Oncology and Translational Medicine
DOI 10.1007/s10330-021-0491-1

October 2021, Vol. 7, No. 5, P229–P234

ORIGINAL ARTICLE

Evaluation of endocrine therapy combined with intensity modulated radiation therapy in patients with advanced prostate cancer

Xiulong Ma[1], Hongbing Ma[1], Dongli Ruan[2] (✉)

[1] Department of Radiotherapy, The Second Affiliated Hospital, Xi'an Jiaotong University, Xi'an 710004, China
[2] Department of Urology, Xijing Hospital, Air Force Military Medical University, Xi'an 710032, China

Abstract

Objective The aim of this study was to study the effect of endocrine therapy combined with intensity-modulated radiation therapy in patients with advanced prostate cancer.

Methods The clinical data of 231 patients with advanced prostate cancer treated with radiotherapy in our hospital from May 2010 to March 2018 were collected. A total of 135 patients were treated with endocrine therapy combined with intensity-modulated radiotherapy, and 96 patients were treated with intensity-modulated radiotherapy only because of drug allergy, serious adverse reactions, and economic reasons. Two months after the end of the treatment, the short-term curative effect was evaluated using imaging reexamination. The total prostate-specific antigen (TPSA) and free prostate-specific antigen (FPSA) were detected before and 2 months after the end of the treatment. All patients were followed up for at least 3 years, and the metastasis-free survival rate and cumulative survival rate of the two groups were calculated.

Results The remission rates (RRs) of the observation and control groups were 64.45% and 46.87%, respectively; the difference was not statistically significant ($P > 0.05$); however, the efficacy distribution of the endocrine therapy combined with intensity-modulated radiotherapy group was significantly better than that of the intensity-modulated radiotherapy group ($P < 0.05$). There was no significant difference in clinical efficacy between the two groups in different TNM stages and Gleason grades. After treatment, the levels of TPSA and FPSA were significantly decreased compared with those before treatment; however, the decrease in the endocrine therapy combined with the intensity-modulated radiation therapy (IMRT) group was significantly higher than that in the IMRT group ($P < 0.05$). Although there were no significant differences in the 1-year and 3-year cumulative survival rates between the two groups, the 1-year and 3-year metastasis-free survival rates of the endocrine therapy combined with the IMRT group were 60% and 38.17%, respectively, which were significantly higher than those of the IMRT group (37.5% and 20.83%, $P < 0.05$).

Conclusion Endocrine therapy combined with IMRT significantly improved the clinical efficacy of advanced prostate cancer, reduced PSA (prostate specific antigen) levels, and improved the metastasis-free survival rates.

Received: 18 April 2021
Revised: 22 July 2021
Accepted: 10 August 2021

Key words: conformal intensity-modulated radiation; endocrine therapy; prostate cancer; metastasis-free survival rate

Prostate cancer is one of the most common malignant tumors of the urinary system. The incidence rate in recent years has been increasing [1–2]. In China, the incidence rate of prostate cancer is the highest among male urogenital tumors [3]. The main treatment methods for prostate cancer are surgical treatment, radiotherapy, and endocrinology. However, the overall age of the patients was large and combined with other internal diseases. Such patients are not suitable for radical prostatectomy, and some patients are unwilling to undergo surgery. Radiotherapy is the appropriate choice for these patients. Intensity-modulated radiation therapy (IMRT) is one of the standard therapies for prostate cancer. A large number of studies have confirmed that IMRT can increase the target dose, reduce the adverse reactions of normal tissues, and lead to an overall higher survival rate (OS) of patients [4–5].

✉ Correspondence to: Dongli Ruan. Email: 745501416@qq.com

This study aimed to investigate the effect of endocrine therapy combined with IMRT in patients with advanced prostate cancer.

Materials and method

General information

The clinical data of 231 patients with advanced prostate cancer treated with radiotherapy in our hospital from May 2010 to March 2018 were collected. The inclusion criteria were as follows: ①patients with a pathological diagnosis of prostate cancer who were not suitable for surgical treatment or unwilling to undergo surgery; ②positron emission tomography (PET) and MRI showed TNM stage III and IV. Exclusion criteria: ①chronic prostatitis and benign prostatic hyperplasia; ②brain metastasis occurred; ③ combined with malignant tumors from other sources; ④complicated with infection, heart, cerebrovascular, liver, kidney, and blood system and other serious primary diseases; ⑤complicated with severe urinary tract infection, urinary tract stenosis, bladder stones; ⑥other diseases associated with detrusor overactivity or detrusor physical and dysuria symptoms; and ⑦patients who had undergone surgical castration before treatment. Among the 231 patients, 135 were treated with endocrine therapy combined with intensity-modulated radiotherapy, and 96 were treated with intensity-modulated radiotherapy only because of drug allergy, serious adverse reactions, and economic reasons. There were no significant differences in age, TNM stage, Gleason score, and PSA level between the two groups (Table 1).

