haematuria of prostatic origin	2 (10.5)	1 (5.5)	
Median (range) preoperative PSA level, ng/dL	10.5 (0.5–27)	3.6 (0.1–15)	0.004

ASA, American Society of Anesthesiologists; TOV, trial of voiding.

were calculated and compared using the following formula; preoperative level minus the postoperative level as assessed on the first postoperative day. The blood transfusion rate was compared between the study subjects. Furthermore, urinary functional outcomes were assessed by symptom score (IPSS), and maximum

Table 2 Efficacy and safety profile.

Variable	Post HoLEP extraction of prostatic adenoma		
	Laparotomy, Group I	TUR, Group II	*P*
N (%)			
BPH	15 (78.9)	14 (77.7)	1
BPH with prostatitis	3 (15.9)	4 (22.3)	
BPH with focal prostate cancer	1 (5.2)	–	
Median (range)			
Tissue retrieval time, min	39 (33–75)	42 (19–85)	0.1
Histopathological weight of specimen, g	115 (56–193)	38 (15–90)	< 0.001
Tissue retrieval rate (specimen weight/retrieval time), g/min	4.6 (1.53–5.3)	1.09 (0.6–2.2)	< 0.001
Haemoglobin deficit*, g/dL	0.3 (0.4–3.5)	0.9 (0.1–4.3)	0.6
Haematocrit value deficit*, %	4.9 (0.8–11.4)	4.9 (1.5–13.5)	0.3
Blood sodium deficit*, mmol/L	3 (1–3)	0.0 (–7 to 3)	0.09
Catheterisation time, days	5 (5–7)	2 (1–3)	0.01
Hospital stay, days	1 (1–4)	2 (1–3)	0.07
Peri-procedure complications, *n* (%)	2 (10.5)	4 (22.3)	0.5
Bladder injury	–	1	
Anaemia necessitates blood transfusion	–	1	
Postoperative haematuria			
Conservative measures	1	–	
Post retrieval cystoscopic haemostasis	–	1	
Readmissions			
Secondary bleeding and clot retention	1	–	
Urethral stricture for endoscopic meatotomy	–	1	

* Preoperative minus immediate postoperative value.

urinary flow rate (Q_{max}) and post-void residual urine volume (PVR) estimations were recorded, and all readmissions were reported.

Statistical analysis

Data analysis was conducted using the commercially available Statistical Package for Social Sciences (*SPSS® 20 for Mac*). Results were compared between study groups using the chi-square and Fisher's exact tests for categorical variables, and the independent samples *t*-test and Mann–Whitney *U*-test for quantitative variables, as appropriate. A $P < 0.05$ was considered to indicate statistical significance.

Results

Between August 2012 and July 2015, of 392 HoLEP procedures, non-morcellation approaches were used for tissue retrieval in 37 (9.4%) procedures. In 19 procedures the laparotomy approach was adopted (Group I) which comprised of 17 mini-laparotomies and two conventional laparotomies for concomitant diverticulectomy, while TUR of the enucleated adenoma (Group II) was used in other 18 patients.

The baseline demographic data and indications for surgery were comparable between the study groups. However, in Group I, the prostates treated were larger and the baseline PSA levels were higher (Table 1).

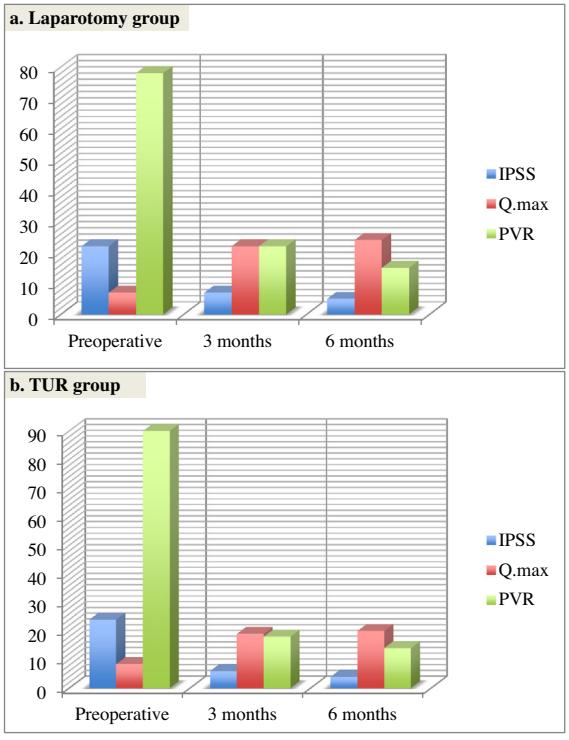

Figure 3 (a) Group I (laparotomy). (b) Group II (TUR).

