FATAL BLADDER EXPLOSION DURING TRANSURETHRAL RESECTION OF PROSTATE: CASE REPORT AND LITERATURE REVIEW

Debora De Bartolo[1], Francesco Ausania[2], Umberto De Gennaro[3], Emilo D'Oro[4], Santo Gratteri[5], Pietrantonio Ricci[6]

[1-6] Department of Legal Medicine, Magna Graecia, University of Catanzaro, Institute of Forensic Medicine. Viale Europa, Località Germaneto, Catanzaro, 88100-Italy.
Address for Correspondence:
Dr. Debora De Bartolo
Department of Legal Medicine, Magna Graecia, University of Catanzaro, Viale Europa, Località Germaneto, Catanzaro, 88100- -Italy.
Email: debora.debartolo@yahoo.it
Date Received:
September 14, 2016
Date Revised:
April 08, 2017
Date Accepted:
April 16, 2017

ABSTRACT

The transurethral resection of the prostate (TURP) is the gold standard in the operative management of benign prostatic hypertrophy. In the last decade, the technological improvements have reduced perioperative and postoperative complications. The intravesical explosion is one of the most infrequent complications of transurethral procedures. We present the case of a man with bladder outlet obstruction who underwent TURP. After complete resection of the adenoma, an audible blast and a sudden movement were felt at the lower abdomen. Inspection showed posterior wall bladder perforation that was repaired. Postoperative course was complicated by transurethral resection syndrome.

This work show an evaluation of the relevant scientific literature available about bladder explosion to define the etiology of this complication, we point out the prevention strategies and discuss the possible connection between these unusual complications.

Key Words: Transurethral resection, Bladder explosion, Transurethral resection syndrome, Prevention

This case report may be cited as: **Bartolo DD, Ausania F, Gennaro UD, D'Oro E, Gratteri S, Ricci P. Fatal bladder explosion during transurethral resection of prostate: Case report and literature review. J Postgrad Med Inst 2017; 31(2): 203-8.**

INTRODUCTION

Benign prostatic hypertrophy (BPH) is a frequent disease, affecting 12% of the male population over 65 years of age; about 20-30% of patients will require prostatectomy. Despite introduction of newer techniques, transurethral resection of the prostate (TURP) still represents the gold standard in the operative management of BPH[1]. Several complications of this surgical procedure have been reported in literature[2,3], but the latest technological improvements such as microprocessor-controlled units, better armamentarium like video TUR and training helped to reduce perioperative (recent vs. early) and postoperative complications[4].

Intravesical explosion is one of the most infrequent complications of transurethral procedures with an incidence of 0.01-0.02%[5,6]; this event can be characterized by different degrees of the bladder mucosa lesions. After transurethral resection, a very small percentage of patients can develop Transurethral resection syndrome (TURP syndrome). It is an iatrogenic form of water intoxication with multifactorial pathophysiology. The diagnosis is based on various signs and symptoms, in association with an excessive absorption of the irrigation liquid that produces cardiovascular, central nervous system (CNS) and metabolic changes. It may happen from as early as 15 minutes after the start of prostatic resection[7] up to 24 hours post-operatively[8].

Recent use of bipolar circuitry, together with advances in training techniques and use of modern irrigation fluids, have reduced the risk of developing this syndrome[9] that have lower incidence rates of between 0.78% and 1.4%[10,11]. However, the most serious forms of the TUR syndrome have a mortality rate that has been quoted as high as 25%[12,13]. In this work, we describe a case of intravesical explosion during TURP, followed by fatal transurethral resection syndrome, in a patient with BPH. Furthermore we carried out a literature review about bladder rupture to define the etiology of this complication, we point out the prevention strategies and discuss the possible connection between these unusual complications.

CASE REPORT

A 66-year-old man with obstruction of urine flow, caused by prostate enlargement, underwent TURP. On digital rectal examination (DRE), the prostate had a benign feel and on ultrasound it was 44g. The patient was suffering from hypertensive heart disease and pulmonary emphysema. The pre-operative chest X-ray and electrocardiogram (ECG) were within normal range. Other pre-operative measurements included: plasma sodium 141.5 mmol/L, potassium 4.5 mmol/L and hemoglobin of 13.3 gm/dl.

The anaesthetists selected spinal anaesthesia during the pre-operative visits, but despite adequate explanation, the patient refused this anaesthetic technique and general anaesthesia has been used from the start.

A continuous flow resectoscope, like the Iglesias model with 1.5% glycine, was used as irrigant. The urethrocystoscopy showed normal anterior urethra in morphology and size and posterior urethra deformed by prostatic lobes. During the last phase of the procedure the area was coagulated to control bleeding. On initiation of the removal of fragments and blood clots with Ellik evacuator, an audible blast and a sudden movement were felt at the suprapubic area by the surgeons.

