



Clinicopathologic and Oncological Outcomes in Korean Men With Advanced Metastatic Testicular Cancer Undergoing Postchemotherapeutic Retroperitoneal Lymph Node Dissection

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Purpose: To evaluate the clinicopathologic and oncological outcomes of advanced metastatic testicular cancer in Korean men who underwent retroperitoneal lymph node dissection (RPLND) following chemotherapy.

Materials and Methods: Data of 26 patients with testicular cancer who underwent RPLND after chemotherapy at 2 hospitals in Korea between September 2004 and June 2016 were retrospectively analyzed. Clinical and histopathological variables such as stage of the testicular cancer, age of the patients during surgery, size of the retroperitoneal lymph nodes (RPLNs), histopathological results, duration and complications related to the surgery, cancer recurrence, and mortality were analyzed.

Results: During testicular surgery, the T stage was pT1, pT2, and pT3 in 50% (n=13), 26.9% (n=7), and 15.3% (n=4) of the patients, respectively. Mixed germ cell tumor was the most common finding, seen in 73.1% (n=19) of patients. The indications for RPLND were residual lymph nodes after chemotherapy, 84.6% (n=22); and disease progression and remission, 7.7% (n=2). Pathological analysis revealed viable tumors in 19.2% of patients (n=5), necrotic/fibrotic tissue in 42.3% (n=11), and teratoma in 34.6% (n=9). Intraoperative and postoperative complications occurred in 23.1% (n=6) and 19.2% of patients (n=5). The median duration of follow-up was 27.5 months (interquartile range, 1.3–108.2 months); 11.5% (n=3) patients had recurrence, and 3.8% (n=1) died of progressive metastatic testicular cancer.

Conclusions: Viable germ cell tumors were present in 19.2% of patients with testicular cancer who underwent RPLND after chemotherapy. This is the first study of its kind in the Korean population. (*Korean J Urol Oncol* 2017;15:143-151)

Key Words: Testicular germ cell tumor • Postoperative complications • Lymph node excision

INTRODUCTION

Testicular cancer is a rare cancer occurring in men, with an incidence of approximately 1%.¹ However, it is one of the most common cancers among young men, and in Western countries, it is the most common urogenital cancer occurring in men between the ages of 20 and 40 years. The disease is also the sec-

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ond most widespread cancer among male adolescents, after leukemia.² Although the mortality rate is low, the incidence of testicular cancer is reportedly increasing in Western populations.³ According to the National Cancer Information Center in Korea, 230 cases of testicular cancer were reported in 2014. The incidence in Korea is reportedly less than that in Western countries; however, it is increasing in a manner similar to that in Western countries.⁴ Germ cell tumors (GCTs) are highly curable cancers when appropriately treated with multimodal therapy. Depending on the stage of the disease, orchidectomy, chemotherapy, and retroperitoneal lymph node dissection (RPLND) are used in combination.⁵ Lymph node metastasis from testicular cancer occurs primarily to the lymph nodes around the large vessels of the retroperitoneal cavity. The commonly involved lymph nodes are the precaval, paracaval, para-aortic, and preaortic lymph nodes.⁶ RPLND is commonly carried out after surgery and first-line chemotherapy in patients with metastatic testicular cancer, especially in those with advanced stage T2b disease. The procedure is indicated in patients who do not achieve complete remission after primary chemotherapy or cases in which the tumor contains a teratoma component. In patients with a metastatic GCT, residual retroperitoneal mass lesions persist in 2%–50% of the patients following chemotherapy.⁷⁻⁹ In such cases, RPLND is used as the primary treatment.¹⁰ RPLND can be performed through various approaches, which include open, laparoscopic, and robot-assisted procedures.¹¹ The overall long-term relapse-free survival after complete RPLND is reported to be over 90%.¹² If residual tissue remains, the risk of relapse increases, and the disease-specific survival rate is only 21%.¹³ However, there have been no such reports of patients in Korea.

The purpose of this study was to evaluate the clinicopathologic and oncological outcomes of advanced metastatic testicular cancer in Korean men who underwent RPLND following chemotherapy. Additionally, we sought to evaluate the treatment and prognosis of patients with metastatic testicular cancer in Korea.