Table 2 summarises the safety and efficacy outcome data in both groups. There were no significant differences between the groups for tissue retrieval time, histopathological findings of retrieved tissue, and peri-procedure

biochemical changes. However, significantly more tissue was retrieved and at a median faster rate in Group I. The groups had similar median hospital stays, but the median time to catheter removal was longer in Group I.

Postoperative haematuria was reported in one patient in each group, conservative measures were satisfactory in the Group I patient, while re-cystoscopy was indicated for haemostasis in the Group II patient. One readmission was reported in each group (Table 2).

Fig. 3 shows the changes in symptom score (IPSS), Q_{max}, and PVR over time. There were statistically significant improvements in all urinary outcome measures from baseline to the last follow-up ($P < 0.05$). There was no statistically significant difference in any of the assessed parameters at different time points between the laparotomy (Group I) and TUR (Group II) groups ($P > 0.05$).

Peri-procedure blood transfusion was indicated in one case (2.7%).

Discussion

Transurethral enucleation of prostate adenoma is an appealing approach for management of all sizes of BPH. Enucleation has become more popular and different kinds of energy have been tried to accomplish the enucleation [10]. Morcellation of the intravesical adenoma is the standard approach for tissue retrieval after transurethral enucleation. Three commercially available morcellators are in the market, of which two have been frequently studied [5,11]. However, in most of the large series of transurethral enucleation procedures, there is a place for non-morcellation approach for tissue retrieval [3,12].

Problems with morcellation have been reported with different kinds of morcellators. Occasionally, it might oblige the surgeon to stage the procedure (secondary morcellation due to bleeding or blade malfunction) [6]. Complications secondary to morcellation include bladder mucosal injuries (up to 7.1%), perforation (up to 5.9%) [13], and bleeding (0.02–6.9%) [5]. Furthermore, mechanical problems of morcellators have been reported; in the Piranha morcellator (Wolf Inc., Knittlingen, Germany) secondary to a leak of negative pressure from the vacuum bottle/tubing set and in the VersaCut (Lumenis Inc., Santa Clara, CA, USA) morcellator obstruction of the tubing set where large tissue piece can cause malfunction of the pump and significantly reduce suction power [5].

Table 3 Review of non-morcellation tissue retrieval approaches following different TUR enucleation techniques in the contemporary series.

References	RCT/CS	Procedure	Mean (SD, range) prostate size, mL	Number of procedures	Tissue retrieval approach	Rational for non-morcellation
Hochreiter et al. (2002) [7]	CS	HoLEP	38 (20–70)	156	Unipolar 'mushroom'	No available morcellator
Elshal et al. (2012) [24]	CS	HoLEP	Group 1, 94.3 Group 2, 79.3	1054	Laparotomy 0.5%	Exceptionally large prostates
Krambeck et al. (2010) [12]	CS	HoLEP	NR	1056	Laparotomy 0.3%	Morcellator malfunction Dense non-morcellating adenoma
Abdel-Hakim et al. (2010) [23]	CS	HoLEP	86.5 (65.4, 20–350)	230	Laparotomy 0.1%	Complicated procedures
Kuntz and Lehrich (2002) [21]	RCT	HoLEP	114.6 (21, 100–230)	60	Unipolar 'mushroom' 83%	No available morcellator
Kuntz et al. (2004) [22]	RCT	HoLEP	53.5 (20, 20–95)	100	Unipolar 'mushroom'	No available morcellator
Zhang et al. (2012) [20]	RCT	HoLEP	43.5 (23, 37.3–76.4)	62	Unipolar 'mushroom'	No available morcellator
Zhang et al. (2012) [20]	RCT	ThulEP	46.6 (25, 34.2–79.6)	71	Unipolar 'mushroom'	No available morcellator
Liao and Yu (2012) [19]	CS	PKEP	77.3 (56–95)	160	Bipolar 'mushroom'	Routine
Luo et al. (2014) [18]	CS	PKEP	61.8 (18.7)	155	Bipolar 'mushroom'	Routine
Zhao et al. (2010) [17]	RCT	PKEP	69.2 (13.5, 35–158)	102	Bipolar 'mushroom'	Routine
Zhu et al. (2013) [16]	RCT	PKEP	113.8 (32)	40	Bipolar 'mushroom'	Routine
Chen et al. (2014) [14]	RCT	PKEP	110 (102–130)	80	Bipolar 'mushroom'	Routine
Rao et al. (2013) [15]	RCT	PKEP	116.2 (32)	43	Bipolar 'mushroom'	Routine

