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Complications of Transurethral Resection of the Prostate (TURP)—Incidence, Management, and Prevention

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Abstract

Objectives: To update the complications of transurethral resection of the prostate (TURP), including management and prevention based on technological evolution.
Methods: Based on a MEDLINE search from 1989 to 2005, the 2003 results of quality management of Baden-Württemberg, and long-term personal experience at three German centers, the incidence of complications after TURP was analyzed for three subsequent periods: early (1979–1994); intermediate (1994–1999); and recent (2000–2005) with recommendations for management and prevention.
Results: Technological improvements such as microprocessor-controlled units, better armamentarium such as video TUR, and training helped to reduce perioperative complications (recent vs. early) such as transfusion rate (0.4% vs. 7.1%), TUR syndrome (0.0% vs. 1.1%), clot retention (2% vs. 5%), and urinary tract infection (1.7% vs. 8.2%). Urinary retention (3% vs. 9%) is generally attributed to primary detrusor failure rather than to incomplete resection. Early urge incontinence occurs in up to 30–40% of patients; however, late iatrogenic stress incontinence is rare (<0.5%). Despite an increasing age (55% of patients are older than 70), the associated morbidity of TURP maintained at a low level (<1%) with a mortality rate of 0–0.25%. The major late complications are urethral strictures (2.2–9.8%) and bladder neck contractures (0.3–9.2%). The retreatment rate range is 3–14.5% after five years.
Conclusions: TURP still represents the gold standard for managing benign prostatic hyperplasia with decreasing complication rates. Technological alternatives such as bipolar and laser treatments may further minimize the risks of this technically difficult procedure.

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1. Introduction

Despite the introduction of alternative techniques, transurethral resection of the prostate (TURP) still represents the gold standard in the operative management of benign prostatic hyperplasia (BPH) [1–7]. TURP underwent significant technical improvements during the last decade with major impact on the incidence of intra- and postoperative complications. On behalf of the European Society of Uro-technology, we focused on actual TURP practices [5], with the intention to update the status, technical advancement, prevention, and management of complications.

2. Methods

MEDLINE search on indications, techniques, technology, and incidence of complications after TURP in larger studies or randomized clinical trials included more than 9000 patients [1,8–27]. We classified the relevant studies into three groups according to the periods of publication: early (1979–1993); intermediate (1994–1999); and recent (2000–2005). Additionally, we analyzed the 2003 results of the urological quality assessment group of Baden-Württemberg, which include our own data in Heilbronn [5]: 8265 patients were treated in 66 departments. The participation rate was 91%, of which 7707 (93.3%) underwent TURP. Finally, based on long-term experience at three German centers, the current TURP management and impacts of further technological improvements are discussed.

3. Results

3.1. *Indications for TURP*

Indications for operative management of BPH include [3,4]:

- Recurrent urinary tract infection (UTI) caused by bladder outlet obstruction
- Recurrent episodes of urinary retention
- Bladder calculi
- Recurrent hematuria caused by bladder outlet obstruction
- Renal insufficiency caused by BPH

Bladder calculi may not be regarded as an absolute indication because only a small percentage of patients (8%) needed prostate surgery after ESWL in a recent study [28].

Contraindications represent untreated UTI and coagulation disorders. High-risk patients have to be checked carefully by the cardiologist or anesthesiologist to minimize the risk of associated morbidity (Table 1).

3.2. *Resection techniques*

Various systematic approaches to TURP have been proposed: In 1943, Nesbit described a procedure that starts with the ventral parts of the gland (between

Table 1 – Incidence and type of intra- and perioperative complications after TUR—detailed comparison of selected studies during three periods