MATERIALS AND METHODS

We retrospectively collected and analyzed the data of patients who underwent RPLND after chemotherapy at the Seoul National University Hospital and the Seoul National University Bundang Hospital between September 2004 and June 2016.

Data of 26 patients were included in this analysis. The most common systemic chemotherapy regimen administered was bleomycin, etoposide, and cisplatin (BEP) and was administered over 3 to 4 cycles. The indications for RPLND after chemotherapy in these patients were residual lymph nodes after chemotherapy, disease progression, and salvage after chemotherapy. Most patients underwent open RPLND, but several underwent robot- and hand-assisted laparoscopic RPLND. Follow-up physical examination, chest radiography, abdominal and pelvic computed tomography (CT), and measurement of serum tumor markers (human chorionic gonadotropin, α -fetoprotein, and lactate dehydrogenase) were performed every 3 months during the first 2 years and every 6 months during the third year. Subsequently, patients were followed up annually for up to 5 years postoperatively.

We analyzed clinical and pathological variables such as stage of the testicular cancer, age of the patients during surgery, size of the retroperitoneal lymph nodes (RPLNs), histopathological results of the testicular resection and RPLND, method followed for the RPLND, time taken for surgery, and operative complications. In addition, the oncological outcomes, such as the recurrence rate after RPLND, and the incidence of cancer-specific death were analyzed. Predictive factors were analyzed using multivariate logistical regression. The primary endpoint was the pathological result after RPLND, and the secondary endpoints were the oncological outcomes.

RESULTS

All 26 patients underwent RPLND after first-line chemotherapy. Patient characteristics are shown in Table 1. The median size of the largest RPLN was 2.75 cm (range, 2.20–4.50 cm), and the interquartile range (IQR) was 2.42–7.00 cm before and after chemotherapy. Twenty patients (76.9%) had an RPLN \geq 3 cm and 11 patients (42.3%) had metastasis to other sites as well. Most patients underwent platinum-based chemotherapy. BEP was the most commonly used chemotherapy regimen (18 patients, 69.2%). In addition, paclitaxel, ifosfamide, and cisplatin, and etoposide, ifosfamide, and cisplatin (VIP) regimens were also used. Twenty-one patients (80.7%) underwent 3 to 4 cycles of BEP chemotherapy. Three patients (11.5%) underwent 4 cycles of VIP chemotherapy. The remaining patients received alternative individualized chemotherapy, mostly combinations of BEP and VIP (Table 2).

Table 1. Characteristics of patients with testicular cancer undergoing postchemotherapy retroperitoneal lymph node dissection (RPLND) (n=26)

Variable	Value
Age (yr) at RPLND	25.5 (22.2–33.2)
Body mass index (kg/m ²)	23.03 (19.85–25.74)
ECOG performance status	
0	21 (80.8)
1	5 (19.2)
Primary tumor laterality	
Right	13 (50.0)
Left	13 (50.0)
Primary tumor size (cm)	4.25 (2.82–6.65)
Pathologic T stage	
pT0	1 (4.0)
pT1	13 (52.0)
pT2	7 (28.0)
pT3	4 (16.0)
Missing	1/26
Primary tumor stage (AJCC)	
I	3 (11.5)
II	5 (19.2)
III	18 (69.2)
Primary tumor pathology	
Seminoma	2 (7.7)
Nonseminoma	5 (19.2)
Mixed-GCT	19 (73.1)
Regimen of chemotherapy	
BEP	18 (69.2)
VIP	3 (19.2)
Combined	3 (73.1)
Maximal nodal size (cm)	
Prechemotherapy	4.45 (2.42–7.00)
Postchemotherapy (before RPLND)	2.75 (2.20–4.50)
Indication of RPLND	
Residual mass after chemotherapy	22 (84.6)
Progression after chemotherapy	2 (7.7)
Salvage treatment	2 (7.7)
Operation type	
Open	21 (80.8)
HALS	2 (7.7)
Robot-assisted	3 (11.5)
Operation time (min)	192.5 (152.5–267.5)
Estimated blood loss (mL)	275.0 (100–387.5)
Adjuvant procedures during surgery	9 (34.6)
RPLND pathology	
Viable GCT	5 (19.2)
Fibrotic tissue	11 (42.3)
Mature teratoma	10 (38.5)
Hospital stay (day)	9 (7–10)
Complications	
Intraoperative	6 (23.1)
Postoperative	5 (19.2)
Recurrence	3 (11.5)

Table 1. Continued

Variable	Value
Mortality	
All-cause	1 (3.8)
Cancer-specific	1 (3.8)
Follow-up duration (mo)	27.5 (1.3–108.2)

Values are presented as median (range) or number (%).