Treatment methods

IMRT: After simulated CT localization (Siemens as20 CT simulator), scanning from L4 to 3 cm below the ischial tubercle, with a slice thickness of 3 mm, the gross tumor volume (GTV), including the whole prostate, bilateral seminal vesicles, and pelvic lymph node drainage area, was delineated by CT scan and pelvic magnetic resonance imaging; the clinical target volume (CTV) was the same as the GTV. Based on the CTV, 1 cm was used as the planning target volume (PTV). After delineation of each target, the radiotherapy plan was made according to the actual situation of each patient. We used 6MeV X-ray, ptv2.23gy/time, 5 times/week, a total of 35 times, with a total dose of 78.05gy; 95% PTV volume received a dose ≥ 76 Gy. The V50 of adjacent sensitive organs such as the rectum and bladder was ≤ 50%, and the V50 of the femoral head (bilateral) was ≤ 5%.

Endocrine therapy: Goserelin Acetate Sustained-Release Depot, 3.6 mg, subcutaneous injection, once every 28d days, did not need to adjust the dose for patients with liver and kidney dysfunction and elderly patients; oral bicalutamide at a dose of 50 mg once per day, regular review of blood routine and liver function, when abnormal liver function occurred during treatment, the treatment was stopped. During the treatment, the drug can be stopped when the serum PSA level is less than 0.2 ng/mL and the lowest value is maintained for 3–6 months. Half a year after drug withdrawal, the total prostate-specific antigen (TPSA) and free prostate-specific antigen (FPSA) were reexamined once a month, half a year later, every two months, and every three months after two years. If biochemical recurrence occurred during the follow-up period (Serum PSA exceeds the minimum value of 2ng/mL), the drug can be used according to the above methods.

Observation indexes

Two months after the end of the treatment, the short-term curative effect was determined by the evaluation results of the imaging reexamination [6]. Complete remission (CR): the tumor completely subsided and was maintained for more than 4 weeks, partial remission (PR): tumor regression ≥ 50% and maintained for more than 4 weeks; no change (NC), tumor regression < 50% or increase < 25%, progression of disease (PD): tumor enlargement ≥ 25% or new lesions. The total remission rate (RR) was calculated using the Cr and PR.

TPSA and FPSA levels were detected before and 2 months after treatment. All patients were followed up by telephone or through in-hospital follow-up, including clinical follow-up, PSA monitoring, imaging examination, treatment-related complications, and evaluation of the quality of life. Generally, they were followed up every 3 months within the first 2 years and every 6 months after the first 2 years. If any abnormality is found during follow-up, the follow-up interval should be shortened if necessary. All patients in this study were followed up for at least 3 years to calculate the metastasis-free survival rate and the cumulative survival rate.

Table 1 Comparison of general condition between two groups before treatment

Groups	Number of cases	Age (years)	Gleason score	TPSA (ng/mL)	FPSA (ng/mL)
Observation	135	72.36 ± 8.66	7.385 ± 0.664	315.62 ± 135.37	165.83 ± 78.51
Control	96	73.89 ± 10.28	7.28 ± 1.67	296.45 ± 103.86	152.35 ± 81.96
t value		35.381	15.14	76.342	48.233
P value		0.851	0.135	0.885	0.286

Statistical methods

SPSS 22.0 was used to analyze and process the data. Continuous data were expressed as the mean and standard deviation while categorical data were expressed as frequencies and percentages (%). The comparison of RR, metastasis-free survival rate, and cumulative survival rate between groups was performed using the chi-square test. Comparisons between groups were performed using the *t*-test for continuous variables. The efficacy distributions of CR, PR, NC, and PD were analyzed using the rank-sum test for categorical data. The threshold for statistical significance was set at $P \leq 0.05$.

Results

Comparison of clinical efficacy between the two groups

The RR of the observation group and the control group were 64.45% and 46.87%, respectively ($\chi^2 = 3.65$, $P > 0.05$). However, the efficacy distribution of endocrine therapy combined with IMRT was significantly better than that of IMRT alone ($z = 4.15$, $P < 0.05$; Table 2).