Type of complication	Early		Intermediate		Recent
	Mebust 1989	Doll 1992	Haupt 1997	Borboroglu 1999	Kuntz 2004
Technical complication (%)					
Clot retention	3.3	11.0	1.9	1.3	5.0
Bleeding & transfusion	6.4	22.0	2.2	0.4	2.0
TUR-syndrome	2.0	n.a.	0.3	0.8	0.0
Capsular perforation	0.9	10.0	n.a.	n.a.	4.0
Hydronephrosis	0.3	n.a.	0.0	0.0	0.0
Epididymitis/UTI	3.9	25.0	1.6	4.0	4.0
Urosepsis	0.2	3.0	0.2	0.0	0.0
Failure to void	6.5	3.0	n.a.	7.1	5.0
Incontinence	n.a.	38.0	0.3	n.a.	1.0
Associated morbidity					
Cardiac arrhythmia	1.1	n.a.	0.4	1.3	n.a.
Myocardial infarction	0.05	0.5	0.2	0.2	0.0
Pulmonary embolism	n.a.	n.a.	0.1	n.a.	0.0
Pneumonitis	n.a.	n.a.	0.2	n.a.	0.0
COPD	0.5	n.a.	0.1	n.a.	n.a.
Deep vein thrombosis	n.a.	n.a.	n.a.	0.0	0.0
Mortality	0.23	0.8	0.1	0.0	0.0

n.a. = not available.

11 and 1 o'clock), followed by both lateral lobes, the mid-lobe, and finishing with the apex [29]. Flocks and Culp preferred to start with the mid-lobe then segmented the lateral lobes at 9 and 3 o'clock [30]. In Germany, the technique developed by Mauermayer [31] and Hartung and May [32] gained popularity. TURP is divided into four steps: mid-lobe resection, paracollicular transurethral resection (TUR), resection of lateral lobes and ventral parts, and apical resection. Further development included suprapubic trocar systems [33] and continuous-flow resectoscopes [34], both of which provide low irrigation pressure. Another milestone was video-assisted resection [35].

3.3. *TURP technology*

Electroresection is performed by monopolar, high-frequency current with a maximum cutting power of 200 watts [3,30]. A microprocessor-controlled electrical unit with an active electrode that transduces permanent signals to the processor allows real-time power adjustment [10]. Coagulation depth during cutting depends on the intensity of the light bow (voltage), so the degree of coagulation is adjusted to the individual tissue properties. Peak powers in the millisecond range may reach 230 watts, but the total power for TURP is lower than that of earlier generators.

Coagulating intermittent cutting was developed to realize blood-sparing TURP by modifying a standard high-frequency generator: phases with a predominant cutting effect alternate with coagulating phases of constant pulses under the control of pulse intervals [36].

Other instrumental alternatives to decrease TURP morbidity include modified electrode shapes (thick loop) [37], generator modifications that enable tissue vaporization (TUVP) [38], and additional mechanical ablative effects such as rotoresect [39].

Recently, manufacturers such as Gyrus, Vista-ACMI, Olympus, and Karl Storz introduced bipolar devices that differ with respect to the loop shape and technical solution of bipolar TURP (active and return electrode) [40–43]. High-frequency (HF) energy up to 160 watts passes through the conductive irrigation solution of 0.9% sodium chloride. This results in a vapor layer of plasma that contains energy-charged particles that induce tissue disintegration through molecular dissociation [41]. This results in a lower resection temperature than conventional monopolar systems, which theoretically reduces thermal damage to surrounding tissue. The use of physiological sodium chloride for irrigation nearly eliminates the risk of TUR syndrome.

3.4. *Laser prostatectomy*

Alternative ablative technologies include Holmium-YAG laser resection [24,25,44] or ablation [45,46] and KTP-laser photoselective vaporization of the prostate [47]. These techniques are reported to be virtually bloodless and to provide short catheter

Table 2 – Main perioperative complications after TUR—comparison of three periods

Authors	N	Transfusion (%)	Revision (%)	Infection (%)	TUR–syndrome (%)
Early					
Zwergel 1979	232	21.2	n.a.	n.a.	1.6
Mebust 1989	3885	6.4	n.a.	2.3	2.0
Doll 1992	388	22.0	3.0	14.0	n.a.
Intermediate					
Zwergel 1995	214	14.6	n.a.	n.a.	0.8
Horninger 1996	1211	7.6	n.a.	n.a.	2.8
Haupt 1997	934	2.2	n.a.	n.a.	0.3
Gallucci 1998	80	0.0	n.a.	5.0	0.0
Gilling 1999	59	6.6	3.3	8.2	0.0
Borboroglu 1999	520	0.4	n.a.	2.1	0.8
Recent					
Heilbronn 2003[a]	126	4.8	4.2	1.7	0.8
Baden-Württemb. 2003	7707	3.0	5.0	3.5	0.8
Kuntz 2004	100	2.0	3.0	4.0	0.0
Muzzonigro 2004	113	7.1	n.a.	n.a.	0.0
Berger 2004[b]	271	2.6	n.a.	n.a.	1.1

n.a. = not available.
[a] Present study.
[b] With coagulating intermittent cutting.

