Is Warm Temperature Necessary to Prevent Urethral Stricture in Combined Transurethral Resection and Vaporization of Prostate?

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OBJECTIVES To compare the effect of warm and room temperature irrigation solution on the incidence of urethral stricture during combined transurethral resection and vaporization of the prostate (CTURVP). Urethral stricture after transurethral surgery of the prostate is a bothersome complication. Warm irrigation improves the blood flow and might decrease the incidence of urethral stricture compared with the use of room temperature irrigation, which decreases the blood flow in the urethral mucosa, resulting in ischemic injury.

METHODS The patients who underwent CTURVP were divided into those receiving only room temperature irrigation solution (group 1, 75 patients) or warm irrigation solution with a system maintaining the temperature of the ventral penile skin at about 36°C continuously (group 2, 78 patients). At follow-up, 1, 3, and 6 months later, the International Prostate Symptom Score and peak urine flow rate were evaluated.

RESULTS The temperature of the ventral penile skin was 20°C and 36°C in groups 1 and 2, respectively. The rate of urethral stricture was 21.3% in group 1 and 6.3% in group 2 at the end of 6 months of follow-up ($P = .002$).

CONCLUSIONS The results of our study have shown that maintaining the temperature of the urethra with warm irrigation solution during CTURVP probably decreases the incidence of urethral stricture. The temperature in the urethra could be another important factor in stricture formation after CTURVP. UROLOGY 74: 125–129, 2009.

Although medicines such as α-adrenergic blockers and 5α-reductase inhibitors are first-line therapy for benign prostatic hyperplasia (BPH), transurethral resection of the prostate (TURP) has been the most effective surgical procedure for patients with BPH with lower urinary tract symptoms.[1] However, significant late complications, including urethral stricture, incontinence, erectile dysfunction, retrograde ejaculation, and bladder neck contracture have been reported to occur in ≤15%-20% of patients who undergo TURP or combined transurethral resection and vaporization of the prostate (CTURVP).[2-5] A significant number (10%-15%) require a second intervention within 10 years.

The normal body temperature in humans is 36.5°C. Hypothermia is a condition in which an organism's temperature decreases to <35°C. When the body temperature decreases by 1-2°C below the normal temperature, the blood vessels constrict, lessening heat loss to the outside environment.[6] The constriction of blood vessels in the urethra during hypothermia or heart surgery can also induce ischemic injury in the urethra, resulting in urethral stricture. Controversies exist regarding the effect of continuous warm irrigation on the morbidity during the peri- or postoperative period of transurethral surgery.[7,8] The incidence of urethral stricture after TURP is 3.7%-9.8%.[5,9-11] However, the true incidence of urethral stricture is probably greater than the reported rates because it depends on how and when the diagnosis is made. TURP and/or CTURVP using room temperature irrigation solution might induce hemodynamic disturbances owing to the bladder and prostatic fossa irrigation.

To spare the normal physiology of the urethra from injury, a shorter operative time, smaller resectoscope,

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minimal handling of the urethra, and good blood circulation in the urethra are helpful during transurethral surgery. A smaller urethral catheter and short indwelling period for a Foley catheter are also effective after transurethral surgery.[11,12] However, urethral stricture is inevitable. The common sites of postoperative urethral stricture are just inside the external meatus, the penoscrotal junction, mid-bulbar, and just below the urethral sphincter, even with careful technique during the peri- and postoperative period.[11]

Because continuous irrigation with room temperature solution might disturb the blood circulation in the urethra, resulting in urethral stricture, we compared the complications after warm irrigation solution vs room temperature irrigation solution during CTURVP in patients with BPH.

MATERIAL AND METHODS

We performed a retrospective study of 167 patients who had undergone CTURVP by the same surgeon to treat BPH at our institution. The hospital ethical review committee approved the study, and all 167 patients provided written informed consent. Of the 167 patients, 153 were completely evaluated at 6 months of follow-up. The patients were divided into 2 groups. In group 1 (n = 75), each patient underwent CTURVP using room temperature irrigation solution. In group 2 (n = 78), each patient underwent CTURVP using warm irrigation solution and a device to maintain the temperature of the ventral penile skin at about 36°C continuously. The irrigation solution was warmed to 39-40°C before surgery. CTURVP was performed with the patient under spinal or general anesthesia.