ECOG: eastern cooperative oncology group, AJCC: American Joint Committee on Cancer, GCT: germ cell tumor, BEP: bleomycin/etoposide/cisplatin, VIP: etoposide/ifosfamide/cisplatin, HALS: hand assisted laparoscopic surgery.

Twenty-one patients (80.8%) had an Eastern Cooperative Oncology Group (ECOG) performance status of grade 0, and 5 (19.2%) had an ECOG performance status of grade 1. The location of the primary tumor was the left testicle in 13 patients (50%) and the right testicle in 13 patients (50%). The median size of the primary tumor was 4.25 cm (range, 2.82–6.65 cm). At the time of testicular surgery, the most common T stage was T1, with stages pT1, pT2, and pT3 present in 13 patients (50%), 7 patients (26.9%), and 4 patients (15.3%), respectively. The histopathology of the primary tumor demonstrated a mixed GCT in 19 patients (73.1%), a nonseminomatous GCT in 5 patients (19.2%), and a seminoma in 2 patients (7.7%). As per the American Joint Committee on Cancer staging system, the disease stage at presentation was stage I in 3 patients (11.5%), stage II in 5 patients (19.2%), and stage III in 18 patients (69.2%). On CT, enlarged lymph nodes were found in the pre-aortic (76.9%), para-aortic (53.8%), interaortocaval (11.5%), paracaval (11.5%), and pelvic (23%) sites. In addition, one patient had renal hilar lymph node enlargement and 1 patient had retrocrural lymph node enlargement. The most common distant metastatic site was the lungs (12 patients, 46.1%). Liver metastasis was present in 1 patient (3.8%). The mean postoperative hospital stay was 9 days (range, 6–12 days).

The indications for RPLND were as follows: residual lymph nodes after chemotherapy in 22 patients (84.6%); disease progression and remission in 2 patients (7.7%); and salvage in 2 patients (7.7%). A total of 21 patients (80.8%) underwent open RPLND, 3 (11.5%) underwent robot-assisted RPLND, and 2 (7.7%) underwent hand-assisted laparoscopic RPLND. The mean time taken for surgery was 190 minutes (range, 120–400 minutes). Vascular injury was the most common intraoperative complication; inferior mesenteric artery sacrifice, inferior mesenteric vein sacrifice, inferior vena cava injury, and renal artery

Table 2. Detailed information of patients with testicular cancer undergoing post-chemotherapy retroperitoneal lymph node dissection (RPLND)