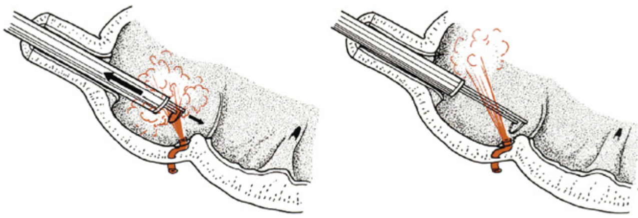

Fig. 1 – Retraction of resectoscope with advancement of the loop to achieve a better angle for visualization of a bleeding artery.

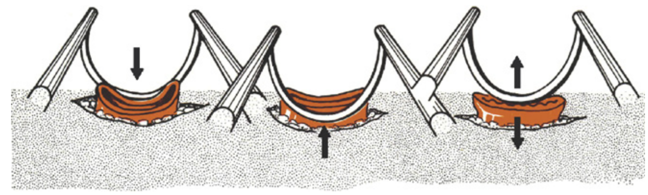

Fig. 2 – Effective coagulation of a large vessel by sealing of the lumen using slow circumferential movements of the loop.

times with comparable functional outcomes like TURP.

3.5. *Intra-operative complications*

These are related to the technical difficulties of the procedure (Tables 1 and 2).

3.6. *Bleeding*

Arterial bleeding can be more pronounced in cases of preoperative infection or urinary retention because of a congested gland. Anti-androgen pretreatment with finasteride or flutamide may reduce bleeding [3]. Venous bleeding generally occurs because of capsular perforation and venous sinusoid openings. The amount of intraoperative bleeding may depend on gland size and resection weight.

3.6.1. *Technical aspects*

According to the literature about resection techniques [29–32], vascular control of prostatic vessels differs. In the Mauermeyer approach [31,32] the vessels at 5 and 7 o'clock are controlled early; the Nesbit technique [29] aims to first reach the capsule at the 11 and 1 o'clock positions. Our experience with both approaches indicates no major difference, at least with modern HF technology.

3.6.2. *Management*

The following problems with arterial bleeders may occur during resection [3]:

- Arterial flow is directed to the optic
- Bleeding is covered by a coagulum or behind prostatic tissue
- Bleeding is close to the apex (12 o'clock position) or bladder neck

In larger arteries, a resectoscope might be used to compress the bleeding. After that, the optimal angle for visualizing the bleeding stump must be found to avoid any arterial flow directed to the optic (Fig. 1). Bleeding arteries have to be coagulated circumferentially once the resection has reached the capsule to seal the stump (Fig. 2). Simultaneous recto-digital manipulation might be useful to expose such vessels. Careful coagulation must be performed toward the end of resection with minimal irrigation flow to visualize the source of small arterial bleeders (Fig. 3). Bleeders, particularly at the bladder neck and apex, might be overlooked at this step.

Venous bleeders may cause an influx of irrigation fluid if they are not visible during resection. However, if the bladder is empty, the fluid is dark red. Venous sinusoids can be coagulated, but must be done very carefully if there is associated capsular perforation to avoid aggravating the perforation. Smaller veins can be occluded with a three-way-balloon catheter at the end of the TUR (Fig. 4).

Fig. 3 – Billard effect of arterial bleeding reflected at the wall of the prostatic fossa aggravating the identification of the bleeding source.