Preparation of Irrigation Solution

The irrigation solution was stored at room temperature, and the temperature of the fluid was recorded during surgery. The warm irrigation fluid was prepared using a heater, set at 40°C, slightly lower than the set temperature just before entering the sheath of the resectoscope.

Preparation of Device Maintaining Urethral Temperature

The warm urethral temperature was achieved in 2 ways: first, continuous irrigation using a warm solution at 40°C was passed through the sheath of the resectoscope to maintain the urethra and bladder temperature; and second, a device was used to maintain the penis at isotherma, with gauze surrounding the penis, a temperature sensor, a tube, and a condom (Fig. 1). The temperature sensor was located between the ventral skin of the proximal penis and the gauze. The tube was located between the ventral skin of the distal penis and gauze, with continuously flowing warm solution to maintain the penile temperature at 36°C, with the penis surrounded by gauze covered with a condom (Fig. 1). Intraoperative temperature monitoring of ventral penile skin in front of the urethra was performed continuously to assess the thermal status of the urethra during the procedure, immediately before starting irrigation and just after the resectoscope was removed from the urethra. Each patient also had his right index finger temperature monitored for control. The temperature was automatically monitored every 5 minutes. The

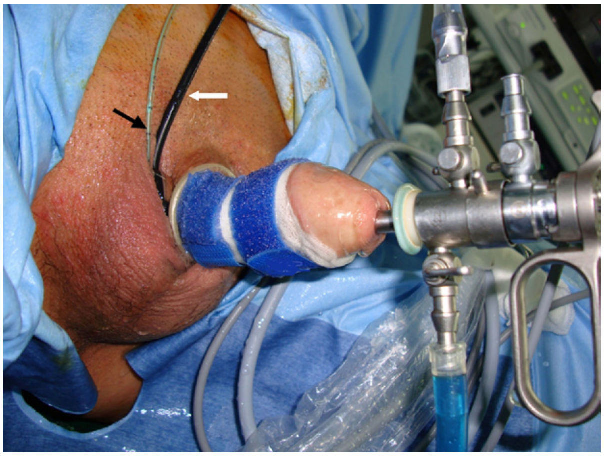

Figure 1. Penile warming device used to maintain isothermic penis was composed of gauze surrounding penis, temperature sensor (white arrow), and tubing (black arrow), with continuously flowing warm solution to maintain temperature of ventral penile skin at 36°C. Condom covered system and penis.

amount of the resected prostatic tissue (g), resection time (minutes), intraoperative complications, hemoglobin and hematocrit, serum electrolyte concentration, hospital stay, duration of Foley catheterization, and need for transfusion were recorded. A postoperative estimation of the hemoglobin and hematocrit and electrolytes was performed 1 hour after surgery.

Preoperative Evaluation

The preoperative workup included determination of the prostate volume as assessed by digital rectal examination and transrectal ultrasonography (BK Medical, Herlev, Denmark), International Prostate Symptom Score, quality of life score, International Index of Erectile Function questionnaire, serum prostate-specific antigen concentration, complete blood count, blood chemistry, and uroflowmetry (peak urinary flow rate [Qmax]).

Operative Technique

CTURVP was performed in a similar manner as for standard resection, apart from the high-cutting power for vaporization and resection. The operation field was cleaned with Betadine solution and the urethra lubricated with chlorhexidine jelly. Resection was performed using the 22F continuous-flow resectoscope and cutting loop (Karl Storz GmbH, Tuttlingen, Germany). During the operation, surgical jelly was frequently applied to the meatus. The electrosurgical generator (AUTOCON, Karl Storz) was set to 150 W for cutting and vaporization and 60 W for coagulation. A camera was used during CTURVP. At the end of the operation, a 16F Foley catheter (Bard GmbH, Karlsruhe, Germany) coated with standard latex and polyvinyl chloride was inserted and mildly traced for hemostasis until the urine became clear. The postoperative catheterization time was recorded.

To analyze the early and late complications, as well as their evolution, follow-up visits were scheduled at 1, 3, and 6 months. The follow-up protocol included International Prostate Symptom Score, quality of life score, Qmax, the International Index of Erectile Function questionnaire, and continence assessment by interview. The reported stricture rate in each group was determined by whether the patients with aggravation in their Qmax or symptom score compared with baseline underwent retrograde urethrography or cystoscopy.

Follow-up

In both groups, the number of patients attending the follow-up visits decreased with time. Thus, complete follow-up evaluations were achieved in 163 patients (group 1, 81; group 2, 82), 160 patients (group 1, 79; group 2, 81), and 153 patients (group 1, 75; group 2, 78) at the end of 1, 3, and 6 months, respectively.

