Peri-operative complications of holmium laser enucleation of the prostate: experience in the first 280 patients, and a review of literature

Hemendra N. Shah, Amol P. Mahajan, Sunil S. Hegde and Manish B. Bansal

Department of Urology, R. G. Stone Urological Research Institute, Mumbai, Maharashtra, India

Accepted for publication 12 January 2007

OBJECTIVE

To evaluate, in a prospective study, the complications in 280 patients undergoing holmium laser enucleation of the prostate (HoLEP) at our institution, and to review previous reports to determine the overall incidence and types of various complications, and analyse their causes and means of prevention.

PATIENTS AND METHODS

We analysed the patients' demographic, peri-operative and follow-up data, and the complications during and after surgery.

RESULTS

HoLEP was completed successfully in 268 patients (95.7%); eight required conversion to transurethral resection of the prostate (TURP) during the initial experience. The morcellation device and laser malfunctioned in two patients each. A blood transfusion was required during HoLEP in one patient; other complications included capsular perforation (9.6%), superficial bladder mucosal injury (3.9%) and ureteric orifice injury (2.1%). A blood transfusion was needed after HoLEP in 1.4% of patients and cystoscopy with clot evacuation in 0.7%. Transient urinary incontinence was the commonest complication after HoLEP, in 10.7% of patients, but recovered spontaneously in all except two (0.7%). Other rare complications were re-catheterization (3.9%), urinary tract infection (3.2%), epididymitis (0.7%), meatal and submeatal stenosis (2.5%), bulbar urethral stricture (2.1%), bladder neck contracture (0.35%) and myocardial infarction (0.35%).

CONCLUSIONS

There was a low incidence of complications with HoLEP; most were minor and easily managed. Our results are comparable with those published previously, and establish HoLEP as safe and reproducible procedure. While gaining experience, HoLEP can be converted to TURP with no harm to the patient.

KEYWORDS

bladder outlet obstruction, laser prostatectomy, HoLEP, complications, BPH, TURP.

INTRODUCTION

Since the first description by Gilling *et al.*, holmium laser enucleation of the prostate (HoLEP) is being increasingly used for the surgical management of BOO. It is a safe and effective procedure for treating symptomatic BPH, independent of prostate size, and with low morbidity and a short hospital stay. Nevertheless, a limitation of this technique is the experience and training required, and the relatively few experts in the field [1]. This significant learning curve is the most daunting impediment to adopting this attractive technique, particularly for surgeons who are not in a situation where they can be closely mentored. The concern is that a patient will have an adverse outcome because of the inexperience of the surgeon. To address this issue, we prospectively reviewed the complications occurring in the first 280 patients operated by one surgeon at our institution. We also assessed the previous reports of HoLEP, to determine the overall incidence and types of various complications, and to analyse their causes and means of prevention.

PATIENTS AND METHODS

From June 2003 to July 2006, 280 patients had HoLEP by one surgeon (H.N.S.) at our institution; all patients were evaluated with the AUA symptom score, a DRE, PSA assay, urine analysis and urine culture. Abdominal ultrasonography was used to measure prostate volume and the postvoid residual urine volume (PVR), and uroflowmetry was used in all patients except those in urinary retention.

All HoLEP procedures were performed as described previously [2–4]. Spinal or epidural anaesthesia was usually preferred, except in patients with coagulopathy and failed regional anaesthesia, in whom general anaesthesia was used. The 100 W holmium:YAG laser with a 550 μm laser fibre (Lumenis, Santa Clara, CA, USA) was used as the energy source, through a 26 F continuous-flow resectoscope (Karl Storz Endoscopy, CA, USA) with a laser bridge. The laser fibre with its 6 F stabilizing ureteric catheter was introduced into the laser bridge. Normal saline was used for irrigation. Most of the enucleation process was done using laser settings of 2 J and 50 Hz, changing to 2 J and 40 Hz during apical lobe dissection. After enucleation, haemostasis was achieved by defocusing the laser over targeted areas at settings of 2.5 J and 40 Hz. Enucleated tissues were morcellated using a Versa Cut morcellator (Lumenis) introduced through an offset rigid nephroscope. At the end of