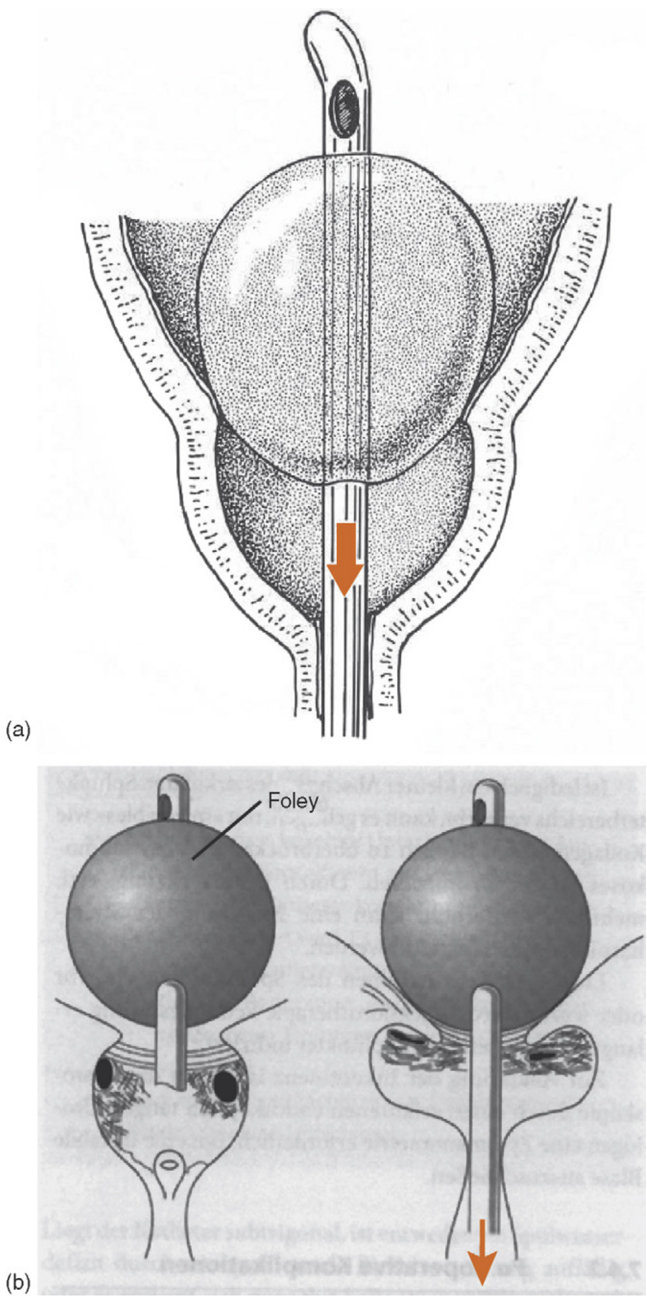

Fig. 4 – Blockade of balloon catheter. (a) Balloon is blocked in the prostatic fossa (volume of balloon = resection weight). (b) Balloon is blocked with 20 cc more than the resection weight in the bladder and put under traction to occlude venous bleeders.

3.6.3. *Balloon compression*

The catheter should be blocked with 20 cc in the fossa; however, in critical cases, the balloon can be blocked in the bladder (60–80 cc) and put under traction to compress the fossa. This can be accomplished with gauze knotted around the catheter at the meatus by use of a 500 cc bottle at the end of the bed (Fig. 4a). Blockage of the balloon in the fossa to tamponade smaller veins (Fig. 4b) may remove thrombi of coagulated vessels or cause the capsule to rupture. Additional recto-digital control with compression of bleeding sources for 5–10 minutes may be useful.

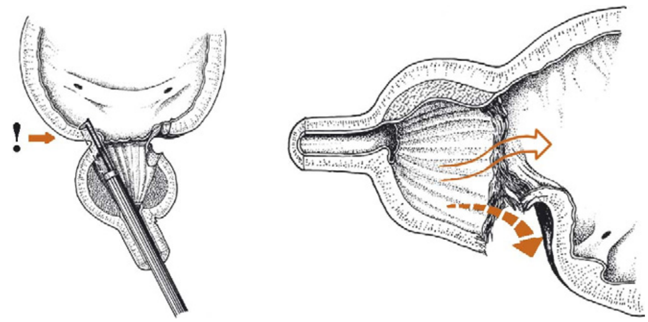

Fig. 5 – Division of the bladder neck with subsequent extraperitoneal extravasation.

3.7. *TUR syndrome*

TUR syndrome is characterized by mental confusion, nausea, vomiting, hypertension, bradycardia, and visual disturbances. It is caused by dilutional hyponatremia (serum sodium <125 mEq/l) caused by early perforation of capsular veins or sinuses with consecutive influx of hypotonic irrigating fluid. Patients under spinal anesthesia may show unrest, cerebral disturbance, or shivering as early signs. Untreated, TUR syndrome may have severe consequences like cerebral or bronchial edema. However, the incidence of TUR syndrome has decreased significantly during the last few decades from 3% to <1% (Table 2).