Case No.	Age at RPLND (yr)	Primary pathology	pTMN stage	Marker stage	Pre-/postchemotherapy LN size (cm)	Chemo-regimen/ cycles	RPLND pathology	Op type/ Op time (min)	Recurrence/ duration (mo)	Survival
1	31	Mixed GCT	pT2N2M1a	S1	4.3/2.9	VIP/4	Necrosis	Open/NA	No/7	Alive
2	31	Seminoma	pT1N0M0	S0	7.0/1.8	BEP/3	Necrosis	Open/370	No/52	Alive
3	24	Mixed GCT	pT2N2M0	S2	2.8/0.6	BEP/4	Necrosis	Open/400	No/56	Alive
4	23	Mixed GCT	pT1N3M1a	S2	6.4/4.5	BEP/4	Viable tumor	Open/180	No/57	Alive
5	18	Mixed GCT	pT1N3M1a	S3	7.0/7.0	BEP/4; TIP/4	Teratoma	Open/150	No/43	Alive
6	24	Mixed GCT	pT2N2M1a	S2	4/1.03	VIP/4	Necrosis	Open/230	No/44	Alive
7	34	Mixed GCT	pT3N3M0	S3	11.1/4.5	VIP/4	Necrosis	Open/120	No/37	Alive
8	25	Mixed GCT	pT1N1M0	S1	1.3/2.2	BEP/3	Teratoma	Open/190	No/9	Alive
9*	27	Yolk sac tumor	pT0N2M1a	S1	9.0/3.7	BEP/4	Necrosis	Open/320	No/3	Alive
10*	25	Teratoma	pT1N2M1a	S1	NA/2.6	BEP/4	Necrosis	HALS/180	No/2	Alive
11	26	Mixed GCT	pT1N2M0	S1	5.6/7.5	BEP/2; VIP/2	Teratoma	HALS/130	No/1	Alive
12	15	Mixed GCT	pT1N1M0	S1	2.3/4.4	BEP/3	Teratoma	Robotic/135	No/4	Alive
13	22	Mixed GCT	pT2N3M1a	S2	5.1/2.2	BEP/4	Necrosis	Open/245	No/31	Alive
14	22	IGCN	pTxN3M0	S2	11/6.6	BEP/4	Teratoma	Open/270	No/117	Alive
15	36	Embryonal carcinoma	pT3N2M1a	S1	3.5/2.3	BEP/4	Necrosis	Open/180	No/28	Alive
16	46	Mixed GCT	pT1N2M0	S0	4.1/2.0	BEP/5	Necrosis	Open/260	No/32	Alive
17	35	Mixed GCT	pT1N2M0	S1	4.0/2.4	BEP/4; TIP/4	Viable tumor	Open/195	No/13	Alive
18	22	Mixed GCT	pT3N2M1a	S2	3.2/4.0	BEP/4	Teratoma	Open/275	No/27	Alive
19	30	Mixed GCT	pT2N2M0	S2	2.3/2.9	BEP/3	Teratoma	Open/215	Yes/92	Alive
20	22	Mixed GCT	pT3N2M0	S2	4.8/5.1	BEP/4	Teratoma	Robotic/140	No/8	Alive
21	45	Teratocarcinoma	pT1NxMx	Sx	5/4.2	BEP/4; VIP/2	Viable tumor	Open/120	No/49	Alive
22	29	Mixed GCT	pT2N0M0	S1	1.7/1.5	BEP/3	Teratoma	Open/150	No/4	Alive
23	54	Mixed GCT	pT2N3M0	Sx	1.7/2.2	BEP/4	Teratoma	Robotic/160	No/4	Alive
24	31	Mixed GCT	pT1N3M0	S0	10/2.2	BEP/6	Viable tumor	Open/175	Yes/2	Dead
25	25	Mixed GCT	pT1N3M1b	S2	10/4.7	BEP/4	Necrosis	Open/195	No/89	Alive
26	41	Seminoma	pT1N2M1a	Sx	5.4/3.5	BEP/4; VIP/3	Viable tumor	Open/280	Yes/4	Alive

AliveLN: lymph node, Op: operation, GCT: germ cell tumor, VIP: etoposide/ifosfamide/cisplatin, BEP: bleomycin/etoposide/cisplatin, TIP: paclitaxel, ifosfamide, and cisplatin, HALS: hand assisted laparoscopic surgery, NA: no account.

*Postchemotherapy status.

injury each occurred in 1 patient (15.3%). One patient also had a splenic injury (3.8%). Adjuvant surgery was performed in 7 patients (26.9%); 3 patients (11.5%) underwent vascular surgery, and 1 patient (3.8%) each underwent nephrectomy, splenectomy, and video-assisted thoracoscopic metastasectomy. Postoperative complications included pleural effusion in 1 patient (3.8%), pneumothorax in 2 patients (7.7%), chylous ascites in 1 patient (3.8%), and arm weakness in 1 patient (3.8%). Histopathological analysis of the lymph nodes dissected during RPLND revealed viable tumors in 5 patients (19.2%). Necrotic/fibrotic tissue and teratoma were found in 11 patients (42.3%) and 10 patients (38.5%), respectively. Intraoperative and postoperative complications occurred in 6 patients (23.1%) and 5 patients (19.2%), respectively (Table 2).

