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Clinical Observation of Transurethral and Suprapubic Laser Therapy for Superficial Bladder Tumors

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Abstract: *Superficial bladder cancer is a highly malignant tumor that may precede invasive bladder cancer. Without timely treatment, there is a high probability of malignancy. Therefore, it is important to take effective measures for timely treatment and prevent disease progression. Based on this, a randomized controlled trial was conducted in this study. Patients were randomly assigned to different treatment groups using a random number table. Different treatment outcomes were observed under two treatment methods, including perioperative indicators, tumor marker levels, quality of life scores, inflammatory factor levels, urinary function, and incidence of postoperative complications. The therapeutic effect of transurethral and suprapubic laser therapy for superficial bladder tumors was analyzed, aiming to provide certain assistance for the treatment of superficial bladder tumors in clinical practice.*

Keywords: *Transurethral and suprapubic puncture laser; superficial bladder tumors; clinical outcome; tumor markers; voiding function*

1. Introduction

Superficial bladder tumors refer to tumors that occur on the surface of the bladder wall in patients. This disease is a malignant tumor in the genitourinary system. According to relevant statistics, the incidence rate of superficial bladder tumors can reach up to 85%. Overall, the disease has a relatively high incidence rate. The factors contributing to superficial bladder tumors are relatively complex and are usually related to smoking, environmental factors, chronic inflammation, and long-term exposure to carcinogens. The occurrence of superficial bladder tumors can lead to chronic bleeding in patients, resulting in weight loss, general fatigue, and decreased hemoglobin levels over time. With the progression of the disease, tumor cells gradually invade the bladder wall, causing complications such as rectal obstruction and intestinal bleeding due to perforation. This poses a significant threat to the patient's overall health. Surgery is generally used to treat bladder tumors [1]. The commonly used surgical method is transurethral resection of the bladder tumor (TURBT). However, during the tumor resection process, bladder perforation can easily occur due to the closure reflex, which affects the patient's prognosis and is not well-received by patients. Transurethral and suprapubic puncture laser therapy, using high-energy holmium laser along the bladder capsule, can completely remove the proliferating tumor and maximize the preservation of bladder function. Postoperative complications are relatively low, making it one of the most effective treatment methods for superficial bladder cancer patients [2]. In this study, the authors selected 60 cases of superficial bladder tumor patients treated in our hospital from January 2022 to September 2023. The aim was to analyze the application and effectiveness of transurethral and suprapubic puncture laser therapy, the following research findings were obtained.

2. Information and Methods

2.1. General information

A total of 60 patients with superficial bladder tumors admitted to our hospital from January 2022 to September 2023 were selected for this study. They were randomly divided into two groups: the control group (n=30) underwent transurethral resection of the bladder tumor (TURBT), consisting of 18 male

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and 12 female patients, with an age range of 40-72 years and an average age of (56.46±3.95) years. The tumor diameter ranged from 2.5 cm to 4.8 cm, with an average diameter of (3.76±0.35) cm. Among them, 26 patients had their first occurrence of tumors, and 4 patients had recurrent tumors. The observation group (n=30) underwent transurethral and suprapubic puncture laser therapy, consisting of 20 male and 10 female patients, with an age range of 39-70 years and an average age of (56.15±3.82) years. The tumor diameter ranged from 2.3 cm to 4.9 cm, with an average diameter of (3.71±0.38) cm [3]. Among them, 27 patients had their first occurrence of tumors, and 3 patients had recurrent tumors. The general data of the two groups were compared (P<0.05).

Inclusion criteria include: ① pathology or cystoscopy confirmation of superficial bladder tumors; ② patients exhibiting varying degrees of hematuria, urinary urgency, urinary frequency, and other reactions; ③ a requirement for complete clinical data; ④ patients and their families having been informed about this study and having agreed to participate.

Exclusion criteria encompass: ① patients with concurrent other urological diseases; ② patients with blood-related diseases; ③ patients experiencing severe multi-organ dysfunction; ④ patients unable to tolerate the surgical treatment required by this study; ⑤ patients with prostate hyperplasia, urethral calculi, or other related diseases [4].

2.2. Methods

Control group: Transurethral resection of the bladder tumor (TURBT): Patients were positioned in the lithotomy position and received epidural anesthesia. After the anesthesia took effect, the tumor tissue was excised using an electric resection loop. The cutting power of the loop was set at 140W, and the coagulation power was set at 60W. First, the surface of the tumor tissue was cleared, then the resection loop was placed around the tumor tissue. Intermittent irrigation with 5% mannitol was applied to cleanse the tumor tissue. The location, size, and number of tumors were confirmed, followed by the removal of the tumor. The tumor base and 1-2cm of surrounding mucosa were resected until normal muscle tissue was exposed. A double-lumen indwelling catheter was also placed after the surgery [5].