TABLE 1
The patients' demographics and peri-operative variables

Variable	Mean (range), n or n (%)
Age, years	65.9 (51–103)
Associated conditions	
Hypertension	112
Ischaemic heart disease	53
Diabetes mellitus	41
Chronic renal failure	6
Cardiac pacemakers	5
Inguinal hernia	9
Strictures	11
Bladder tumour	1
Upper tract urolithiasis	9
Past history of prostate surgery	17
Associated coagulopathy	59
Anti-platelet medication (low-dose aspirin/clopidogrel)	49
Warfarin	4
Thrombocytopenia	5
Autoimmune dermatitis with idiopathic coagulopathy	1
Indications for surgery	
Recurrent urinary retention	79 (28.2)
Failure of medical management	130 (46.4)
Bladder calculi	34 (12.1)
Recurrent UTI, including epididymitis	3 (1.1)
Bladder diverticulum	4 (1.4)
Obstructive uropathy	5 (1.8)
Refusal of medical management	25 (8.9)
Preoperative:	
AUA symptom score	21.12 (4–35)
prostate weight, g	54.62 (8–225)
maximum urinary flow rate, mL/s	7.2 (0.9–22.4)
PVR, mL	179.63 (2–2100)
PSA, ng/mL	4.08 (0.2–44.1)
Duration of:	
HoLEP, min	61.27 (18–228)
enucleation, min	49.88 (12–180)
morcellation, min	11.39 (5–48)
Enucleation efficiency, g/min	0.59 (0.2–0.81)
Morcellation efficiency, g/min	2.62 (0.5–6.44)
Weight of prostate tissue retrieved, g	29.8 (4–128)
% of resected tissue	54.6
Overall HoLEP efficiency, g/min	0.48
Decrease in haemoglobin, g/dL	0.8 (0–2.4)
Duration of catheterization, h	34.9 (16–56)
Duration of hospitalization, h	39.1 (19–62)

surgery, a 22 F urethral Foley catheter was placed.

The catheter was removed 12 h after HoLEP, when the urine had cleared of haematuria; patients were discharged after removing the catheter. Resected prostatic tissue was assessed histopathologically in all patients. The AUA symptom score, uroflowmetry and PVR measurement were repeated during the follow-up at 1, 3, 6 and 12 months and yearly thereafter.

The demographic and peri-operative data were assessed statistically using standard methods. All the complications during and after HoLEP were analysed, and previous publications reviewed to document the incidence and type of various complications reported.

RESULTS

The patients' demographics are shown in Table 1. The procedure was completed successfully in 268 patients (95.7%). From the initial series of 25 consecutive patients, eight required conversion to TURP, due to failure to progress during enucleation of the lateral lobes. The morcellation device malfunctioned in two patients, and the procedure was abandoned and completed 48 h later. The laser machine malfunctioned in two patients, and the procedure was completed uneventfully using TURP in one; in the another with a 120 g prostate, the device malfunctioned after the initial 5 min of enucleation, so the procedure was abandoned and completed 2 days later when the laser machine was repaired. Five patients had round adenomas with a smooth surface that did not engage in the morcellation blades. These adenoma tissues were cut into small pieces in the bladder, with a serrated loop, and then removed mechanically with a nephroscopic alligator forceps. The detailed peri-operative variables are also given in Table 1.

Capsular perforation was the commonest complication during HoLEP, in 9.6% of patients (Table 2). Most of these perforations were either 'threatened' or 'covered' and did not change the subsequent management of the patients. Two patients had free perforation and one had subtrigonal perforation that was treated with urethral catheterization for 3–5 days. One patient with anaemia before HoLEP (haemoglobin 8.6 g/dL) required a blood transfusion during surgery. No patient had any evidence of TUR syndrome.

A blood transfusion was required in four patients after HoLEP. One patient had retained adenoma due to morcellation malfunction and was given 2 units of pack cells. One patient with unknown coagulopathy was given 4 units of fresh frozen plasma before surgery and then repeated every 6-h after surgery for 24 h. He came back 1 and 3 weeks after discharge with secondary haematuria and clot retention; he required cystoscopy and clot evacuation both times. There was minimal oozing from the prostatic fossa, which was fulgurated with electrocautery. He was given fresh frozen plasma and 2 units of packed cells during both admissions. One patient with a haemoglobin level of 8.9 g/dL before HoLEP was given 2 units of packed cells afterwards. Three of four patients who needed a blood transfusion after surgery had coagulopathy or were on anti-platelet treatment.

Re-catheterization was needed in 11 patients; nine responded well to a trial without catheter after 3–5 days. Two patients were taught clean intermittent catheterization due to failure of a second trial without catheter; their cystoscopy revealed a wide open prostatic fossa.

Stress urinary incontinence after HoLEP improved in all except two patients, at a mean (range) duration of 42.3 (1–110) days, with perineal exercises and bladder relaxants. One patient with persistent stress urinary incontinence at 2 years of follow-up was managed with a submucosal injection of dextranomer and hyaluronic acid. However, he failed to respond to this and is currently using a penile clamp. One patient had mild stress urinary incontinence at 10 months of follow-up. The results of variables assessed during the follow-up are shown in Table 3.