The median follow-up duration was 27.5 months (IQR, 1.3–108.2 months). Three patients experienced a recurrence

(11.5%), and 1 patient (3.8%) died of progressive metastatic testicular cancer. Two of the 3 patients who had recurrence were found to have viable tumors at RPLND, and 1 of these patients died (the only death in our study). Patients with recurrence presented with interaortocaval lymph node, preaortic lymph node, para-aortic lymph node, and common iliac lymph node metastasis. At the time of recurrence, 2 patients had elevated lactate dehydrogenase (LDH) levels, and elevated LDH and alpha fetoprotein levels, respectively, and one had no elevated biomarker levels. The pathological results after RPLND for these patients were necrosis, viable tumor, and teratoma. One of 3 patients with recurrence underwent additional radiation therapy, and 2 underwent further observation.

Table 3 shows the response to preoperative chemotherapy according to pathology results of RPLND specimens. In the viable tumor group, the mean lymph node size before chemo-

Table 3. Outcomes after chemotherapy according to pathology results after retroperitoneal lymph node dissection (RPLND)

RPLND pathology	Necrosis (n=11)	Viable tumor (n=5)	Teratoma (n=10)	p-value
Lymph node size				
Prechemotherapy	5.6±2.6	7.2±2.8	3.9±3.0	0.217
Postchemotherapy	2.6±1.3	4.1±2.0	4.0±2.0	0.062
Lymph node change				0.001
No change	0 (0)	1 (20.0)	0 (0)	
Increase	0 (0)	0 (0)	7 (70.0)	
Decrease	11 (100)	4 (80.0)	3 (30.0)	
Lymph node location				
Prechemotherapy				
Preaortic	0 (0)	1 (20.0)	1 (10.0)	0.357
Para-aortic	10 (90.9)	4 (80.0)	7 (70.0)	0.478
Interaortocaval	7 (63.6)	5 (100.0)	3 (30.0)	0.031
Para-caval	1 (9.1)	2 (40.0)	1 (10.0)	0.236
Renal hilar	1 (9.1)	0 (0)	0 (0)	0.492
Pelvic	3 (27.3)	0 (0)	2 (20.0)	0.438
Postchemotherapy				
Preaortic	0 (0)	1 (20.0)	0 (0)	0.113
Para-aortic	9 (81.8)	4 (80.0)	7 (70.0)	0.800
Interaortocaval	8 (72.7)	3 (60.0)	2 (20.0)	0.048
Para-caval	1 (9.1)	1 (20.0)	0 (0)	0.381
Renal hilar	1 (9.1)	0 (0)	0 (0)	0.492
Pelvic	3 (27.3)	0 (0)	2 (20.0)	0.438
AFP prechemotherapy	1,356.6±2,287.9	361.6±333.8	1,433.2±2,589.8	0.953
AFP postchemotherapy	7.0±7.2	175.8±232.9	2.8±1.6	0.984
hCG prechemotherapy	22,658.9±60,981.8	21,941.5±45,919.4	2,376.4±7,107.7	0.306
hCG postchemotherapy	2.0±1.9	2.6±0.9	2.3±0.9	0.636
LDH prechemotherapy	638.6±854.3	571.6±421.8	313.4±197.4	0.223
LDH postchemotherapy	152.6±81.7	223.8±75.3	199.6±77.8	0.187

Values are presented as mean±standard deviation or number (%).

AFP: alpha fetoprotein, hCG: human chorionic gonadotropin, LDH: lactate dehydrogenase.

therapy was relatively large. The lymph node size decreased after chemotherapy in the necrosis group and the viable tumor group, but increased in the teratoma group. Seven patients showed increased lymph node size. Recurrent lymph node metastases were relatively common in the interaortocaval and para-aortic areas. Biomarker levels decreased in all groups after chemotherapy. There were some patients who were not normalized in the viable tumor group. Post-RPLND specimens in most patients showed viable and teratoma tumors. In 1 patient with a viable tumor and teratoma, 2 cycles of the VIP regimen were performed as post-RPLND chemotherapy.

Multivariate logistic regression analysis was performed to determine predictive factors for viable tumors, but no significant factor was identified.