Comparison of the clinical efficacy of the two groups in different stages and grades (Table 3 and 4)

There was no significant difference in RR between the IMRT + endocrine therapy and IMRT groups in stage III and IV patients ($\chi^2 = 2.76$, $P = 0.38$). There was no significant difference in RR between the IMRT + endocrine therapy and IMRT groups in Gleason grades 4 and 5 patients ($\chi^2 = 3.25$, $P = 0.57$).

Comparison of PSA levels between the two groups before and after treatment (Table 5)

Before treatment, there was no statistically significant difference between the levels of TPSA and FPSA in the two groups ($P > 0.05$). After treatment, PSA levels in both groups decreased significantly; however, TPSA and FPSA levels in the IMRT + endocrine therapy group decreased more significantly than those in the IMRT group ($P < 0.05$).

Comparison of adverse reactions between the two groups (Table 6)

The common adverse reactions of the two groups were acute bladder irritation symptoms such as frequent micturition, urgency, and pain of micturition; intestinal irritation symptoms such as diarrhea, constipation, and abdominal pain; Grade 1–2 skin reactions such as erythema and pigmentation in the treatment area; anemia, leukopenia, thrombocytopenia, and other myelosuppression reactions. Most of the adverse reactions were grade 1–2, and most patients could tolerate them. A few patients with severe symptoms were treated with active symptomatic treatment, and the symptoms were significantly relieved. All patients could cooperate to complete the entire course of treatment. There was no significant difference in bladder irritation, intestinal irritation, grade 1–2 skin reaction, and grade 1–2 myelosuppression between the two groups during the follow-up period.

Comparison of the survival rates between the two groups (Table 7)

There were no significant differences in the 1-year and 3-year cumulative survival rates between the two groups

Table 2 Comparison of clinical efficacy between the two groups [*n* (%)]

Groups	Number of cases	CR	PR	NC	PD	RR
Observation	135	26 (19.26)	61 (45.19)	39 (28.88)	9 (6.66)	87 (64.45)
Control	96	10 (10.42)	35 (36.46)	32 (33.33)	19 (19.79)	45 (46.87)

Table 3 Comparison of the clinical efficacy of two groups in different stages [*n* (%)]

Groups	TNM stage	Number of cases	CR	PR	NC	PD	RR
Observation	III	72	17 (23.61)	41 (56.94)	14 (19.44)	0 (0.00)	58 (80.55)
	IV	63	9 (14.29)	20 (31.75)	25 (39.68)	9 (14.29)	29 (46.03)
Control	III	52	7 (13.46)	21 (40.38)	20 (38.46)	4 (7.69)	28 (53.84)
	IV	44	3 (6.82)	14 (31.82)	12 (27.27)	15 (34.09)	17 (38.64)

Table 4 Comparison of the clinical efficacy of two groups with different grades [*n* (%)]

Groups	Gleason grade	Number of cases	CR	PR	NC	PD	RR
Observation	4	54	17 (31.48)	26 (48.15)	8 (14.81)	3 (5.56)	43 (79.63)
	5	81	9 (11.11)	35 (43.21)	31 (38.27)	6 (7.41)	44 (54.32)
Control	4	46	6 (13.04)	19 (41.30)	20 (43.48)	1 (2.17)	25 (54.35)
	5	50	4 (8.00)	16 (32.00)	12 (24.00)	18 (36.00)	20 (40.00)

($P > 0.05$); however, the 1-year and 3-year metastasis-free survival rates of the IMRT + endocrine therapy group were 60% and 38.17%, respectively, which were significantly higher than those of the IMRT group (37.5% and 20.83%, $P < 0.05$).

Discussion

With the increasingly prominent aging phenomenon, the number of prostate cancer patients is increasing. Prostate cancer is one of the main causes of male deaths in European and American countries [7]. Especially in advanced prostate cancer, some patients often miss the best treatment time, and the prognosis is often poor [8]. The choice of safe and effective treatment for elderly patients with prostate cancer has also aroused widespread concern. Fan *et al.* [9] conducted a 10-year follow-up of laparoscopic radical prostatectomy for elderly patients with prostate cancer over 80 years of age and concluded that radical prostatectomy is not suitable for elderly patients above the age of 80 years. Radical radiotherapy is considered the standard treatment for localized prostate cancer. At present, comprehensive treatment based on it plays an important role in reducing the recurrence rate and improving the quality of life of patients with prostate cancer. Wang Xing *et al.* [10] found that compared with simple castration, radiotherapy combined with drug castration can effectively prolong the PFS and OS of elderly patients with advanced prostate cancer.