Observation group: Transurethral and suprapubic puncture laser therapy: After epidural anesthesia or local anesthesia on the urethral surface, a urethrocystoscope was inserted. The location, number, and volume of the tumor were confirmed. Superficial bladder tumors within T2 stage were identified, while attention was paid to the relationship between the tumor and the ureteral orifice. A mixture of 20ml of saline solution and 20mg of mitomycin C was injected into the submucosa around the tumor base. During laser treatment, the cutting power was set at 50W, and each treatment unit lasted for 5 seconds. The tumor was removed using a contact laser, and the tumor base was irradiated with a non-contact laser. During the irradiation, uniform vaporization was maintained to prevent bladder perforation [6]. If the tumor stalk was relatively long, it was severed first, and the laser vaporization time was reduced. When irradiating the tumor base, it was important to select a bladder state that was not overly distended to avoid bladder perforation and minimize damage to surrounding organs. If the tumor was near the ureteral orifice, a F4 vascular catheter was inserted under fluoroscopic guidance before the treatment. If the ureter was affected, a pigtail catheter was inserted for drainage, which lasted for 7-14 days to prevent postoperative stricture at the ureteral orifice. The location of the tumor was observed using the cystoscope. If the tumor was located in a difficult-to-reach area, such as the junction of the neck and sidewall, a suprapubic puncture was performed using a 10mm cannula needle. Then, the cystoscope and fiber optic guide were inserted, and the tumor was vaporized. After the surgery, patients required routine indwelling catheterization for 3-7 days, and prophylactic antibiotics were administered to prevent infection. Two weeks after the surgery, 20mg of mitomycin C was instilled into the bladder weekly, and regular cystoscopy examinations were performed [7,8].

2.3. Observation Indicators

① Perioperative indicators (bladder irrigation time, intraoperative blood loss, hospital stay, surgical time, indwelling catheter time);

② Levels of tumor markers [vascular endothelial growth factor (VEGF), fibroblast growth factor (FGF), matrix metalloproteinase 9 (MMP9), matrix metalloproteinase 2 (MMP2)] before and after treatment: before and after treatment, it is necessary to collect 3-5 ml of peripheral venous blood from

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the patient, centrifuge it for 10 minutes at 4,000 r/min, and detect the levels of the above tumor markers by enzyme-linked immunosorbent assay. The level of the above tumor markers should be detected by enzyme-linked immunosorbent assay;

③ Quality of life scores before and after treatment: the relevant personnel will be evaluated according to the SF-36 scale, which includes 8 indexes. The maximum score for each index is 100 points. A higher score indicates a higher quality of life for the patient;

④ Levels of inflammatory factors after treatment (interleukin-6 (IL-6), procalcitonin (PCT), tumor necrosis factor-alpha (TNF-α)) and urinary function (maximum urine flow rate (QMax), post-void residual urine (PVR)): Before and after treatment, collect 3-5ml of peripheral venous blood from patients, centrifuge at a speed of 3000r/min for ten minutes, and use enzyme-linked immunosorbent assay to detect the levels of inflammatory factors in patients. All procedures are performed using the corresponding reagent kits. The maximum urine flow rate is recorded by a uroflowmeter, measuring the urine flow rate per second during the patient's voiding process, and plotting it as a curve [9]. Three consecutive measurements are taken to obtain the maximum urine flow rate. Post-void residual urine volume is measured using a color Doppler ultrasound diagnostic instrument to measure the volume of urine in the patient's bladder, from which the residual urine volume is calculated;

⑤ Incidence of postoperative complications: it includes difficulty urinating, bladder perforation, and postoperative bleeding [10-12].

2.4. Statistical Analysis

SPSS 20.0 statistical analysis software was used, and the count data were expressed as %, $\chi 2$ test; the measurement data were expressed as ($\bar{x}$ ±s), t test; $P<0.05$ was considered as statistically significant difference.