DISCUSSION

RPLND after chemotherapy was first reported by Comisarow and Grabstald¹⁴ about 40 years ago. The authors recommended RPLND for relapse of primary disease after RPLND or after chemotherapy. With improvements in the efficacy and delivery of chemotherapy, a more recent study found that the rate of residual GCT at the time of RPLND has decreased, and the ratio of fibrosis and necrosis has increased; however, there is no difference in the frequency of teratomas.¹⁵ Additionally, several studies have reported a difference in survival rates depending on the final pathological results. Several researchers have tried to determine the predictive factors for pathological outcomes.¹⁶ They reported that although size is not a predictor, residual masses of about 2-cm size have potential for recurrence in 20%–33% of cases. This is the reason for performing RPLND when a residual mass is present.¹⁷

RPLND is associated with a low mortality rate, despite the complicated and difficult nature of the procedure. Gels et al.¹⁸ reported a mortality rate of <1%, while Nowroozi et al.¹⁹ reported a mortality rate of 0.8%–1%. Five other larger studies reported mortality rates of 1%. In agreement with the results in these reports, the mortality rate in our study was 1%.

With respect to complications associated with RPLND after chemotherapy, Baniel et al.²⁰ and Considine et al.²¹ reported complication rates of 18% and 29.5%, respectively. Maldonado-Valadez et al.²² and Nowroozi et al.¹⁹ reported complication rates of 57.1% and 20%–35%, respectively. Additionally, Djaladat et al.²³ and Steiner et al.²⁴ reported com-

plication rates of 35% and 43.8%, respectively.

In our study, intraoperative (23.1%) and postoperative complication rates (11.5%) were not significantly different from those obtained in previous studies. Clavien-Dindo classification grades 3 and 4 complications occurred in 19.2% of our patients. However, a high incidence of intraoperative and postoperative complications reflects the complexity of RPLND surgery. RPLND after chemotherapy is more challenging due to the extensive connective tissue response and distortion of tissue planes caused by the tumor. After chemotherapy, the residual tumor can invade other structures including the ureters and major blood vessels, such as the aorta and the vena cava. Therefore, additional surgeries following RPLND, such as nephrectomy, aortic replacement, vena cava resection, and ureter repair, may be necessary.²¹ Djalada et al.²³ reported that 30% of patients underwent additional surgery; 15% of patients underwent vascular surgery, and 14% underwent nephrectomy. Considine et al.²¹ reported that 28% of patients required further surgery including vascular surgery in 2.6% and nephrectomy in 20% of patients. In our study, adjuvant surgery was performed in 7 patients (26.9%); 11.5% underwent vascular surgery, and 3.8% underwent nephrectomy. Additionally, 1 patient each underwent lung surgery and splenic surgery.

With regards to pathology, several other studies have reported different prevalence rates for teratoma, necrosis and fibrosis, and viable tumors. Nakamura et al.²⁵ and Alane et al.²⁶ reported a probability of 9.0% and 43% for the presence of viable tumors, respectively, while several other studies have also reported viable tumors in 10%–40% of patients.^{21–27} In our study, the frequency of viable tumors was 19.2%, similar to that observed in previous studies. Compared to earlier studies, recent studies have shown that the percentage of patients with residual cancer after chemotherapy has declined, which could potentially be related to the improved efficacy and delivery of chemotherapy.

Fléchon et al.²⁷ reported a 4% relapse rate after post-chemotherapy RPLND 26 and Considine et al.²¹ reported a relapse rate of 18.5% with a median follow-up of 6.1 months (range, 1.3–39 months). The relapse rate after post-chemotherapy RPLND in our study was 11.5%, with a median follow-up of 30 months (range, 1–117 months), similar to that in the previous studies.^{15,23}

Several studies have reported different prevalence rates for fibrosis/necrosis, teratoma, and viable GCT (Table 4). In a his-

Table 4. Information regarding the relevant studies of patients with testicular cancer undergoing postchemotherapy retroperitoneal lymph node dissection (RPLND)