Overall, 14 patients developed some type of stenotic complications during the follow-up. Of these, five patients were from the first 50 cases. We attribute the progressive decrease in the incidence of stenotic complications to modifications in our technique. After the first 20 cases, the urethra was calibrated to 30 F in all the patients, using an Otis urethrotome before starting enucleation. Throughout the procedure the urethra was lubricated every 20 min. The need for TURP in eight patients might also explain the higher incidence of stenotic complications in the initial 50 patients.

TABLE 2 Complications during and after HoLEP

Complication	n (%)
During	
Blood transfusion	1 (0.35)
Capsular perforation	27 (9.6)
threatened	15
covered	9
free	2
subtrigonal	1
Superficial bladder mucosal injury	11 (3.9)
Bladder perforation	0
Ureteric orifice injury (superficial)	6 (2.1)
After	
Blood transfusion	4 (1.4)
Cystoscopy and clot evacuation	2 (0.7)
Re-catheterization	11 (3.9)
Transient urinary incontinence	30 (10.7)
Permanent urinary incontinence	2 (0.7)
UTI	9 (3.2)
Epididymitis	2 (0.7)
Meatal/submeatal stenosis	7 (2.5)
Bulbar stricture	6 (2.1)
Bladder neck contracture	1 (0.4)
Acute myocardial infarction	1 (0.4)
Incidental prostate carcinoma diagnosed	3 (1.1)

TABLE 3 The variables assessed during the follow-up

Follow-up,	No. of	Mean (range)		
months	patients	AUA score	Q_{max}, mL/ s	PVR, mL
Before HoLEP	186*	21.12 (4–35)	7.2 (0.9–22.4)	179.63 (2–2100)
1	263	6.9 (2–19)	18.9 (9.8–42.1)	39.9 (0–516)
3	224	5.5 (3–17)	19.2 (9.1–38.5)	25.5 (5–254)
6	182	5.4 (1–12)	17.8 (10.2–32.9)	28.9 (0–170)
12	156	4.9 (2–16)	17.6 (9.4–29.1)	19.1 (0–125)
24	83	5.1 (1–11)	19.1 (9.1–33.9)	22.9 (5–110)

**Data not available in patients on urethral catheterization for retention of urine. Q_{max}, maximum urinary flow rate.*

DISCUSSION

There are no standard criteria for reporting complications, thus comparison with reported data is difficult. The complications reported by various authors during and after HoLEP are listed in Tables 4 and 5 [4–11,12–32]. The complications during surgery were defined as those related to technical difficulties of the procedure.

Blood loss in HoLEP is less than that reported after TURP and open prostatectomy, because the holmium laser is haemostatic and cuts tissue by vaporization, simultaneously coagulating minor to medium-sized blood vessels [5–8]. Larger blood vessels can be coagulated by defocusing the laser fibre, i.e. pulling the fibre back by 2–3 mm [9]. Also in HoLEP, blood vessels are transected once during the enucleation procedure off the capsule; during TURP the vessels are repeatedly cut until the prostatic capsule is reached [10]. Hence, the overall incidence of blood transfusion is low during HoLEP, even for large prostates [11].

The holmium laser is an endoscopic haemostatic scalpel that cuts and coagulates the vessels simultaneously, thereby decreasing the absorption of irrigation fluid. The coagulative properties of the holmium laser adequately seal venous channels and prevent the absorption of irrigation fluid [33]. Additionally, the use of normal saline obviates the risk of dilutional hyponatraemia. We found that 26.4% of patients showed evidence of fluid absorption of 213–930 mL. The preoperative prostate weight, duration of irrigation, total amount of irrigation fluid used and weight of resected prostatic tissue all directly influence the amount of fluid absorption [34]. To counteract any fluid absorption 20 mg frusemide i.v. is

TABLE 4 A summary of complications reported previously during HoLEP, as n (%), unless otherwise stated