3. Results

3.1. Comparison of perioperative indicators

All perioperative indicators of patients in the observation group were better than those of the control group ($P < 0.05$), see Table 1;

Table 1. Comparison of perioperative indicators (A ±s)

Group	Number of cases	Bladder washing time (min)	Intraoperative bleeding (ml)	Hospitalization time (d)	Operation time (min)	Urethral retention time (d)
Observation Group	30	19.10±1.89	25.10±2.49	9.59±0.94	26.23±2.61	22.59±2.24
Control group	30	35.83±3.60	47.36±4.76	14.80±1.50	28.08±2.83	38.51±3.87
t	-	22.537	22.696	16.120	2.632	19.501
P	-	0.000	0.000	0.000	0.011	0.000

3.2. Comparison of tumor marker levels before and after treatment

Before treatment, the levels of various tumor markers of the two groups of patients were compared ($P > 0.05$), and after treatment, the levels of various tumor markers of the patients in the observation group were lower than those of the control group ($P < 0.05$), see Table 2 [11].

Table 2.Comparison of tumor marker levels before and after treatment ($\bar{x}$ ±s)

Group	number of examples	VEGF(ng/ml)		FGF(pg/ml)		MMP9(mg/ml)		MMP2(mg/ml)	
		Before Treatment	After treatment	Before Treatment	After treatment	Before Treatment	After treatment	Before Treatment	After treatment
Observation Group	30	59.06±5.13	21.32±2.82	13.13±1.20	6.36±1.32	198.70±22.33	105.34±18.72	281.20±30.16	117.86±19.31
Control group	30	58.27±4.98	36.28±3.47	13.16±1.28	11.32±2.39	199.47±22.16	169.35±26.35	280.35±30.23	205.36±22.42
t	-	0.605	18.325	0.094	9.950	0.134	10.847	0.109	16.197
P	-	0.547	0.000	0.926	0.000	0.894	0.000	0.914	0.000

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3.3. Comparison of quality of life scores before and after treatment

Before treatment, the quality of life scores of the two groups of patients were compared (P>0.05), and after treatment, all the quality of life scores of the patients in the observation group were higher than those of the control group (P<0.05), see Table 3;

Table 3.Comparison of quality of life scores before and after treatment (AA±s) (points)

Group	Number of examples	Somatic Function		Impact of somatic functioning on the role		Physical Pain		General Health	
		Before Treatment	After treatment	Before Treatment	After treatment	Before Treatment	After treatment	Before Treatment	After treatment
Observation Group	30	56.33±8.17	72.56±10.34	53.36±7.56	67.20±9.40	55.37±7.62	70.06±9.91	57.15±7.05	72.36±10.25
Control group	30	55.40±8.09	65.78±9.25	51.92±7.40	61.87±8.54	54.96±7.55	63.42±8.48	56.69±6.89	66.64±8.27
t	-	0.443	2.677	0.746	2.299	0.209	2.788	0.256	2.379
P	-	0.659	0.010	0.459	0.025	0.835	0.007	0.799	0.021

Table 3 (continued)

Group	Number of examples	Vitality		Social Functioning		Effects of Emotions on Role Functioning		Mental Health	
		Before Treatment	After treatment	Before Treatment	After treatment	Before Treatment	After treatment	Before Treatment	After treatment
Observation Group	30	51.12±6.45	66.81±8.45	61.10±5.44	75.52±10.12	58.81±6.72	73.34±9.92	57.76±6.49	72.20±9.30
Control group	30	50.74±6.27	60.27±7.72	60.18±5.12	69.90±8.63	57.93±6.59	67.79±8.43	57.28±6.33	65.24±8.10
t	-	0.231	3.130	0.675	2.314	0.512	2.335	0.290	3.091
P	-	0.818	0.003	0.503	0.024	0.611	0.023	0.773	0.003

3.4. Comparison of inflammatory factor levels and urinary function after treatment

Before treatment, the inflammatory factor level and urinary function of the two groups of patients were compared (P>0.05), after treatment, the inflammatory factor level of the patients in the observation group was lower than that of the control group, and the urinary function of the observation group was stronger than that of the control group (P<0.05), Table 4;

Table 4.Comparison of inflammatory factor levels and voiding function after treatment ($\overline{x}$ ±s)

Indicator	Time	Observation Group(n=30)	Control group(n=30)	t	P
IL-6(pg/ml)	Before Treatment	17.90±1.81	17.76±1.79	0.301	0.764
	After treatment	81.10±7.09	88.59±7.88	3.870	0.000
PCT(g/L)	Before Treatment	0.49±0.07	0.50±0.08	0.515	0.608
	After treatment	0.69±0.08	0.76±0.09	3.184	0.002
TNF-α (g/ml)	Before Treatment	31.50±3.13	31.62±3.14	0.148	0.883
	After treatment	42.08±4.23	47.63±4.78	4.763	0.000
QMax(ml/s)	Before Treatment	6.55±0.64	6.32±0.61	1.425	0.160
	After treatment	13.76±1.39	10.59±1.04	10.002	0.000
PVR(ml)	Before Treatment	74.53±7.47	74.69±7.49	0.083	0.934
	After treatment	34.79±3.46	41.08±4.13	6.394	0.000

3.5. Comparison of postoperative complication rates

The incidence rate of postoperative complications of patients in the observation group was lower than that of the control group (P < 0.05), see Table 5.