3.7.1. *Diagnosis*

With any suspicion of TUR syndrome, serum sodium levels must be checked immediately. Adding ethyl alcohol to the irrigant may allow early detection of influx by permitting analysis of the alcohol content in the exsufflated air [19,23]. However, because of the low incidence of TUR syndrome, we do not recommend this as routine treatment.

3.7.2. *Management and prevention*

In cases of significant hyponatriemia, the procedure has to be stopped and 20 mg furosemide must be applied with an infusion of hypertonic sodium chloride [3]. A suprapubic trocar is recommended for larger glands (>60 cc) [19,33].

3.8. *Extravasation*

This occurs when the capsule is injured or the bladder neck is divided (Fig. 5). Extravasation of the irrigation fluid is extra-retroperitoneal in most instances. However, irrigation fluid can also be found intraperitonally (e.g., by diffusion of large amounts or if the bladder is injured).

3.8.1. Diagnosis

If the irrigation input does not correlate with the output and a palpable increase in abdominal pressure, an ultrasound is necessary to identify intra- or retroperitoneal fluid collection. Usually this is associated with complications such as abdominal pain and respiratory insufficiency, and requires drainage.

3.8.2. Management and prevention

In cases of extraperitoneal extravasation, forced diuresis (20–40 mg furosemide) may be sufficient. Intraperitoneal fluid collection should be drained percutaneously via a cystostomy or nephrostomy catheter placed under ultrasonic guidance or perhaps by open surgical drainage. The irrigation pressure should be reduced by lowering the height of the irrigation bag or inserting an suprapubic trocar if there is a capsular perforation. Chips should be evacuated carefully so as not to increase the perforation at the bladder neck. When bipolar technology is used together with sodium chloride irrigation, extravasation induces fewer symptoms. Percutaneous drainage is needed only in cases of massive transperitoneal effusion.

3.9. Injury of orifices

Such a lesion may occur when large mid-lobes are resected and the ureteral orifice is difficult to identify. As in TUR of bladder tumors, the management depends on the severity of the lesion.

3.9.1. Management and prevention

In cases of severe urethral injury a DJ-stent may be indicated; otherwise, sonographic follow-up is sufficient. The stent should be kept indwelling for two to three weeks. The orifices should be identified before TURP starts. If this is not possible because of a large mid-lobe, TURP should be performed very carefully, particularly close to the bladder neck. Suprapubic cystoscopy can be helpful in this situation [33].

3.10. Injury of external sphincter

Most forms of postoperative incontinence are not caused by iatrogenic trauma of the external sphincter muscle. The lesion usually occurs ventrally (at 12 o'clock), where the veru montanum (ejaculatory duct) is not visible. Also, there is an increased risk of sphincteric injury if the veru has already been resected.

3.10.1. Prevention

The exact location of the external sphincter should be checked repeatedly, particularly during apical paracollicular resection [32]. Rectal palpation might be helpful for this. Traction on the balloon catheter should be minimized if there is a suspicious lesion on the external sphincter [3].

3.11. Postoperative complications

Postoperative complications occur early and late (Tables 1 and 4).

3.12. Bladder tamponade

Recurrent or persistent bleeding sometimes results in clot formations and a bladder tamponade that require evacuation or even reintervention (1.3–5%). Arterial bleeders can usually be identified by intermittent change of colour in the irrigation outflow from clear to red (cloudy red spots), whereas venous bleeders result in a dark red continuous irrigation fluid.

3.12.1. Management

Obstructing clots should generally be evacuated. The balloon catheter should then be replaced under rectal palpation. The balloon can be either blocked in the fossa or inflated in the bladder (20–40 cc more than the resection weight) and put under traction (Fig. 4b). However, this technique does not work with active arterial bleeders, particularly at the bladder neck.

If the irrigation fluid does not clear in the recovery room, immediate reintervention with tamponade evacuation and bleeder coagulation is required to minimize the risk of further complications.