Endoscopically, a wide laceration in the bladder wall was noticed. The patient was immediately referred to the open operating theatre. Intestines and other intra-abdominal structures were intact. During surgery his hematocrit decreased and required blood transfusion. During laparotomy exploration, the rupture of bladder was confirmed and the wall was sutured. Time of surgery (prostate resection and bladder repair) has been about 3 hours.

Post-operative course was complicated by hypothermia (34°C), bradycardia, arterial hypotension and hypoxemia. The patient was intubated and moved to intensive care. The electrolytes analysis revealed acute hyponatremia (sodium concentration 110 mmol/L) and ultrasound scan showed accumulation of fluid in the abdominal cavity. A leakage of serosanguineous fluid from draines and metabolic acidosis were noted. Therapeutic intervention was hypertonic saline solution 3%, volume expansion, blood transfusions and tracheal intubation with mechanical ventilation.

In the following days the patient appeared in a comatose state, with progressive deterioration of clinical condition, cardiovascular instability and neurological disorders. The patient died 15 days after the surgical procedure.

An autopsy was performed to prove a possible medical malpractice and to find other pathological conditions. Macroscopically we found the bladder wall with a large full-thickness laceration and segments of suture material. Examination of other organs was negative. The histological examination showed intense inflammatory infiltration in the edges of suture and plurivisceral stasis of the blood.

DISCUSSION

In the present case, bladder perforation during bipolar TURP was followed by the onset of a transurethral resection syndrome that caused the death of patient.

The etiology of intravesical explosions during the endoscopic procedure is due to formation of explosive gases in the bladder, especially oxygen (O_2) and hydrogen (H_2)[3,14]. Oxygen can penetrate into the bladder during endoscopic procedures[15]. In vitro experiments have shown that hydrogen is formed by pyrolysis of bladder tissue and the higher temperature of the resectoscope cause greater accumulation of this gas[16,17]. Hydrogen gas alone is not explosive, but the mixture of these two gases is potentially very explosive[17,18] and the sparks from the cutting electrode may ignite the mixture of gases[19]. Furthermore, the amount of gas formed and the risk of explosion are proportional to the operating time and the use of high power current for cutting and coagulation while the nature of the bladder irrigation liquid does not appear to play an important role[20].

We report an additional possible cause of bladder perforation; the present patient had a low vesical compliance for chronic lower urinary tract obstruction which may have resulted in stretching and thinning of the bladder wall. In these conditions an overdistension of the bladder using the Ellik evacuator and an inadequate evacuation of accumulated air can result in explosion.

Major intravesical explosion is a rare, but potentially devastating complication of transurethral endoscopic resections and in the literature few cases are described. We have carried out an evaluation of scientific literature and this complication has been previously described in 28 reports; a total of 36 patients who underwent transurethral resection have had a bladder rupture as a complication, but the patients have developed transurethral resection syndrome after bladder rupture in three reports only.

The first case of bladder explosion has been signaled by Cassuto in 1926[21]. Next, Kretschmer[22] described two cases of a bladder rupture following TURP as early as 1934. Another single report was published by Bobbitt[23] in 1950, until in 1975[16] two cases; single cases of bladder explosion were reported in 1979[24], 1984[25] and 1987[26]. Since then no further case was published until 2001 when Dublin et al[15] presented two cases, followed by 26 cases described in 21 reports through 2015.