Statistical Analysis

The data were analyzed using the Statistical Package for Social Sciences, version 11, for Windows (SPSS, Chicago, IL). A comparison of the mean values was done using the χ^2 test, and $P < .05$ was considered significant.

RESULTS

The pre-, peri-, and postoperative parameters are listed in Table 1. The prostatic weight was >60 g in 21 patients in group 1 and 19 patients in group 2. The resected prostate volume was 20.9 ± 5.9 g in group 1 and 22.3 ± 7.3 g in group 2, with no statistical significance. In both groups, the prostate was resected by >44% of the total prostate volume. The changes in the symptom score and Qmax at 1, 3, and 6 months postoperatively are listed in Table 2. In both groups, the symptom scores had improved significantly at 1, 3, and 6 months of follow-up compared with the pretreatment values. No statistically significant differences were found in symptomatic improvement or Qmax between the 2 groups. The mean postoperative catheterization time was 1.9 and 2.4 days (range 1-5) respectively, and the mean postoperative hospital stay was 3.1 and 3.3 days (range 1-7) in groups 1 and 2, respectively, with no statistically significant differences between the 2 groups.

In groups 1 and 2, meatal stricture developed in 17.3% and 1.3% ($P < .002$) and bulbous urethral stricture in 4% and 5.1% at the end of 6 months, respectively. At the end of surgery, injury to the proximal bulbous urethra by compression from the sheath of resectoscope was usually visualized, and this could develop into a stricture (Fig. 2A,B). Multiple narrow rings in the penile urethra were also found and could develop into stricture after CTURVP (Fig. 2C). However, the strictures were easily treated by soundation or internal urethrotomy, except for severe urethral stricture (Fig. 2D,E). Significant differences were found in the incidence of urethral stricture between the 2 groups, with an incidence of 21.3% vs 6.4% in groups 1 and 2, respectively ($P = .002$).

COMMENT

In our study, CTURVP using warm irrigation solution decreased the incidence of urethral stricture compared with the incidence using room temperature irrigation solution.

Table 1. Comparison of pre-, peri-, and postoperative variables between groups

Variable	Group 1	Group 2
Preoperative		
Age (y)	69.6 ± 7.0	68.3 ± 6.9
Total prostate volume (cm^3)	46.7 ± 18.8	48.1 ± 20.2
Transition zone volume (cm^3)	22.9 ± 14.3	24.0 ± 12.3
Total PSA (ng/mL)	4.08 ± 4.9	4.7 ± 6.5
Free PSA (ng/mL)	1.56 ± 3.2	1.38 ± 3.8
Peri- and postoperative		
Mean operative time (min)	51.9 ± 22.9	67.4 ± 23.7
Mean temperature (°C)	24.3 ± 1.2	36.8 ± 0.7
Mean resected prostate volume (cm^3)	20.9 ± 5.9	22.3 ± 7.3
Mean prostate volume remaining (cm^3)	16.3 ± 6.8	21.0 ± 8.6
Mean catheter time (d)	1.9 ± 1.2	2.4 ± 1.6
Mean hospital day (d)	3.3 ± 1.7	3.1 ± 1.5

PSA = prostate-specific antigen.

TURP using radiofrequency energy is the cornerstone of surgical management of BPH.[1,13] Despite the improvements in surgical instruments and techniques, TURP is associated with morbidity at a rate of ≤30%, including transurethral resection syndrome, bleeding, infection, urinary retention, incontinence, urethral stricture, bladder neck stenosis, and retrograde ejaculation.[2,6-9] However, the exact etiology of urethral stricture is still controversial. The suggested factors involved in urethral stricture formation after TURP include infection, mechanical trauma, ischemic urethral mucosa, prolonged indwelling catheter time, use of local anesthesia, and electrical injury by a stray current.[14-17]

The human body loses heat to the environment by 4 heat transfer modes: radiation, convection, evaporation, and conduction. When the body temperature decreases by 2-4°C, shivering becomes more violent and the surface blood vessels constrict further as the body focuses its remaining resources on keeping the temperature of the vital organs.[9] However, when the deep body temperature is increased by 1°C, the total peripheral resistance is decreased by 11% and skin blood flow is improved.[18]