Occasionally, associated coagulation disorders that were undetected preoperatively may not respond to coagulation alone. In such situations, additional recto-digital palpation may stop the bleeding. Another alternative is transfemoral superselective embolization [48].

3.13. Infection

The infection rate is usually low (e.g., in Baden-Württemberg 3.5%); however, in the French multicentric study the incidence of post-TURP infection was 21.6%, including a 2.3% rate of septic shock [49]. Risk factors included:

- Preoperative bacturia
- Longer duration of the procedure (>70 min.)
- Preoperative stay longer than two days
- Discontinuation of catheter drainage (tamponade evacuation)

The low rate in Heilbronn (1.7%) is based on routine preoperative urinalysis to rule out any significant untreated UTI. This might be problematic in cases of indwelling catheters. We recommend antibiotic prophylaxis such as cotrimoxazole or gyrase inhibitors. We also see a low incidence of postoperative epididydimitis and do not recommend routine simultaneous vasectomy.

3.14. *Urinary retention*

Urinary retention (3–9%) is mainly attributed to primary detrusor failure rather than to incomplete resection [50]. We are very conservative about early repeated TURP in cases of persisting residual urine (RU) or micturation problems. Unless TRUS shows significant tissue (ventile effects), TURP should be postponed until the fossa heals. RU may persist above 100 cc for a significant amount of time without presenting a problem to the patient, particularly in cases of previous detrusor decompensation. In such cases, we remove the suprapubic catheter once RU is <150 cc.

3.15. *Incontinence*

Early incontinence may occur in up to 30–40% of patients; however, late iatrogenic stress incontinence occurs in fewer than 0.5% of patients.

3.15.1. *Early management*

Incontinence after BPH surgery requires careful evaluation [4,51]. Early incontinence is usually urge symptomatic, either because of irritative symptoms such as fossa healing and associated UTI or detrusor instability caused by long-lasting BPH [4]. Symptomatic treatment should include time-limited anticholinergic selective drugs such as Toldoridine or Darifenacin, as well as anti-inflammatory regimens such as Diclofenac.

3.15.2. *Urodynamic evaluation*

Incontinence that persists longer than six months requires complete investigation, including ascending urethrogram, cystourethroscopy, and urodynamic evaluation [4]. There are several causes of incontinence [51,52]: sphincter incompetence (30%), detrusor instability (20%), mixed incontinence (30%), residual adenoma (5%), bladder neck contracture (5%), and urethral stricture (5%).

3.15.3. *Late management*

Depending on endoscopic and urodynamic findings, conservative treatment with pelvic floor exercise combined with TRUS-biofeedback and electrostimulation might be indicated. Promising experiences with Duloxetine (40 mg b.i.d.) must be balanced against the side effects, which cause patients to discontinue use. Since periurethral injection therapy was not very successful, an artificial sphincter might be indicated for a few patients [52]. Recently, higher success rates (67% dry, 92% improvement) were reported with inflatable paraurethral balloons [53].

3.16. *Urethral stricture*

The rate of urethral stricture varies from 2.2% to 9.8% in the literature; there is no relationship to time periods (Table 4). There are two main reasons related to location [3]:

- Meatal strictures usually occur because of an inappropriate relationship between the size of the instrument and the diameter of the urethral meatus.
- Bulbar strictures occur because insufficient isolation by the lubricant causes the monopolar current to leak.

The gel should be applied carefully in the urethra and along the shaft of the resectoscope. The lubricant must be reapplied in cases of longer resection time. Moreover, high cutting current should be avoided. An internal urethrotomy must be performed before TURP if there are pre-existing meatal or urethral strictures [3,32,35].

3.17. *Bladder neck stenosis*

The incidence varies from 0.3% to 9.2%, usually after smaller glands (<30 g) are treated. Therefore, the indication for TURP in cases of smaller glands should be taken very seriously according to the criteria mentioned earlier. A prophylactic bladder neck incision at the end of the procedure may reduce the incidence [3,32]. Treatment includes electrical, or preferably, laser incision of the bladder neck [2,44].

3.18. *Retrograde ejaculation*

According to the nature of the procedure, retrograde ejaculation occurs in the majority of patients

(53–75%). Retrograde ejaculation might be avoided if the tissue around the veru montanum is spared during resection. More importantly for younger patients, the indication for TURP should be taken seriously versus medical treatment with alpha-blockers or 5-alpha-reductase-inhibitors, or a transurethral incision of the prostate.