We have analyzed only the reports published in En-

Table 1: Reports evaluated

Authors	Cases	Age	Case of Surgery	Type of Anesthesia	Methodology - Irrigant
Dublin et al (2001)	2	82	BPH	N.A.	N.A.
		80	BPH	N.A.	N.A.
Di Tonno et al (2003)	1	67	BPH	N.A.	1.5% Glycin Solution
Dorotta et al (2003)	4	72	Bladder tumor	General Anesthesia	5% Glycin Solution
		68	Bladder tumor	Spinal Anesthesia	Sterile Water
		81	Bladder tumor	General Anesthesia	Sterile Water
		77	Bladder tumor	Spinal Anesthesia	Glycine 1.5% Solution
Horger et al (2004)	1	56	Bladder tumor	N.A.	Sterile Water
Ribeirp da Silva et al (2006)	1	71	BPH	N.A.	3% Mannitol Solution
Srivastava et al (2006)	1	61	BPH	N.A.	1.5% Glycine as Irrigant
Rezaee et al (2006)	3	N.A.	BPH	Spinal anesthesia	N.A.
Seitz et al	1	73	BPH	N.A.	1.5 % Glycocoll Solution
Kim et al (2009)	1	74	BPH	General Anesthesia	3.3% Mixed Solution of Mannitol and Sorbitol
Sataa Sallami et al (2011)	1	73	BPH	Spinal Anesthesia	Glycocoll Solution
Gonca et al (2013)	1	82	Prostatic carcinoma	Spinal Anesthesia	Glycine as Irrigant
T. Shindo et al (2013)	1	79	Bladder tumor	N.A.	N.A.
Sun-Kyung et al (2013)	1	84	BPH	Spinal Anesthesia (Switched to General Anesthesia)	0.9% Saline Solution
Baldvinsdottir et al (2014)	1	83	BPH	Spinal Anesthesia	N.A.
Adiyat et al (2014)	1	72	BPH	Spinal Anesthesia	Sterile Water
Ibrahim et al (2015)	1	73	BPH	Spinal Anesthesia	Saline Solution (0.9% Nac1)
Georgios et al (2015)	1	79	Bladder tumor	N.A.	N.A.
Eiko et al (2015)	1	64	BPH	Spinal Anesthesia	N.A.

glish language, after the year 2000, to identify the predisposing factors for bladder explosion and the prevention strategies approved by the scientific literature.

Eighteen case reports, in which 24 cases of bladder explosion are reported following transurethral endoscopy, were included in our analysis (Table 1). The mean age of the patients was 74 years and the cause of surgery was BPH (14 cases), bladder tumor (6 cases), one case of bladder biopsy and prostatic carcinoma. In all reported cases, as in ours, the authors were sure that they made no bladder perforations.

The degree of bladder injury secondary to an explosion varies from a loud "pop" sound only to a ruptured bladder needing surgical repair[19]. Only in three of the reported cases, the explosion was not accompanied by a bladder perforation[14,27]. However, the bladder rupture may lead to severe consequences especially when the surgeon does not notice the rupture and the treatment is delayed.

Table 2: Recommendations for the prevention of intravesical explosion

S. No.	Recommendations
1	Avoidance of high-temperature cautery
2	Decreasing the duration of resection with judicious coagulating of tissue
3	Reduction in the use of a cutting and coagulation current of moderate power
4	Use of continuous irrigation sheets (because with intermittent sheet, some air enters the bladder during its evacuation that causes explosion)
5	Perform frequent evacuation of the gas bubble in the bladder (ureteral catheter, suprapubic trocar or supra pubic pressure)
6	Placement of the patient in the trendelenburg position may shift the air bubble more caudally
7	Emptying the bladder ilntermittently during the TUR procedure
8	Constantly changing the position during resection will also dislodge the air bubble
9	Prefer regional anesthesia (to facilitate the early detection of mental status change or diaphragmatic irritation)
10	Give more attention to elderly patients with over distended and thinned bladder walls
11	In patients with diseased bladder due to radiation, cystitis, tuberculosis etc., extra cation need to be taken to avoid hyper-distension
12	Good interaction between surgeon and anesthetist
13	Closely monitored patient care to recognize the complication and make the necessary intervention immediately

The diagnosis of a bladder injury have been facilitated by the patient's ability to report the sudden onset of mental status change, severe abdominal pain and discomfort. Therefore the choice in the type of anesthesia is very important to early detection of bladder damage. In previously reported cases, various types of anesthesia have been used. General anesthesia was used from start in three cases[28,29], while in one case spinal anesthesia was changed to general anesthesia during surgery because the patient complained of pain on operative site, considered to be caused by a low level of anesthesia[30]. Spinal anesthesia was used in nine cases[14,28,31-34]. In the remaining 9 reported cases[3,15,20,36-40] the type of anesthesia was not reported.

Spinal anesthesia is to be preferred for transurethral resection of the prostate because it decreases blood loss, it reduces the onset of pulmonary edema; unlike general anesthesia, it allows early detection of any change in mental status and permits early recognition of the typical syndrome. The patients developed worst complications when general anesthesia has been used, in particular bladder perforation was associated with ascites[30], retroperitoneal air and fluid accumulation[29].

The surgery was complicated in 5 patients with bladder explosion and transurethral resection syndrome, 3 of which were under general anesthesia[28,30].

Only one case (as well in general anesthesia) has had negative outcome. The bladder perforation was diagnosed in a considerable delay and postoperative course was complicated by renal failure and the patient needed permanent hemodialysis[28]. In all other reported cases the post-operative course was uneventful and no patient died from complications of transurethral endoscopy.