RCT, randomised clinical trials; CS, case series; ThulEP, thulium laser enucleation of the prostate; PKEP, plasma kinetic enucleation of the prostate; NS, not specified; NR, not reported; NA, not applicable.

The main indications for non-morcellation approaches are concomitant pathology, and malfunction or absence of a tissue morcellator. Hochreiter et al. [7] in 2002, described the 'mushroom technique' for tissue retrieval after HoLEP. They concluded that combining HoLEP and TUR of partially enucleated adenomas is a safe, efficient and bloodless (no blood transfusion) surgical treatment for BPH, with no need for a mechanical tissue morcellator [7]. With the evolution of bipolar technology resection of the partially detached adenoma can be achieved without the need to change the irrigant and maintaining safety using an isotonic irrigant. Table 3 [7,12,14–24] reviews the role of non-morcellation tissue retrieval approaches used in contemporary series of transurethral enucleation procedures. In the present study, we exclusively report on these approaches in our growing HoLEP series.

Concomitant pathology requiring non-endourological management indicates laparotomy to complete the procedure. The advantage of HoLEP is that it permits a visually controlled laser-assisted enucleation of the prostate even after performing laparotomy to allow retrieval of the enucleated adenoma. No peri-procedure blood transfusions were required in HoLEP/laparotomy group (Group I) and the median hospital stay was 1 day. Conventional laparotomy was needed in the two patients with concomitant diverticulectomy. A mini-laparotomy with a small incision was used for the remaining patients in HoLEP/laparotomy group (Group I). In the absence of a tissue morcellator, mini-laparotomy is a safe, effective and convenient approach for adenoma retrieval. Large adenomas that fill most of the bladder cavity might hinder safe morcellation. Open extraction is the preferred option with exceptionally large prostates [24]. The 'mushroom technique', particularly if a bipolar electrosurgical generator is available, might be a reasonable option for tissue retrieval. Resection *in situ* of a partially detached adenoma is safe, effective and bloodless [7]. In the HoLEP/TUR group (Group II), one case unusually required postoperative blood transfusion after a lengthy procedure with TUR of a completely detached intravesical adenoma; however, the overall median haemoglobin and haematocrit values deficits were comparable between Groups I and II. Furthermore, the median hospital stay was similar in both groups (Table 2). There were no statistically significant differences between the groups for peri-procedure complications. When considering the efficiency of both procedures, significantly more tissue was retrieved and at a faster rate in the HoLEP/laparotomy group (Group I; Table 2). The pathology of the retrieved specimens was similar in both groups.