3.19. *Erectile dysfunction*

Theoretically, HF-generated current close to the capsule may damage the neurovascular bundles. The rate of impotence varies from 3.4 to 32% in the literature [2,3]. However, there are also reports of improved erections after TURP [52].

3.20. *Recurrent BPH*

The retreatment rate of TURP is lower than the rates of other alternatives such as TUMT and TUNA (3–14.5% after five years) [2]. Reasons for Re-TURP include insufficient resection and the natural course of the disease.

3.21. *Associated morbidity and mortality (Table 1)*

Despite the increasing mean age (55% of patients are older than 70), the associated morbidity of TURP maintained a similar low level <1% with a mortality rate of 0–0.25% in large series [5,7]. Nevertheless, TURP still has to be taken seriously, particularly with cardiac patients. Coagulation disorders should be checked preoperatively (no aspirin, clopidogel (oumadine)).

4. Discussion

Mortality after TURP has decreased substantially during the past few decades to <0.25% in contemporary series (Table 1) [5,7]. This might be mainly attributable to the advances in anesthesia and to the technical improvements of TURP [2].

4.1. *Intraoperative complications*

The major intraoperative complication remains hemorrhaging that requires blood transfusions. Technical improvements of monopolar HF generators [10,35] and the instrumentarium [32,33,36] resulted in a significant decrease of transfusion rates. Whereas in early series, transfusion rates of up to 22% were reported, the incidence has decreased to 0.4–7.1% (Table 2). An important factor represents the improved training of TUR with video technology [35]: both the trainee and mentor comfortably observe every technical step of the procedure, in contrast to the cumbersome use of side lens oculars. Significant bleeding during resection can be almost eliminated with alternative energy sources such as the Holmium laser [24,25,43] or KTP laser [44]; however, newer TURP generators also achieve bloodless resection [36,40–43].

TUR syndrome largely disappeared with the use of modern irrigation fluids, improved surgical techniques, and instrumentation (low pressure). The incidence decreased from >2% to <1% (Tables 1 and 2). Heidler [18] showed that fluid absorption seems to be avoidable with an appropriate drainage system. Studies that add alcohol to the irrigation fluid show a clear correlation between alcohol absorption in expiratory air and a decrease of serum concentration. Sodium in serum thus represents a good marker of fluid absorption [16,20]. Hypotonic intoxication does not occur with bipolar or laser technology with sodium chloride as irrigation fluid [40–44].

4.2. *Resection speed*

Some complications are related to prolonged operating times. Despite all technical improvements, overall data reveal no decrease in resection speed of 0.5–0.9 g/min (Table 3). The average speed of all series is about 0.6 g/min, far from the frequently cited 1 g/min. This reflects the status of TURP as the gold standard during the last few decades. Improved technologies such as microprocessor-controlled electrosurgery, coagulating intermittent cutting, and bipolar resection aim at simultaneous cutting and coagulation [10,36–43] usually are associated with slower loop movements. Consequently, even in cases of less bleeding, the resection speed may not be reduced.

4.3. *Postoperative complications*

Most frequent complications within the first four to six weeks after TURP are prolonged urinary retention, postoperative bleeding with clot retention, and UTI. The rate of clot retention with major bleeding was 2–5% in recent studies [2]. Previous acute urinary retention with high retention volumes (>1000 cc) represents a risk factor of post-TURP voiding difficulties [50]. UTI can be minimized with routine use of prophylactic antibiotic regimens and by minimizing the disconnection of the draining systems [49].