The bladder injuries were identified by cystoscopy or computed tomography scan and then repaired with open surgery; in 2014[33] the first case where laparoscopy was offered as a treatment option was reported. Values of the electrocautery current (for cutting and coagulation) was not reported by all authors. The mean of cutting current was 127.5 watts and that for coagulation was 69 watts. We report several strategies suggested by many authors to limit the probability of bladder explosion (Table 2).

About the transurethral resection syndrome, several authors have shown that injuries on venous sinus or perforation of prostatic capsule in the course of resection increases the incidence of this complication[41], but there aren't papers that emphasize the correlation between the explosion of bladder and the etiology of this syndrome. However, it should be emphasized that the irrigating fluid is most frequently absorbed directly into the vascular system when a vein has been severed by electrosurgery.

In our case, the bladder rupture has provoked, concurrently, extravasation and an intravascular absorption; these conditions have generated a fatal TUR syndrome.

CONCLUSION

Bladder rupture, although rare, should be kept in mind by those who perform transurethral resections in daily practice.

RECOMMENDATIONS

Through this work, we emphasize the importance of knowledge of bladder rupture and possible prevention strategies. Furthermore, we underline the key role of an early recognition and prompt treatment of TUR syndrome. This syndrome cannot be protocol driven; high index of suspicion, optimal interaction between clinicians (surgeon and anesthetist) during surgery, intensive monitoring, prevention of large fluid extravasation and multidisciplinary approach are required to recognize the complication and make the necessary intervention immediately.

REFERENCES

1. Madersbacher S, Alivizatos G, Nordling J, Sanz CR, Emberton M, De La Rosette JJ. MCH. EAU 2004 Guidelines on assessment, therapy and follow-up of men with lower urinary tract symptoms suggestive of benign prostatic obstruction (BPH guidelines). Eur Urol 2004; 46: 547–54.
2. Black L, Naslund MJ, Gilbert TD, Davis EA, Ollendorf DA. An examination of treatment patterns and costs of care among patients with benign prostatic hyperplasia. Am J Manag Care 2006; 12:S99-S110.
3. Horger DC, Babanoury A. Intravesical explosion during transurethral resection of bladder tumors. J Urol 2004; 172:1813.
4. Rassweiler J, Teber D, Kuntz R, Hofmann R. Complications of Transurethral Resection of the Prostate (TURP)—Incidence, Management, and Prevention. Eur Urol 2006; 50:969–80.
5. Summerton DJ, Kitrey ND, Lumen N, Serafetinidis E, Djakovic N. EAU Guidelines on Iatrogenic Trauma. Eur Urol 2012; 62:628–39.
6. Martov AG, Kornienko SI, Gushchin BL, Ergakov DV, Sazonov OA. Intraoperative urological complications in transurethral surgical interventions on the prostate for benign hyperplasia. Urologiia. 2005; 4:3–8.
7. Hurlbert BJ, Wingard DW. Water intoxication after 15 minutes of transurethral resection of the prostate. Anesthesiology 1979; 50:355–6.
8. Swaminathan R, Tormey WP. Fluid absorption during transurethral prostatectomy. Br J Urol 1981; 282:317.
9. Hawary A, Mukhtar K, Sinclair A, Pearce I. Transurethral Resection of the Prostate Syndrome: Almost Gone but Not Forgotten. J Endourol 2009; 23:2013-20.
10. 10. Zepnick H, Steinbach F, Schuster F. Value of transurethral resection of the prostate (TURP) for treatment of symptomatic benign prostatic obstruction (BPO): An analysis of efficiency and complications in 1015 cases. Aktuelle Urol 2008; 39:369–72.
11. Reich O, Gratzke C, Bachmann A, Seitz M, Schlenker B, Hermanek P et al. Morbidity, mortality and early outcome of transurethral resection of the prostate: A prospective multicenter evaluation of 10,654 patients. J Urol 2008; 180:246–9.
12. Hahn RG. Irrigating fluids in endoscopic surgery. Br J Urol 1997; 79:669–80.
13. Vijayan S, Robinson S, Mouton R. TURP syndrome e an inconvenience or a fatal complication? 2008. www.bjui.org/case%20reports; 2008.
14. Rezaee MM. Intravesical Explosion during Endoscopic Transurethral Resection of prostate. Urol J 2006; 3:109-10.
15. Dublin N, Razack AH, Loh CS. Intravesical explosion during transurethral resection of the prostate. Anz J Surg 2001; 71:384–5.
16. Ning TC Jr, Atkins DM, Murphy RC. Bladder explosions during transurethral surgery. J Urol 1975; 114:536-9.
17. Davis TR. The composition and origin of the gas produced during urological endoscopic resections. Br J Urol 1983; 55:294-7.
18. Andrews PE, Segura JW. Renal pelvic explosion during conservative management of upper tract urothelial cancer. J Urol 1991; 146:407-8.
19. Khan A, Masood J, Ghei M, Kasmani Z, Ball AJ, Miller R. Intravesical explosions during transurethral endoscopic procedures. Int Urol Nephrol 2007; 39:179–83.
20. Seitz M, Soljanik I, Stanislaus P, Sroka R, Stief C. Explosive gas formation during transurethral resection of the prostate (TURP). Eur J Med Res 2008; 13:399-400.
21. Cassuto A. Explosion dans la vessie au coursd'une electrocoagulation. J Urol 1926; 22:263.
22. Kretschmer HL. Intravesical explosions as a complication of transurethral electroresection: report of two cases. J Am Med Asso 1934; 103:1144-5.
23. Bobbitt RM. Intravesicalrupture of bladder during transurethral prostatic resection. J Urol 1950; 64:338–40.
24. Hansen RI, Iversen P. Bladder explosion during uninterrupted transurethral resection of the prostate. A case report and an experimental model. Scand J Urol Nephrol 1979; 13:211–2.
25. Viville C , de Petriconi R, Bietho L. Intravesical explosion during endoscopic resection. Apropos of a case. J Urol 1984; 90:361-3.
26. Weber S, Acuff JH, Mazloomdoost M, Kirimli BI. Transurethral prostatectomy complicated by intraperitone-