Fig. 4 shows an algorithm outlining our approach for tissue retrieval after transurethral prostate enucleation. Morcellation is routinely performed provided that a perfectly working morcellator and cutting blades are

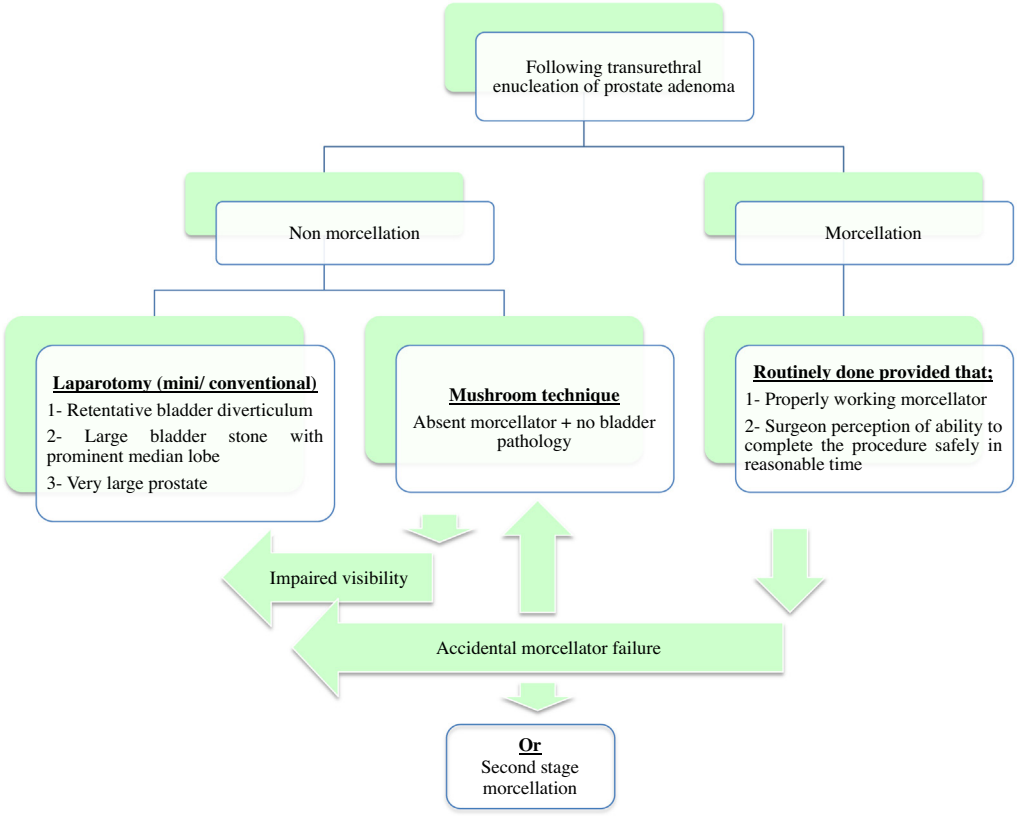

Figure 4 Algorithm for tissue retrieval approaches after transurethral enucleation of prostate adenoma.

available. Non-morcellation approaches are valid options in cases of an absence of a perfectly working morcellator, very large prostates, and when there is concomitant lower urinary tract pathology. Piao et al. [25] identified men aged $\geqslant$65 years and a total prostate volume of $\geqslant$65 mL as independent predictors for hard nodules resistant to morcellation, with mainly dense fibrous tissue forming these nodules. Hard nodules resistant to morcellation make morcellation cumbersome and time-consuming. Ishikawa et al. [26] showed that morcellation efficiency may decrease significantly in larger glands of >80 g enucleated weight. Monn et al. [27] showed that a larger prostate volume significantly reduced morcellation efficiency; furthermore, a history of UTI and clean-intermittent catheterisation were associated with modest increases in morcellation times. Secondary HoLEP after previous transurethral prostate surgery is associated with a lower morcellation rate [24].

Lithotripsy for large bladder stones of >2 cm using pneumatic or holmium laser lithotripsy could be associated with bladder complications that might abort same session prostatectomy [28]. The presence of a large median lobe affecting the visibility of the vesical stone might be an indication to start the procedure by prostate enucleation followed by a mini-laparotomy to extract the vesical stone and the enucleated prostate adenoma. Concomitant transurethral prostatectomy and suprapubic minimal incision cystolithotripsy have been reported to be superior to a staged procedure [29].

Limitations of the present study include the small sample size and retrospective nature. However, to the best of our knowledge, this is the first report that addresses different viable non-morcellation approaches for tissue retrieval after transurethral enucleation of prostate adenoma. Another limitation is that the choice of the approach was purely based on surgeon preference.