Few data reveal the relationship of the applied electric energy and the irritative symptoms

Table 3 – Development of weight and resection speed during three periods

Authors	N	Weight (mean g)	OR-time (min.)	Resection speed (g/min.)
Early				
Zwergel 1979	232	29.3	n.a.	n.a.
Mebust 1989	3885	22.0	n.a.	n.a.
Doll 1992	388	23.0	38.0	0.6
Intermediate				
Zwergel 1995	214	28.5	n.a.	n.a.
Haupt 1997	934	29.0	45.0	0.6
Gallucci 1998	80	36.6	n.a.	n.a.
Hammadeh 1998	52	20.1	21.6	0.9
Gilling 1999	59	14.5	25.3	0.6
Borboroglu 1999	520	18.8	62.5	0.3
Recent				
Heilbronn 2003[a]	126	47.9	77.0	0.6
Baden-Württemb. 2003	7707	35.1	52.0	0.7
Kuntz 2004	100	37.2	73.8	0.5
Muzzonigro 2004	113	31.0	52.5	0.6
Berger 2004[+]	271	33.0	46.0	0.7

n.a. = not available.
[a] Present study.

postoperatively. Nevertheless, the amount of energy should be minimized [40]. A smooth fossa with minimal residual necrotic tissue guarantees better healing and thus reduces the risk of chronic infection and irritative symptoms [3].

The major two late complications are urethral strictures (2.2–9.8%) and bladder neck contractures (0.3–9.2%). Despite improvements in surgical techniques, lubricants, instruments, and electrical technology, the incidence of urethral strictures did not change significantly (Table 4). Theoretically, bipolar technology or laser minimizes the risk of a urethral stricture [41,44]. However, recently Tefelki et al. [42] reported on a higher stricture rate in a randomized study that compared bipolar to standard TURP (6.1 vs. 2.1%). The reason for this might not be the use of bipolar technology, but the fact that the latter required a larger resectoscope (27 F). Also, Kuntz et al. [25] observed similar stricture rates after Holmium laser resection and TURP when a resectoscope was used for morcellation. This underlines the multifactoral causes of urethral strictures, depending on technique (i.e. operating room time), technology, and the regimen of antibiotic treatment.

The controversy about erectile dysfunction after TURP was clarified by the Veterans Affairs cooperative study group that compared TURP with watchful waiting [52]: After a follow-up of almost three years, the proportion of patients who

Table 4 – Main late complications after TUR-comparison of three periods

Authors	N	Incontinence (%)	Re-TUR (%)	Impotence (%)	Stricture (%)
Early					
Zwergel 1979	232	11.4	n.a.	n.a.	4.4
Doll 1992	388	9.0	1.5	24[a]	n.a.
Intermediate					
Zwergel 1995	214	3.2	n.a.	n.a.	3.9
Horninger 1996	1211	7.6	n.a.	n.a.	5.6
Hammadeh 1998	52	0.0	4.0	11.0	8.0
Gallucci 1998	80	3.8	0.0	5.0	3.8
Gilling 1999	59	3.2	6.6	8.2	9.8
Borboroglu 1999	520	n.a.	2.5	2.1	3.1
Recent					
Kuntz 2004	100	5.0	3.0	10.5	2.2
Muzzonigro 2004	113	1.8	n.a.	n.a.	3.6

n.a. = not available.
[a] 22% preoperative impotent.

reported deterioration of sexual performance was identical in both arms (19% vs. 21%), whereas 3% in each group reported improvement. When excluding the study of Doll et al. [8] with 22% of patients reporting erectile dysfunction preoperatively, the rate was 2.1–11% in the reviewed literature (Table 4). However, none of these studies used a validated questionnaire such as an IEEF score to evaluate impotence.

5. Conclusions

The morbidity of contemporary TURP is lower than previously reported. This is based on a continuously improving armamentarium and technique, but is also related to a significant improvement in teaching modalities, including video technology such as video TUR, hands-on courses with phantoms, TURP courses with live demonstrations, and textbooks with CD-ROMs that demonstrate the steps of the technique [3]. Further technical improvement may also include the use of flexible instruments to improve the visibility and maneuverability of the resection loop [54].

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Editorial Comment

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This is an important review paper which should be used in the future as a reference for comparison studies regarding new techniques and technologies for BPH treatment. As a matter of fact, the incidence of significant bleeding and late incontinence mainly contributed in the past to the definition of TURP as an ''invasive'' operation and nowadays it is greatly decreased. Blood replacement has become hepisodical and permanent incontinence is less than 0.5%. Bipolar technology might in the future even reduce the complication rate avoiding the already rare TUR syndrome. TURP is still a difficult operation with a consistent learning curve, but I presume that in the future review papers it could be rightly listed within the ''non-invasive'' procedure for the treatment of BPH.