Ref	N	Resected tissue weight, g	Blood transfusion	Capsular perforation	Bladder injury	Ureteric orifice injury	Incomplete morcellation	Additional procedure	Cardiac events (%)
[4]	64	35.5	0	–	–	–	–	–	–
[28]	43	61.8	0	–	–	–	–	–	–
[12]	27	23.3	0	–	–	–	–	–	0
[25]	38	7	0	–	–	–	–	–	–
[29]	18	82.7	0	–	–	–	–	–	–
[18,27]	31	40.4	0	?	–	–	–	–	–
[15]	20	12.1	–	–	–	–	–	–	–
[21]	225	86.5	2	–	2	–	–	9*	–
[10]	552	52.1	3 (0.5)	2 (0.3)	4 (0.7)	–	–	–	1, MI (0.1) 2, bradycardia (0.3)
[22]	83	54.7	1 (1.2)	1 (1.2)	2 (2.4)	–	–	–	1, MI (1.2)
[7]	10	151	–	1 (10)	–	–	–	–	–
[20]	108	120.6	–	2 (1.9)	1 (0.9)	–	4 (3.7)†	2 (1.9)‡	–
[14]	206	68.2	2 (1.0)	3 (1.5)	4 (1.9) 1 (0.5)¶	–	4 (1.9%)	–	–
[30]	80	25	–	–	–	–	–	–	–
[23]	164	81.9	0	–	–	–	–	–	–
[9]	384	44.6	0	–	–	4 (1.0)	–	–	–
[6,31]	60	83.9	0	–	–	–	–	–	–
[5]	100	32.6	–	–	–	–	–	–	–
[8]	41	59.3	–	–	3 (7.3)	–	–	–	–
[26]	52	36.08	–	–	10 (18.2)	–	–	–	–
[17]	155	37	–	1 (0.6)	13 (8.3) 1 (0.5)§	–	–	3 (1.9)**	–
[16]	196	36.3	–	2†† (1)	14 (6.6)	–	–	5 (2.5)**	–
[19]	70	29.5	–	–	2 (3)	–	–	–	–
[11]	86	140.2	–	–	1	–	–	3‡‡	1, MI
[24]	50	17.2	0	1 (2)	2(4)	–	–	–	–
[32]	40		–	–	–	–	–	–	–

*MI, myocardial infarct; *1 perineal urethrostomy, 8 small cystostomy (1 stone, 3 inadequate morcellation, 4 large adenoma); †Morcellation blade malfunction; ‡1 cystostomy, 1 perineal urethrostomy; ¶Bladder neck false passage; §bladder perforation; **residual tissue in bladder; ††extraperitoneal fluid extravasation; ‡‡1 perineal urethrostomy, 2 open cystostomy.*

routinely given by some urologists at the end of the procedure [3].

The plane of enucleation is characterized by flimsy transverse or diagonal fibres with vessels running from capsule to adenoma. During enucleation, the surgical capsule appears very thin or even perforated, which is not the case most of the time [12].

Capsular perforation can be graded as follows [13]: (i) threatened perforation; an area of diverging capsular fibres through which periprostatic fat might be visible; (ii) covered perforation; fatty tissue is freely visible at the site of perforation, but it firmly covers the perforated hole; (iii) free perforation; a more-or-less obvious hole through which irrigation fluid can be seen to run in and, occasionally, out. Little or no periprostatic fat is visible at the margins; (iv) subtrigonal perforation (bladder neck false passage); likely to occur in large prostates, especially with large median lobes, during initial insertion of the resectoscope [14]. The acute angle at the junction of the prostatic capsule and bladder makes it more prone to free perforation. Proper use of the resectoscope beak and repeated orientation during enucleation can help to decrease the risk of this injury.

Capsular perforations are more common while learning HoLEP and in smaller prostates [10]. In smaller fibrotic prostates the surgical capsule is often less distinct and the plane of dissection more difficult than in larger glands, in which the greater degree of peripheral compression tends to create a more easily identifiable plane [15].

Threatened and covered perforation does not change the postoperative course of the patient; only free or subtrigonal perforation need attention, as they can lead to significant extravasation of irrigation fluid in the extraperitoneal space. Most of these patients can be managed by urethral catheter drainage. If there is extensive extravasation and concern about infecting perivesical tissue, suprapubic drainage should be instituted [16].

Bladder injury is a potential hazard of morcellation, and can be averted by thorough haemostasis and bladder distension before starting morcellation [17]. The operator must be careful not to engage the bladder mucosa.

TABLE 5 A summary of complications reported previously after HoLEP, as n (%), unless otherwise stated