During TURP using warm irrigation solution, the body temperature only decreased by 0.27-0.74°C.[19,20] However, if room temperature solution was used to irrigate during transurethral surgery, the body temperature decreases 1.5°C/h. Also, the urethral temperature is lower than the body temperature, because the urethra is completely exposed to the surrounding environment.[19] When the urethral temperature decreases by the constriction of the blood vessels, ischemia induced by hypoxia can occur more easily than during warm conditions.[19] Moreover, mechanical manipulation is added to the ischemic condition, and the blood circulation in the urethra is worsened, resulting in the development of urethral stricture. The urethral ischemia caused by the decrease of the blood supply in the urethral mucosa has an important

Table 2. Subjective and objective changes before and after surgery

Variable	Preoperative	Postoperative (mo)		
		1	3	6
IPSS				
Group 1	19.1 ± 8.4	16.2 ± 3.7	12.7 ± 4.3	10.7 ± 3.3
Group 2	20.9 ± 5.9	15.9 ± 4.1	13.4 ± 4.5	10.1 ± 3.8
Qmax (mL/s)				
Group 1	9.4 ± 5.7	11.2 ± 3.3	14.5 ± 6.3	16.8 ± 9.7
Group 2	8.9 ± 5.3	11.3 ± 3.9	13.7 ± 7.9	17.5 ± 7.8

IPSS = International Prostate Symptom Score; Qmax = peak urinary flow rate.

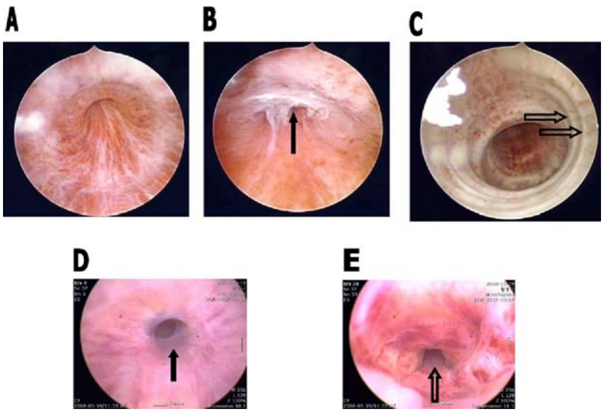

Figure 2. (A) Urethroscopy showing normal mucosa of proximal bulbous urethra before combined transurethral resection and vaporization of prostate (CTURVP). **(B)** Urethroscopy showing injured proximal bulbous urethra (solid arrow) that had been compressed by sheath of resectoscope during CTURVP. Injured urethra might develop stricture postoperatively. **(C)** Urethroscopy showing multiple constrictions like bands in penile urethra (open arrows). **(D)** Urethroscopy showing urethral stricture in proximal bulbous urethra (solid arrow) at 3 months after CTURVP. **(E)** Urethra completely dilated by soundation (open arrow).

role in the development of stricture during transurethral surgery or urethral catheterization.[7]

In our study, the incidence of urethral stricture was significantly increased, at 21.3%, in the patients who underwent CTURVP using room temperature irrigation solution and was greater than the rate in other reports. The incidence of urethral stricture after CTURVP depends on the method used to diagnose it and period in which the evaluation is undertaken. The frequency of urethral stricture might be much greater if we were to check all patients who undergo transurethral surgery. When CTUPVP was performed using warm irrigation solution, the incidence of urethral stricture decreased significantly to 6.4%. Therefore, when the efficiency of the 2 techniques was compared in terms of the formation of stricture after CTURVP, warm irrigation was significantly more efficient than room temperature irrigation. Although the incidence of urethral stricture in our study was very high compared with other reports, we do not know the mechanism for this finding.

The hypothesis concerning the etiology of urethral stricture after TURP is as follows. The mechanical damage in the urethral mucosa leads to leakage of urine, resulting in inflammation and scar formation. Another hypothesis is that the catheter, a foreign body, is placed in the mucosal lesion and keeps the wound wide open, resulting in sustaining infection and scar formation. Regardless of the mechanism of urethral stricture formation after TURP, the results of our study have shown that using warm irrigation solution during CTURVP decreases the incidence of urethral stricture and that a lower temperature might be another cause of urethral stricture formation after transurethral prostate surgery.

CONCLUSIONS

Warm irrigation and a system to maintain the penis at isothermia during CTURVP might decrease the incidence of urethral stricture and morbidity. The difference in the incidence of urethral stricture between the 2 groups showed that warm irrigation is more efficient than room temperature irrigation in the prevention of urethral stricture.

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