Study	Year	Country	Study design	No. of patients	Age (yr) at RPLND, median (range)	Primary histology	LN diameter (pre-/postchemotherapy)	Main chemo-regimen	% of viable tumors	FU duration (mo), median (range)
Maldonado-Valadez et al. ²²	2007	Germany	Retrospective	17	28 (25.5-38)	Mixed GCT	NA/2.05 (cm)	Cisplatin-based	17.6% (3/17)	26 (4-38)
Djalada et al. ²³	2012	U.S	Retrospective	85	30.2 (15-51)	Nonseninoma (68%)	NA/7.86 (cm)	BEP	32% (9/85)	18 (2-61)
Steiner et al. ²⁴	2013	Austria	Retrospective	100	29.6 (11.4-52.0)	Nonseninoma (100%)	3.5/1.4 (cm)	Cisplatin-based	about 20% (NA)	59 (1-222)
Nakamura et al. ²⁵	2015	Japan	Retrospective	156	NA	Nonseninoma (86.5%)	5.7/2.2 (cm)	Cisplatin-based	9.0% (14/156)	39.5 (1-169)
Sharma et al. ³⁰	2015	U.S	Retrospective	19	32 (28-39)	Nonseninoma (100%)	NA/2.1 (cm)	NA	NA (42%, teratoma)	24 (IQR, 5-76)
Considine et al. ²¹	2015	Ireland	Retrospective	78	28.5±7*	Nonseninoma (62.8%)	NA	BEP	11.5%	101 (11-207)
Alanee et al. ²⁶	2016	U.S	Retrospective	21	NA	NA	NA/5 (cm)	NA	43.0% (9/21)	58 (NA)
Singh et al. ²⁹	2016	India	Retrospective	35	26.8 (16-50)	Mixed GCT (54.3%)	8.8/5.4 (cm)	BEP	17.1% (6/35)	33 (9-60)
Present study	2016	Korea	Retrospective	26	25 (22-34)	Mixed GCT (73.1%)	4.45/2.75 (cm)	BEP	19.2 (5/26)	27.5 (1.3-108.2)

GCT: germ cell tumor, LN: lymph node, FU: follow-up, NA: no account, BEP: bleomycin/etoposide/cisplatin, IQR: interquartile range.

*Mean±standard deviation.

topathological comparison of RPLND specimens after chemotherapy with multiple chemotherapy regimens, Donohue⁵ reported fibrosis in 40%-45% of cases, teratoma in 40%-45% of cases, and viable GCT in 10%-20% of cases. Eggener et al.²⁸ and several other groups have also reported fibrosis/necrosis in 35%-51% of cases, teratoma in 21%-50% of cases, and viable GCT in 15%-28% of cases.¹⁵ In our study, fibrosis/necrosis was present in 42.3% of cases, teratoma was present in 38.5% of cases, and viable GCT was present in 19.2% of cases, similar to the findings in the previous studies.^{5,15} This is important clinical evidence regarding the treatment and prognosis of metastatic testicular carcinoma in Korean men.

Singh et al.²⁹ showed that the mean lymph node size before chemotherapy was 8.8 cm (range, 2.2-20.4) and the size after chemotherapy was reduced to 5.4 cm (range, 1.2-14.6 cm). The sites were the para aortic (40%), paracaval (34%), and inter-aortocaval (23%) lymph nodes. In our study, the overall lymph node size decreased after chemotherapy. In the case of teratoma, the overall lymph node size did not decrease, but increased instead. The para-aortic and interaortocaval lymph nodes were the most common sites, and paracaval and pelvis were similar (Table 3).

Predictive factors could not be identified in multivariate analysis because of the small sample size. This study is limited by its retrospective design and small sample size. Larger prospective studies in the future are needed to overcome these limitations. However, owing to the low incidence rate of viable GCT, conducting a study with a large sample size remains a challenge. We believe that in spite of these limitations, our study provides valuable insights about testicular cancer.

CONCLUSIONS

Viable GCT was present in 19.2% of tumor specimens from patients with testicular cancer who underwent RPLND after chemotherapy, and predictive factors for the presence of viable tumors were not identified. To our knowledge, this is the first study to provide important clinical evidence regarding the treatment and prognosis of metastatic testicular carcinoma in Korean men.

CONFLICT OF INTEREST

The authors claim no conflicts of interest.

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