Ref	Loss of Hb, g/dL	BT	H&C	Clot retention	Re-catheter-ization	Infection	IVS	Incontinence		BNC	UrS	Sub-MS or MS	Additional procedure needed
								transient	persistent				
[4]	–	0	0	0	3	2	–	4	–	–	–	–	–
[28]	–	0	–	–	–	3	–	2	–	–	1	–	1*
[12]	1.02	0	–	–	1	4†	3	1	–	–	1	–	–
[25]	–	0	–	–	3	–	–	–	–	1	–	–	–
[29]		0	–	–	–	–	–	–	–	1	1	–	–
[18,27]	–	0	_	–	5	0	–		1	0	0	1	0
[15]	–	0	0	0	0	–	–	44	–	–	–	1	–
[21]	0.9	–	–	1	–	4 (1.7)	21 (9.3)	16 (7.1)	2	1	3 (1.3)	1	–
[10]	0.9	8 (0.5)	–	4 (0.7)	8 (1.4)	6 (1.1)	52 (9.2)	24 (4.2)	3 (0.5)	7 (1.3)	7 (1.3)	3 (0.5)	2 (0.5)‡
[22]	1.3	7 (8.4)		3 (3.6)	3 (3.6)	3 (3.6)	7 (8.4)	5 (6)	–	1 (1.2)	1 (1.2)	–	–
[7]	1.2	–	–	–	–	–	–	4 (40)	–	–	–	–	–
[20]	–	2 (1.9)	–	3 (2.8)	–	–	–	–	–	–	–	–	–
[14]	–	–	–	5 (2.4)	16 (7.8)¶	–	–	–	–	5 (2.4)	5 (2.4)	–	–
[30]	–	–	–	–	–	–	–	–	–	–	–	–	–
[23]	1.6	0	–	3	1	10, 1§	–	16	1	1	1	–	–
[9]	0.9/1.2/1.9	0	8 (2.1)	–	–	–	–	5 (1.3)	–	0	0	–	6 (1.6)
[6,31]	1.9	0	3	–	–	–	–	–	–	2	2	–	2‡
[5]	1.3	0	1 (1)	–	0	–	–	–	1 (1)	3 (3.2)	3 (3.2)	–	1‡
[8]	2.12	–	1 (2.4)	–	5 (12.1)	–	28 (68.2)	14 (34.1)	1 (2.4)	–	3 (7.3)**	–	–
[26]	1.32	–	1 (1.7)	–	3 (5.3)	–	33 (58.9)	25 (44)	1 (1.7)	–	1 (1.7)	–	–
[17]	0.6	–	–	–	–	6 (3.8)	39 (25)	13 (8.3)	1 (0.6)	1 (0.6)	5 (3.2)	–	4 (2.5)
[16]	1.0	–	–	–	–	8 (4)	45 (23)	14 (7.1)	1 (0.5)	1 (0.5)	6 (3)	–	5 (2.5)
[19]	1.3	–	4 (6)	–	–	4 (6)	–	8 (11)	–	–	5 (7)	–	–
[11]	1.9	1	–	1	–	1 sepsis	–	–	–	–	–	–	–
[24]	0.83	0		–	2 (4)	1 fever	5 (10)	1 (2)			1 (2)	–	–
[32]	2	–	–	6	–	–	–	–	–	–	–	–	–

*Hb, haemoglobin; BT, blood transfusion; H&C, haemorrhage requiring coagulation; IVS, irritative voiding symptoms; BNC, bladder neck contracture; UrS, urethral stricture; Sub-MS, MS, sub-meatal/meatal stenosis; *evacuation of residual fragments; †Fever >38 °C; ‡re-operation for adenoma; ¶excluding patients with clot retention or history of retention requiring catheterization; §Epididymitis; **includes bladder neck stenosis.*

If this happens, the foot should be taken off the pedal, and the pump suction released by opening the hinged gate on the roller pump. The injury to the bladder mucosa is generally minor and uneventful. Large, full-thickness injuries can lead to extravasation of irrigant or excessive bleeding [18]. Such patients may need open surgery to close the perforation [19].

To limit the incidence of bladder injury some authors advocated morcellation in the prostatic fossa [12]. Hochreiter *et al.* [33] described the mushroom technique to avoid the need for morcellation and its associated hazards.

Small round prostate adenomas are sometimes difficult to morcellate because they dislodge from the morcellator blades. These could be irrigated out or removed with the serrated loop. When they persist, incising the surface with the laser fibre renders them irregular enough for morcellation [12]. For patients in whom the vision is unclear or the prostatic tissue tough, morcellation can be postponed to another session [20,21].

Injuries to the ureteric orifice occur most often while resecting large and endovesically developed median lobes. Careful identification of the ureteric orifice before starting enucleation and relocating it repeatedly thereafter can avoid this injury. When the orifice is very close to the median lobe, the bladder should be filled to move the orifice away from the median lobe and make it visible [9]. Care must be taken to avoid undermining the trigone. For better orientation, the surgeon should work back and forth from one lateral incision to the other, keeping the same depth of dissection [12].