Conclusion

Non-morcellation tissue retrieval approaches are valid options for endourologist practicing transurethral enucleation of prostate adenoma. In the absence of or malfunction of a tissue morcellator, or whenever concomitant pathology indicates laparotomy, these approaches are valid alternatives that retain most of the advantages of the transurethral prostate enucleation procedure.

Source of funding

None.

Conflicts of interest

None.

References

[1] Humphreys MR, Miller NL, Handa SE, Terry C, Munch LC, Lingeman JE. Holmium laser enucleation of the prostate – outcomes independent of prostate size? *J Urol* 2008;**180**:2431–5.

[2] Elshal AM, Mekkawy R, Laymon M, Barakat TS, Elsaadany A, El-Assmy A, et al. Holmium laser enucleation of the prostate for treatment for large-sized benign prostate hyperplasia; is it a realistic endourologic alternative in developing country? *World J Urol* 2015. http://dx.doi.org/10.1007/s00345-015-1639-8 [Epub ahead of print].

[3] Elkoushy MA, Elshal AM, Elhilali MM. Reoperation after holmium laser enucleation of the prostate for management of benign prostatic hyperplasia: assessment of risk factors with time to event analysis. *J Endourol* 2015;**29**:797–804.

[4] Patel A, Nunez R, Mmeje CO, Humphreys MR. Safety and feasibility of concomitant surgery during holmium laser enucleation of the prostate (HoLEP). *World J Urol* 2014;**32**:1543–9.

[5] Elshal AM, Mekkawy R, Laymon M, El-Assmy A, El-Nahas AR. Towards optimizing prostate tissue retrieval following holmium laser enucleation of the prostate (HoLEP): assessment of two morcellators and review of literature. *Can Urol Assoc J* 2015;**9**:E618–25.

[6] Gross AJ, Netsch C, Knipper S, Holzel J, Bach T. Complications and early postoperative outcome in 1080 patients after thulium vapoenucleation of the prostate: results at a single institution. *Eur Urol* 2013;**63**:859–67.

[7] Hochreiter WW, Thalmann GN, Burkhard FC, Studer UE. Holmium laser enucleation of the prostate combined with electrocautery resection: the mushroom technique. *J Urol* 2002;**168**:1470–4.

[8] Yu XX, Zhang RM, Zhou DQ, Mo ZN, Li WG, Wang Q, et al. Transurethral plasmakinetic enucleation of prostate and suprapubic small cut in the treatment of high risk and senior patient with benign prostatic hyperplasia and bladder stones. *Zhonghua Yi Xue Za Zhi* 2013;**93**:597–9.

[9] Elshal AM, Elkoushy MA, Elhilali MM. V412 evaluation of a new enucleating loop for holmium laser enucleation of the prostate (HoLEP); pilot study. *J Urol* 2013;**189**:e166–7.

[10] Gomez Sancha F, Rivera VC, Georgiev G, Botsevski A, Kotsev J, Herrmann T. Common trend: move to enucleation-is there a case for GreenLight enucleation? Development and description of the technique. *World J Urol* 2015;**33**:539–47.

[11] El Tayeb MM, Borofsky MS, Paonessa JE, Lingeman JE. Wolf Piranha versus Lumenis Versacut prostate morcellation devices: a prospective randomized trial. *J Urol* 2015;**195**:413–7.

[12] Krambeck AE, Handa SE, Lingeman JE. Experience with more than 1000 holmium laser prostate enucleations for benign prostatic hyperplasia. *J Urol* 2010;**183**:1105–9.

[13] Lee SH, Choi JI, Moon KY, Na W, Lee JB. Holmium laser enucleation of the prostate: modified morcellation technique and results. *Korean J Urol* 2012;**53**:779–84.

[14] Chen S, Zhu L, Cai J, Zheng Z, Ge R, Wu M, et al. Plasmakinetic enucleation of the prostate compared with open prostatectomy for prostates larger than 100 grams: a randomized noninferiority controlled trial with long-term results at 6 years. *Eur Urol* 2014;**66**:284–91.