At present, external radiotherapy for prostate cancer mainly includes stereotactic radiotherapy (SBRT) and IMRT. It has a good curative effect, wide indications, few complications; it is also safe and effective. It is one of the most important treatment methods for patients with prostate cancer. For locally advanced prostate cancer, ionizing radiation can kill and destroy the cancer tissue to different degrees, thereby reducing the tumor volume. In view of the large radiation dose and relative complexity of SBRT, some researchers have questioned its safety [11]. There are also studies showing that [12] SBRT is cheaper and more convenient and suitable for replacement therapy for localized prostate cancer. Hamdy *et al.* [13] compared the quality of life of patients with SBRT and radical prostatectomy through prospective research and found that the two treatment methods were associated with decreased quality of life of urination and intestinal tract within 1 month. The quality of life of SBRT patients gradually recovered 6 months after treatment and recovered 36 months after treatment. The quality of life scores of radical prostatectomy patients at all time points was lower than the baseline level. With the continuous improvement of radiotherapy technology and medical equipment, IMRT advocates that different doses can be obtained by different target areas through the output of non-uniform radiation doses, which can moderately increase the local radiation dose of the tumor and the total radiation dose of the target area, and reduce the radiation dose to surrounding normal tissues and organs (such as the rectum and the bladder). It is superior to conventional

Table 5 Comparison of PSA levels between the two groups before and after treatment

Groups	TPSA (ng/mL)		FPSA (ng/mL)	
	Before treatment	After treatment	Before treatment	After treatment
Observation	70.46 ± 13.46	15.25 ± 4.87	13.56 ± 3.94	2.67 ± 0.59
Control	60.35 ± 12.86	31.98 ± 5.36	12.89 ± 2.63	3.86 ± 0.73
t value	0.26	16.35	0.38	12.36
P value	> 0.05	< 0.05	> 0.05	> 0.05

Table 6 Comparison of adverse reactions between the two groups [*n* (%)]

Groups	Number of cases	Bladder irritation	Intestinal irritation	Grade 1-2 skin reaction	Grade 1-2 myelosuppression
Observation	135	59 (43.7)	32 (23.7)	49 (36.3)	50 (37.0)
Control	96	35 (36.46)	16 (16.67)	26 (27.08)	29 (30.21)
χ^2 value		8.213	1.69	2.17	1.16
P value		> 0.05	> 0.05	> 0.05	> 0.05

Table 7 Comparison of survival rate between the two groups [*n* (%)]

Groups	Number of cases	Metastasis free survival rates		Cumulative survival rates	
		1 year	3 years	1 year	3 years
Observation	135	81 (60)	50 (38.17)	125 (92.59)	85 (62.96)
Control	96	36 (37.5)	20 (20.83)	86 (89.58)	51 (53.13)
χ^2 value		4.35	6.27	0.17	0.68
P value		< 0.05	< 0.05	> 0.05	> 0.05

and three-dimensional radiotherapy in increasing the radiation dose and controlling rectal radiation [14]. The EAU prostate cancer guidelines also pointed out that [15] simple transperineal continuous low-dose brachytherapy is a clear, reliable, and reproducible modality for the treatment of low-risk prostate cancer. There are also a few cases in our center with good clinical effects. Due to the small sample size, we need to increase the sample size and draw a conclusion after long-term follow-up. In this study, IMRT was used in both groups and had a good clinical effect. The PSA level was significantly lower than that before treatment, and there was no significant difference in the cumulative survival rate between the two groups.