The possible additional procedures that might be needed include: (i) perineal urethrotomy; if the length of the resectoscope is insufficient to perform the enucleation [11,21]; (ii) cystostomy might be needed for associated large or multiple bladder stones, or to remove inadequately morcellated large adenoma. In such situations, the enucleated prostate volume might occupy most of the bladder volume, leaving inadequate space for safe morcellation [21]; (iii) TURP might be needed during the learning phase or to complete the procedure in case of machine malfunction [35].

Of complications after HoLEP, the incidence of haemorrhage needing coagulation is 0–6%

and of clot retention is 0–3.6% (Table 5). The overall decrease in haemoglobin is 1.15 (0.2–2.12) g/dL. The incidence of blood transfusion is low except in patients with coagulopathy, in whom the requirement increases dramatically to 8.4% [22]. Blood loss is only marginally higher in patients with a larger prostate, with no clinical implication [9]. Other factors that increase the need for blood transfusion include preoperative anaemia and retained prostate tissue due to malfunction of morcellation. Capsular sinuses are unlikely to coapt in presence of retained tissue, resulting in bleeding [14].

Re-catheterization is required in 0–12.1% of patients (Table 5); most respond to short-term re-catheterization. Recurrent failure of a trial to void is mainly attributed to primary detrusor failure rather than to incomplete resection. It is managed by clean self-intermittent catheterization or suprapubic catheterization [14,33].

The rate of documented UTI after HoLEP is 0–6.7%, but the criteria used for diagnosis were not specified. It is also unclear if the documented UTI was clinical or subclinical. Patients with urinary retention before HoLEP have a higher incidence of developing UTI [23]. Some patients might develop fever unrelated to the UTI [12,24]. The incidence of epididymitis or sepsis is rare, with only one case reported [11,23].

For irritative voiding symptoms, some degree of subjective 'burning' is frequent after HoLEP, but this, is always, a transient and self-limiting condition. It is probably caused by the high laser energy applied to the capsule [8]. Increasing experience and technical refinement of the enucleation time can decrease the incidence of irritative voiding symptoms [17]. Vavassori *et al.* [16] noted that these patients had microhaematuria and leukocyturia with negative urine cultures, and can be treated with NSAIDs alone. This inflammatory effect is probably related to tissue regeneration on the surface of the surgical cavity. Larner *et al.* [25] subjectively graded dysuria after HoLEP into: (i) none; (ii) mild (causing minimal bother); (iii) moderate (causing some bother but not interfering with daily activities); and (iv) severe (sufficient to cause significant bother or interfere with daily activities). They found that discomfort in most patients was mild and no patients had a severe grade of dysuria.

Early incontinence occurs in up to 44% of patients; however, late iatrogenic stress incontinence is rare, with incidence of 0–2.4% (Table 5). Early incontinence is usually urge symptomatic, with irritative symptoms secondary to fossa healing, associated UTI or detrusor instability caused by long-lasting BPH. The higher incidence of transient incontinence is probably due to more complete removal of the adenoma and weakening or stretching of the external sphincter from lack of use [36]. Seki *et al.* [19] suggested that the resection of adenoma tissue close to the external sphincter temporarily damaged the continence mechanisms. Most of the cases resolve over 1–6-months with anticholinergic treatment [10]. The severity of incontinence was not graded in any series.

To prevent damage to the external sphincter the incision at the 12 o'clock position should be made carefully, so as not to be distal to the verumontanum. Two difficulties encountered while making this 12 o'clock incision include recognizing the adequate depth and length of the incision. These dimensions might seem greater to a novice surgeon and one incision will usually suffice [12]. The supero-apical attachment incision (a strip of mucosa between the 2 and 12 o'clock or 10 and 12 o'clock positions) must be made judiciously because of the proximity of the sphincter. Withdrawing the resectoscope inside the sphincter allows a better view of the remaining attachments. The fibre is retracted to make it shorter, and the energy is lowered to 80 W to reduce thermal damage to the sphincter (power setting of 2.0 J at 40 Hz). Short bursts of the laser are used to cut the mucosa only [3].

Despite the longer surgery during HoLEP the incidence of urethral stricture is less than during TURP [26,27] and open surgery [6,8]. The lack of leakage of monopolar current is a possible explanation for the lower incidence of bulbar urethral stricture in HoLEP. Most strictures are at the external meatus, probably secondary to the use of a larger nephroscope for morcellation [19]. The use of a smaller calibre resectoscope and reduction of movements of the resectoscope within the urethra by using an inner rotating sheath might contribute to the lower incidence of stricture formation [6,10]. Similarly, calibrating the urethra to 30 F with an Otis urethrotome and lubricating the urethra every 20–30 min might help to decrease the incidence of urethral stricture.