[15] Rao JM, Yang JR, Ren YX, He J, Ding P, Yang JH. Plasmakinetic enucleation of the prostate versus transvesical open prostatectomy for benign prostatic hyperplasia >80 mL: 12-month follow-up results of a randomized clinical trial. *Urology* 2013;**82**:176–81.

[16] Zhu L, Chen S, Yang S, Wu M, Ge R, Wu W, et al. Electrosurgical enucleation versus bipolar transurethral resection for prostates larger than 70 ml: a prospective, randomized trial with 5-year followup. *J Urol* 2013;**189**:1427–31.

[17] Zhao Z, Zeng G, Zhong W, Mai Z, Zeng S, Tao X. A prospective, randomised trial comparing plasmakinetic enucleation to standard transurethral resection of the prostate for symptomatic benign prostatic hyperplasia: three-year follow-up results. *Eur Urol* 2010;**58**:752–8.

[18] Luo YH, Shen JH, Guan RY, Li H, Wang J. Plasmakinetic enucleation of the prostate vs plasmakinetic resection of the prostate for benign prostatic hyperplasia: comparison of outcomes according to prostate size in 310 patients. *Urology* 2014;**84**:904–10.

[19] Liao N, Yu J. A study comparing plasmakinetic enucleation with bipolar plasmakinetic resection of the prostate for benign prostatic hyperplasia. *J Endourol* 2012;**26**:884–8.

[20] Zhang F, Shao Q, Herrmann TR, Tian Y, Zhang Y. Thulium laser versus holmium laser transurethral enucleation of the prostate: 18-month follow-up data of a single center. *Urology* 2012;**79**:869–74.

[21] Kuntz RM, Lehrich K. Transurethral holmium laser enucleation versus transvesical open enucleation for prostate adenoma greater than 100 gm: a randomized prospective trial of 120 patients. *J Urol* 2002;**168**:1465–9.

[22] Kuntz RM, Ahyai S, Lehrich K, Fayad A. Transurethral holmium laser enucleation of the prostate versus transurethral electrocautery resection of the prostate: a randomized prospective trial in 200 patients. *J Urol* 2004;**172**:1012–6.

[23] Abdel-Hakim AM, Habib EI, El-Feel AS, Elbaz AG, Fayad AM, Abdel-Hakim MA, et al. Holmium laser enucleation of the prostate: initial report of the first 230 Egyptian cases performed in a single center. *Urology* 2010;**76**:448–52.

[24] Elshal AM, Elmansy HM, Elhilali MM. Feasibility of holmium laser enucleation of the prostate (HoLEP) for recurrent/residual benign prostate hyperplasia (BPH). *BJU Int* 2012;**110**:E845–50.

[25] Piao S, Choo MS, Wang Y, Lee YJ, Bae J, Oh SJ. Clinical and pathological characteristics of hard nodules resistant to morcellation during holmium laser enucleation of the prostate. *Int Neurourol J* 2015;**19**:90–8.

[26] Ishikawa R, Shitara T, Wakatabe Y, Kubo S, Hirayama T, Fujita T, et al. Relationship between morcellation efficiency and enucleated tissue weight in holmium laser enucleation of the prostate (HoLEP) for patients with benign prostatic hyperplasia. *Nippon Hinyokika Gakkai Zasshi* 2011;**102**:675–8.

[27] Monn MF, El Tayeb M, Bhojani N, Mellon MJ, Sloan JC, Boris RS, et al. Predictors of enucleation and morcellation time during holmium laser enucleation of the prostate. *Urology* 2015;**86**:338–42.

[28] Ercil H, Altunkol A, Alma E, Goren MR, Sener NC, Kuyucu F, et al. Comparison of Ho: Yag laser and pneumatic lithotripsy combined with transurethral prostatectomy in high burden bladder stones with benign prostatic hyperplasia. *Asian J Surg* 2015. http://dx.doi.org/10.1016/j.asjsur.2015.03.010 [Epub ahead of print].

[29] Zhao J, Shi L, Gao Z, Liu Q, Wang K, Zhang P. Minimally invasive surgery for patients with bulky bladder stones and large benign prostatic hyperplasia simultaneously: a novel design. *Urol Int* 2013;**91**:31–7.