Androgen dependence is the basis for endocrine therapy for prostate cancer. Reducing androgen levels and inhibiting the synthesis of androgens by the adrenal glands can help to inhibit the conversion of testosterone to dihydrotestosterone, block the binding of androgens and androgen receptors to a certain extent, and inhibit or control the growth of prostate cancer cells. Mandel [16] conducted a randomized, double-blind, parallel controlled trial on 1218 patients with hormone-sensitive and non-metastatic prostate cancer. The results of long-term survival analyses revealed that compared with placebo, oral bicalutamide (150 mg) once a day can reduce the mortality of locally progressive prostate cancer, improve the overall survival rate, and prolong the average survival time of 1.8 years. However, bicalutamide did not improve the survival of patients with localized prostate cancer. In this study, goserelin acetate sustained-release depot combined with bicalutamide was used for endocrine therapy, which can help to reduce the serum androgen level of patients with prostate cancer, promote the death of androgen-sensitive cells *in vivo*, inhibit tumor growth, alleviate tumor metastasis to a certain extent, inhibit the proliferation of cancer cells after radiotherapy, and enhance the effect of radiotherapy. According to the results of this study, although there was no significant difference in clinical efficacy between the IMRT + endocrine therapy group and the IMRT group, the levels of TPSA and FPSA decreased more significantly than those in the IMRT group, and the 1-year and 3-year metastasis-free survival rates were significantly higher than those in the IMRT group, with the differences being statistically significant.

PSA, as a specific biomarker of prostate cancer, can be increased in prostate cancer, benign prostatic hyperplasia, prostatitis, and other non-malignant diseases. Compared with digital rectal examination and transrectal prostate ultrasound, PSA is a better predictor of prostate cancer; however, the correlation between PSA levels and prostate cancer risk in Chinese men is significantly weaker than that in Western countries [17]. The main purpose of prostate cancer screening with PSA as the main detection method is to reduce the mortality of prostate cancer in the screening population without affecting the quality of life of the population [18]. The basic purpose of prostate cancer follow-up is to detect changes in serum PSA levels after treatment. The prostate gland still exists after radiotherapy; therefore, the PSA level decreases slowly. PSA may reach its lowest value 3 years after the end of radiotherapy. At present, there is still controversy regarding the optimal cut-off value for determining the prognosis of the lowest PSA level after radical radiotherapy. Generally, the lower the cut-off value, the higher the cure rate. It is generally believed that the prognosis of patients with the lowest PSA level reaching 0.5 ng/m after 3–5 years is better [19]. Whether endocrine therapy was used at the same time, biochemical recurrence was considered when the PSA level exceeded the minimum PSA level of ≥ 2ng/mL after radiotherapy [20]. The follow-up PSA level in this study was limited to the change in PSA level two months after treatment. The levels of TPSA and FPSA in the IMRT + endocrine therapy group decreased more significantly than those in the IMRT group ($P < 0.05$). The follow-up of PSA was not comprehensive, and no further studies were carried out; however, no biochemical recurrence was found during the follow-up period.

Common acute complications of external radiotherapy include frequent micturition, urgency of micturition, nocturia, hematuria, diarrhea, tenesmus, hematochezia, and perianal skin ulceration; these symptoms generally disappear a few weeks after radiotherapy, which is a reversible pathological change [21–22]. The most obvious delayed complication of external radiotherapy is rectal bleeding; however, less than 1% of rectal bleeding seriously affects life and requires surgical treatment. Other possible complications include hemorrhagic cystitis, which generally improves after nonsurgical treatment [21–22]. Compared with surgical treatment, radiotherapy rarely causes urinary incontinence and urethral stricture and has less effect on erectile function than surgical treatment. Retrospective studies have shown that radiotherapy for prostate cancer can increase the risk of rectal cancer and bladder cancer; however, these small-probability adverse events do not affect the choice of radiotherapy for prostate cancer patients [21–22]. There was no significant difference in the incidence of complications between the two groups. After giving positive symptomatic treatment, they were significantly improved and could complete the entire course of the treatment.

In conclusion, endocrine therapy combined with intensity-modulated radiotherapy has a good clinical effect on patients with advanced prostate cancer; the decrease in PSA levels and the 1-year and 3-year metastasis-free survival rates are significantly improved. However, the long-term prognostic effect still needs to be

determined after follow-up.

Conflicts of interest

The authors indicated no potential conflicts of interest.