The incidence of bladder neck contracture in HoLEP is 0–3.2% (Table 5); it is more likely to occur in smaller prostates [14]. A prophylactic bladder neck incision at the end of procedure for the smaller prostate might reduce the incidence.

A re-operation might be needed to evacuate residual prostatic tissue or resect residual adenoma [5,6,10,28]. There are few reports of peri-operative myocardial infarction or bradycardia [10,11,21].

The review confirmed that HoLEP is one of the most rigorously analysed surgical techniques for treating men with BOO [23]. Five randomized controlled trials were reported analysing this method [5,6,18,26,27,31]. The holmium laser allows precise enucleation of the prostate, with a haemostatic effect that limits bleeding during resection [23]. There are inherent advantages of HoLEP over TURP and open prostatectomy. From the present series and the review, the concern that HoLEP might be associated with more complications is unfounded. This procedure has become standardized and is safe and reproducible. With meticulous attention to the technical details, HoLEP should incur a low complication rate.

In conclusion, we report the peri-operative complications in our initial series of 280 patients undergoing HoLEP; the study showed a low incidence of complications with HoLEP. Most complications were minor and easily managed. Our results are comparable with those published previously and establish HoLEP as a safe and reproducible procedure.

ACKNOWLEDGEMENTS

We sincerely thank Dr Tenaz S. Hegde for language and grammatical review of manuscript.

CONFLICT OF INTEREST

None declared.

REFERENCES

1 **Reich O, Gratzke C, Stief CG.** Techniques and long-term results of surgical

procedures for BPH. *Eur Urol* 2006; **49**: 970–8

2 **Kuo RL, Paterson RF, Kim SC, Siqueira TM Jr, Elhilali MM, Lingeman JE.** Holmium laser enucleation of the prostate (HoLEP): a technical update. *World J Surg Oncol* 2003; **1**: 6–9

3 **Fong BC, Elhilali MM.** Video article. Ho:YAG laser enucleation of the prostate: technical details. *BJU Int* 2002; **90**: 870–1

4 **Gilling PJ, Kennett K, Das AK, Thompson D, Fraundorfer MR.** Holmium laser enucleation of the prostate (HoLEP) combined with transurethral tissue morcellation: an update on the early clinical experience. *J Endourol* 1998; **12**: 457–9

5 **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

6 **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

7 **Moody JA, Lingeman JE.** Holmium laser enucleation for prostate adenoma greater than 100 gm: comparison to open prostatectomy. *J Urol* 2001; **165**: 459–63

8 **Naspro R, Suardi N, Salonia A *et al.*** Holmium laser enucleation of the prostate versus open prostatectomy for prostates >70g: 24-month follow-up. *Eur Urol* 2006; **50**: 563–8

9 **Kuntz RM, Lehrich K, Ahyai S.** Does perioperative outcome of transurethral holmium laser enucleation of the prostate depend on prostate size? *J Endourol* 2004; **18**: 183–8

10 **Elzayat EA, Habib EI, Elhilali MM.** Holmium laser enucleation of the prostate: a size-independent new 'gold standard'. *Urology* 2005; **66** (Suppl.): 108–13

11 **Matlaga BR, Kim SC, Kuo RL, Watkins SL, Lingeman JE.** Holmium laser enucleation of the prostate for prostates of >125 mL. *BJU Int* 2006; **97**: 81–4

12 **El-Hakim A, Elhilali MM.** Holmium laser enucleation of the prostate can be taught: the first learning experience. *BJU Int* 2002; **90**: 863–9

13 **Mauermayer W.** *Transurethral Surgery.* Berlin, New York: Springer Verlag, 1983

14 **Kuo RL, Paterson RF, Siqueira TM Jr *et al.*** Holmium laser enucleation of the prostate: morbidity in a series of 206 patients. *Urology* 2003; **62**: 59–63

15 **Aho TF, Gilling PJ, Kennett KM, Westenberg AM, Fraundorfer MR, Frampton CM.** Holmium laser bladder neck incision versus holmium enucleation of the prostate as outpatient procedures for prostates less than 40 grams: a randomized trial. *J Urol* 2005; **174**: 210–4

16 **Vavassori I, Hurle R, Vismara A, Manzetti A, Valenti S.** Holmium laser enucleation of the prostate combined with mechanical morcellation: two years of experience with 196 patients. *J Endourol* 2004; **18**: 109–12

17 **Hurle R, Vavassori I, Piccinelli A, Manzetti A, Valenti S, Vismara A.** Holmium laser enucleation of the prostate combined with mechanical morcellation in 155 patients with benign prostatic hyperplasia. *Urology* 2002; **60**: 449–53