al extravasation of irrigating fluid. Can J Anaesth 1987; 34:193–5.

27. Sallami S, Rhouma SB, Dahmani A, Cherif K, Horchani A, Nouira Y. Intravesical explosion during endoscopic transurethral resection of a bladder tumor. Ibnosina J Med BS. 2011; 3:215-217.
28. Dorotta I, Basali A, Ritchey M, O'Hara JF Jr, Sprung J. Transurethral Resection Syndrome After Bladder Perforation. Anesth Analg 2003; 97:1536-8.
29. Kim SH, Shin WJ, Park JY, Kim YK, Hwang GS, Hwang JH. Pneumomediastinum due to inadvertent bladder perforation during transurethral resection of the prostate - A case report -. Korean J Anesth 2009; 56:597-600.
30. Park SK, Cho WJ, Choi YS. Fluid extravasation caused by bladder perforation during bipolar transurethral resection using saline solution -a case report-. Korean J Anesth 2013; 65:163-6.
31. Oguz G, Subaşı D, Kaya M, Güven O, Ünver S. Intravesical explosion: a rare complication of transurethral resection of prostate. J Anesth 2013; 27:145–6.
32. Baldvinsdóttir B, Gíslason T, Jónsson E. Explosion of the urinary bladder during transurethral resection of the prostate. Scand J Urol 2014; 48:1–2.
33. Adiyat KT, Shetty A, Jayakrishnan T. Laparoscopic repair of a rare case of bladder rupture due to intravesical explosion during transurethral resection of the prostate. Urol J 2014; 11:1692–4.
34. Buldu I, Karatağ T, Kaynar M, İstanbulluoğlu MO. A rare complication of transurethral resection of the prostate: explosion of the bladder. J Urol Surg 2015; 2:97-9.
35. Hirai E, Tokumine J, Lefor AK, Ogura S, Kawamata M. Bladder explosion during transurethral resection of the prostate with nitrous oxide inhalation. Case Rep Anesthesiol 2015; 30:464562.
36. Di Tonno F, Fusaro V, Bertoldin R, Lavelli D. Bladder explosion during transurethral resection of the prostate. Urol Int 2003; 71:108-9.
37. Ribeiro da Silva MN, Lopes Neto AC, Zambon JP, Verotti MJ, Wroclawski ER. Vesical explosion during transurethral resection of the prostate: report of a case. Arch Esp Urol 2006; 59:651-2.
38. Srivastava A, Sandhu AS, Sinha T, Madhusoodanan P, Karan SC, Sethi GS et al. Intravesical explosion during transurethral resection of prostate – a reminder. Urol Int 2006; 77:92–3.
39. Shindo T, Hashimoto K, Itoh N. Bladder injury due to intravesical explosion during transurethral resection of bladder tumor: a case report. Japanese J Endourol 2013; 26:319-20.
40. Georgios K, Evangelos B, Helai H, Ioannis G. Intravesical explosion during transurethral electrosurgery. Scott Med J 2015; 60:e25-6.
41. Hahn RG. Trapping of electrolytes during fluid absorption in transurethral resection of the prostate. Scand J Urol Nephrol 1997; 31:259-63.