References

1. Chen W, Zheng R, Baade PD, *et al*. Cancer statistics in China, 2015. CA Cancer J Clin, 2016, 66: 115–132.
2. Pang C, Guan Y, Li H, *et al*. Urologic cancer in China. Jpn J Clin Oncol, 2016, 46: 497–501.
3. Su Q, Li L, Zhang M. Diagnostic values of SI, TPSA and FPSA for prostate cancer. Labeled Immunoassays Clin Med, 2018, 25: 445–449.
4. Luo HC, Cheng HH, Fu ZC, *et al*. The clinical effects for the prostate cancer patients treated reduced clinical target volume of intensity-modu-lated radiotherapy. J Clin Oncol, 2016, 21: 1019–1023.
5. Liu YP, Xu J, Zhang LS, *et al*. An analysis of interfractional and intrafractional prostate motion in hypofractionated precise radiotherapy for prostate cancer. Chin J Radiat Oncol (Chinese), 2016, 25: 1199–1203.
6. Dell' Oglio P, Zaffuto E, Boehm K, *et al*. Long-term survival of patients aged 80 years or older treated with radical prostatectomy for prostate cancer. Fyr J Surg Oncol, 2017, 43: 1581–1588.
7. Kaufman HL, Wang W, Manola J, *et al*. Phase II randomized study of vaccine treatment of advanced prostate cancer (E7897): a trial of the Eastern Cooperative Oncology Group. J Clin Oncol, 2016, 22: 2122–2132.
8. Ward JF, Slezak JM, Blute ML, *et al*. Radical prostatectomy for clinically advanced (cT3) prostate cancer since the advent of prostate-specific antigen testing: 15-year outcome. BJU Int, 2015, 95: 751–756.
9. Zhang F, Zhang SD, Xiao CL, *et al*. Perioperative parameters and prognosis analysis of patients aged 80 years or older treated with radical prostatectomy for prostate cancer. Acta Sci Nat Univ Pekinensis, 2018, 50: 822–827.
10. Wang X, Jiang Z, Rong WW. Efficacy and safety of drug castration with radiotherapy in treatment of prostate cancer. China J Modern Med (Chinese), 2020, 30: 111–116.
11. Zhao SG, Chang SL, Spratt DE, *et al*. Development and validation of a 24-gene predictor of response to postoperative radiotherapy in prostate cancer: A matched, retrospective analysis. Lancet Oncol, 2016, 17: 1612–1620.
12. Gao QN. Stereotactic body radiation therapy versus conventional intensity-modulated radiation therapy for the treatment of prostate cancer. Nat J Androl, 2019, 25: 424–429.
13. Hamdy FC, Donovan JL, Jane JA, *et al*. 10-year outcomes after monitoring, surgery, or radiotherapy for localized prostate cancer. N Engl J Med, 2016, 375: 14–15.
14. Zheng J, Tao LS, Chen YS, *et al*. Clinical analysis of intensity modulated radiotherapy combined with endocrine therapy for 42 patients with advanced prostate cancer. Int J Urol Nephrol, 2017, 37: 70–73.
15. Mottel N, Bellmunt J, Briers E, *et al*. EAU gulidlines on prostate cancer. 2017, [2017-04-22].
16. Mandel P, Kriegmair MC, Kanphake JK, *et al*. Tumor characteristics and oncologic outcome after radical prostatectomy in men 75 years old or older. J Urol, 2016, 196: 89–94.
17. Chen R, DD Sjoberg, Huang Y, *et al*. Prostate specific antigen and prostate cancer in Chinese men undergoing initial prostate biopsies compared with Western cohorts. J Urol, 2017, 197: 90–96.
18. Fleshner K, Carlsson SV, Roobol MJ . The effect of the USPSTF PSA screening recommendation on prostate cancer incidence patterns in the USA. Other, 2017, 14.
19. Ray ME, Thames HD, Levy LB, *et al*. PSA nadir predicts biochemical and distant failures after external beam radiotherapy for prostate cancer: a multi-institutional analysis. Int J Radiat Oncol Biol Phys. 2006, 64: 1140–1150.
20. Iii MR, Hanks G, Thames H, *et al*. Defining biochemical failure following radiotherapy with or without hormonal therapy in men with clinically localized prostate cancer: recommendations of the RTOG-ASTRO Phoenix Consensus Conference. Int J Radiat Oncol Biol Phys, 2006, 65: 965–974.
21. Matzinger O, Duclos F, Bergh A, *et al*. Acute toxicity of curative radiotherapy for intermediate- and high-risk localised prostate cancer in the EORTC trial 22991. Eur J Cancer, 2009, 45: 2825–2834.
22. Rma B, Crc C, Mf D, *et al*. Pelvic complications after prostate cancer radiation therapy and their management: an international collaborative narrative review. Eur Urol, 2019, 75: 464–476.

DOI 10.1007/s10330-021-0491-1
Cite this article as: Ma XL, Ma HB, Ren DL. Evaluation of endocrine therapy combined with intensity modulated radiation therapy in patients with advanced prostate cancer. Oncol Transl Med, 2021, 7: 229–234.