18 **Tan AH, Gilling PJ, Kennett KM, Frampton C, Westenberg AM, Fraundorfer MR.** A randomized trial comparing holmium laser enucleation of the prostate with transurethral resection of the prostate for the treatment of bladder outlet obstruction secondary to benign prostatic hyperplasia in large glands (40–200 grams). *J Urol* 2003; **170**: 1270–4

19 **Seki N, Mochida O, Kinukawa N, Sagiyama K, Naito S.** Holmium laser enucleation for prostatic adenoma: analysis of learning curve over the course of 70 consecutive cases. *J Urol* 2003; **170**: 1847–50

20 **Kuo RL, Kim SC, Lingeman JE *et al.*** Holmium laser enucleation of prostate (HoLEP): the Methodist Hospital experience with greater than 75 gram enucleations. *J Urol* 2003; **170**: 149–52

21 **Elzayat EA, Elhilali MM.** Holmium laser enucleation of the prostate (HoLEP): the endourologic alternative to open prostatectomy. *Eur Urol* 2006; **49**: 87–91

22 **Elzayat E, Habib E, Elhilali M.** Holmium laser enucleation of the prostate in patients on anticoagulant therapy or with bleeding disorders. *J Urol* 2006; **175**: 1428–32

23 **Peterson MD, Matlaga BR, Kim SC *et al.*** Holmium laser enucleation of the prostate for men with urinary retention. *J Urol* 2005; **174**: 998–1001

24 **Gupta N, Sivaramakrishna B, Kumar R, Dogra PN, Seth A.** Comparison of standard transurethral resection, transurethral vapour resection and holmium laser enucleation of the prostate for managing benign prostatic hyperplasia of >40 g. *BJU Int* 2006; **97**: 85–9

25 **Larner TR, Agarwal D, Costello AJ.** Day-case holmium laser enucleation of the prostate for gland volumes of <60 mL: early experience. *BJU Int* 2003; **91**: 61–4

26 **Montorsi F, Naspro R, Salonia A *et al.*** Holmium laser enucleation versus transurethral resection of the prostate: results from a 2-center, prospective, randomized trial in patients with obstructive benign prostatic hyperplasia. *J Urol* 2004; **172**: 1926–9

27 **Wilson LC, Gilling PJ, Williams A *et al.*** A randomised trial comparing holmium laser enucleation versus transurethral resection in the treatment of prostates larger than 40 grams: results at 2 years. *Eur Urol* 2006; **50**: 569–73

28 **Gilling PJ, Kennett KM, Fraundorfer MR.** Holmium laser enucleation of the prostate for glands larger than 100 g: an endourologic alternative to open prostatectomy. *J Endourol* 2000; **14**: 529–31

29 **Hettiarachchi JA, Samadi AA, Konno S, Das AK.** Holmium laser enucleation for large (greater than 100 mL) prostate glands. *Int J Urol* 2002; **9**: 233–6

30 **Kim SC, Matlaga BR, Kuo RL *et al.*** Holmium laser enucleation of the prostate: a comparison of efficiency measures at two institutions. *J Endourol* 2005; **19**: 555–8

31 **Kuntz RM, Lehrich K, Ahyai S.** Transurethral holmium laser enucleation of the prostate compared with transvesical open prostatectomy: 18-month follow-up of a randomized trial. *J Endourol* 2004; **18**: 189–91

32 **Pedraza R, Samadi A, Eshghi M.** Holmium laser enucleation of the prostate in critically ill patients with technique modification. *J Endourol* 2004; **18**: 795–8

33 **Hochreiter WW, Thalmann GN,**

Burkhard FC, Studer UE. Holmium laser enucleation of the prostate combined with electrocautery. *J Urol* 2002; **168**: 1470–4
34 **Shah HN, Kausik V, Hegde S, Shah JN, Bansal MB.** Evaluation of fluid absorption during holmium laser enucleation of prostate by breath ethanol technique. *J Urol* 2006; **175**: 537–40
35 **Kuntz RM.** Current role of lasers in the treatment of benign prostatic hyperplasia (BPH). *Eur Urol* 2006; **49**: 961–9
36 **Elhilali MM.** Editorial comment: Day-case holmium laser enucleation of the prostate for gland volumes of <60 mL: early experience. *BJU Int* 2003; **91**: 64

Correspondence: Hemendra N. Shah, Chief Urologist, 21-A, 14-A Road, Ahimsa Marg, R. G. Stone Urological Research Institute, Khar (W), Mumbai- 400052, India.
e-mail: drhemendrashah@yahoo.co.in

Abbreviations: **HoLEP**, holmium laser enucleation of the prostate; **PVR**, postvoid residual urine volume.