Table 5.Comparison of postoperative complication rates [n (%)]

Group	Number of cases	Voiding obstruction	Bladder perforation	Postoperative bleeding	Incidence
Observation Group	30	1	0	0	1(3.3)
Control group	30	4	1	1	6(20.0)
X^2	-	-	-	-	4.043
P	-	-	-	-	0.044

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4. Discussion

Superficial bladder tumors refer to early-stage tumors that do not invade the submucosa. They mainly occur in individuals over 50 years old. The development of this disease is primarily caused by the activation of oncogenes, infection of surrounding tissues, excessive replication of cancer cells, and subsequent carcinogenesis. Patients with superficial bladder tumors may experience symptoms such as hematuria, urgency, and dysuria. Without prompt treatment, the bladder can gradually fibrose, leading to a decreased bladder capacity and the development of urinary reflux. In severe cases, it can cause inflammation and edema in the kidneys, eventually resulting in uremia [12].

In the past, transurethral resection of bladder tumors (TURBT) was commonly performed in clinical practice. Although this procedure can effectively remove tumor tissue, it can also cause thermal damage to deep tissues, nerve stimulation, and incomplete clearance due to the avoidance of nerve reflex during surgery, leading to an increased risk of postoperative recurrence.

Transurethral and suprapubic laser surgery is a minimally invasive procedure based on laser technology. It utilizes a flexible fiber optic cable to deliver holmium laser energy to areas that cannot be reached by conventional cystoscopy. This allows for precise removal of tumor tissue without excessive heat generation, minimizing the impact on local nerves. Additionally, the procedure can seal lymphatics to prevent cancer cell spread, reducing tumor burden and preventing disease recurrence.

The results of this study showed that perioperative outcomes in the observation group were superior to those in the control group. Laser treatment in this procedure allows for precise tumor removal while minimizing bleeding, reducing surgical time, accelerating postoperative recovery, and preventing tissue charring, providing clear tissue anatomy and high tissue resolution. This ensures effective tumor clearance while minimizing damage to surrounding healthy tissue, reducing bladder irrigation time, and improving clinical outcomes [13].

Tumor marker levels serve as indicators of tumor occurrence and development. Vascular endothelial growth factor (VEGF) is a pro-angiogenic factor that promotes blood vessel growth, thereby increasing tumor recurrence and metastasis rates. Fibroblast growth factor (FGF) promotes the proliferation of endothelial cells within blood vessels and contributes to neovascularization. Matrix metalloproteinases (MMP9 and MMP2) degrade collagen and gelatin, facilitating tumor angiogenesis. The results of this study demonstrated that tumor marker levels in the observation group were superior to those in the control group, indicating improved tumor marker levels in patients undergoing transurethral and suprapubic laser surgery.

IL-6 belongs to peptides and can reflect the degree of inflammation in the body. It can regulate the growth and differentiation of various cells. PCT is a protein, and its level in the plasma rises when the body is injured. TNF-α belongs to inflammatory mediators and is associated with immune-inflammatory responses. If the body experiences an inflammatory reaction, its level will increase. This study found that the levels of inflammatory factors in the observation group were lower than those in the control group.

This study also found that the observation group had better urinary function than the control group, indicating that this treatment method can improve patients' urinary function. The procedure is simple, precise, provides a clear surgical view for the attending physician, and the laser does not generate electric currents, which can avoid urethral stricture and promote the recovery of urinary function [14,15].

Furthermore, this study found that the complication rate in the observation group was lower than that in the control group. The reason for this is that the surgery provides a clear anatomical level, offers a clear surgical view, prevents damage to normal tissues, and thus reduces the incidence of complications.

In summary, superficial bladder tumor patients can benefit from transurethral and suprapubic laser surgery, as it can enhance clinical outcomes and is associated with good safety. It is worth promoting.

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