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NEoAdjuvant radiohormonal therapy versus standard of care for oligometastatic prostate cancer (NEAR-TOP): study protocol of a multicenter, open-label, randomised controlled trial

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Abstract

Background Metastatic prostate cancer is commonly treated with androgen deprivation therapy (ADT) and chemotherapy, which often leads to treatment resistance and disease progression with limited effective interventions. Recent advances in robotic surgery and precision radiotherapy have prompted research into comprehensive treatments for low-burden metastatic prostate cancer, particularly oligometastatic prostate cancer (OMPC). Our phase I/II clinical study confirmed the safety and efficacy of neoadjuvant radiotherapy combined with endocrine therapy before radical prostatectomy, warranting further investigation.

Methods This study protocol outlines a prospective, open-label, multicenter, randomized controlled trial to evaluate preoperative neoadjuvant radiohormonal therapy versus standard care in OMPC. The experimental group receives LHRHa, abiraterone, IMRT for pelvic lesions, and SBRT for extrapelvic lesions, followed by RARP and lymph node dissection. The control group receives long-term LHRHa and abiraterone. The primary endpoint is 3-year failure-free survival (FFS), and secondary endpoints include time to CRPC, 2-year FFS, OS, TRG rating, and complications.

Conclusion This trial is the first to assess whether neoadjuvant radiohormonal therapy with robotic prostatectomy offers better prognostic outcomes than long-term endocrine therapy alone for OMPC. The results aim to provide high-level evidence for this approach, potentially influencing future treatment protocols.

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Trial registration The study has been registered on clinicaltrials.gov (NCT05707468). Registered on February 1, 2023.

Keywords Oligometastatic prostate cancer, Preoperative radiotherapy, Robotic-assisted, Radical prostatectomy, Endocrine therapy, Prognosis

Introduction

Prostate cancer (PCa) is the second most common malignancy in males globally [1]. In China, while its overall occurrence is relatively lower than in Europe and the Americas, there has been a significant surge in the past two decades, making it the predominant urological tumor among Chinese males [2]. Disease categorization includes organ-confined, locally advanced, or metastatic stages [3].Radical Prostatectomy (RP) is consistently recommended as one of the standard treatments for PCa in international urological guidelines. In locally advanced cases with limited metastasis, current approaches involve extended ADT and chemotherapy, but resistance often develops, necessitating alternative strategies [4]. Metastatic PCa traditionally treated with ADT alone has a median survival time of 42 months [5]. Recent large-scale trials show that combining ADT with novel endocrine therapies or chemotherapy significantly improves the prognosis of metastatic hormone-sensitive prostate cancer (mHSPC) [6]. In cases of limited metastases, the population with OMPC [7]is anticipated to benefit from a combination of systemic and localized therapies [8]. However, a lack of large prospective clinical studies exists for the comparative validation of prognostic indicators, necessitating further exploration to determine the optimal treatment approach for OMPC.

In the last two decades, radiotherapy advances, including IMRT and SBRT, have been widely used for tumor treatment [9]. Preoperative radiotherapy has demonstrated efficacy in advanced malignancies, offering improved tumor control and reduced toxicity compared to postoperative radiotherapy or systemic therapy alone, as seen in colorectal and pancreatic cancer [10]. For advanced prostate cancer, combining radiotherapy targeting the primary tumor or metastases is suggested to yield superior oncologic outcomes than ADT alone [11]. Combining the results from the HORRAD, STAMPEDE, and STOPCAP meta-analyses, radiotherapy (RT) combined with ADT has shown a survival advantage over ADT alone in patients with low-volume disease [12–14]. Additionally, the ORIOLE and STOMP trials demonstrated improvements in median progression-free survival (PFS) and median ADT-free survival, respectively [15]. The potential value of Robotic-Assisted Radical Prostatectomy (RARP) in focal progressive PCa shows promise in tumor control and complications. Further research is needed to determine if systemic preoperative and postoperative therapies can synergistically benefit patients with advanced PCa. Research increasingly supports the achievements of RARP in tumor control, postoperative quality of life recovery, and complication management for early and locally advanced PCa [16]. Recent international guideline updates underscore surgery's incorporation as a comprehensive treatment for localized advanced PCa, reinforcing the growing importance of robotic surgical systems in PCa treatment, widely acknowledged for their efficacy in the medical community.

Building on the above, our team conducted an early-phase clinical trial (Phase I/II) evaluating neoadjuvant radiotherapy for OMPC [17]. Results demonstrate that, in conjunction with innovative initial hormone-based treatment, the precise use of preoperative radiotherapy, specifically "IMRT and SBRT" for primary and secondary cancer sites, combined with targeted robotic prostate gland removal, exhibited positive tolerance in OMPC individuals. The outcomes of our preliminary examination exhibited remarkable rates of radiographic progression-free survival that surpass significantly the findings documented in existing literature concerning initial treatment protocols centered exclusively on endocrine treatment or chemotherapy. Based on these results, our team aims to lead a prospective multicenter RCT named NEoAdjuvant Radiohormonal Therapy for OMPC (NEAR-TOP) to further explore the regimen's efficacy, assess potential survival benefits compared to first-line treatments, and validate its clinical application.

Materials and methods

Study design

The NEAR-TOP study is a prospective, open-label, multicenter prospective RCT of preoperative neoadjuvant radiotherapy versus standard of care for OMPC. Approximately 174 patients will be recruited at six tertiary hospital centers in China (The Second Affiliated Hospital of Naval Medical University, The First Affiliated Hospital of Naval Medical University, The First Affiliated Hospital of Ningbo University, The First Affiliated Hospital of Soochow University, The First Affiliated Hospital of Guangzhou Medical University, and The First Affiliated Hospital with Nanjing Medical University). All participating centers have extensive experience in urologic oncology and robotic surgery. This trial is designed to evaluate the safety and efficacy of preoperative radiation hormone therapy versus ADT combined with a novel androgen receptor axis-targeted therapeutic agent (ARTA) in patients with OMPC. The study was divided into a screening period, a treatment period and a follow-up period.The trial program is illustrated in Fig. 1.

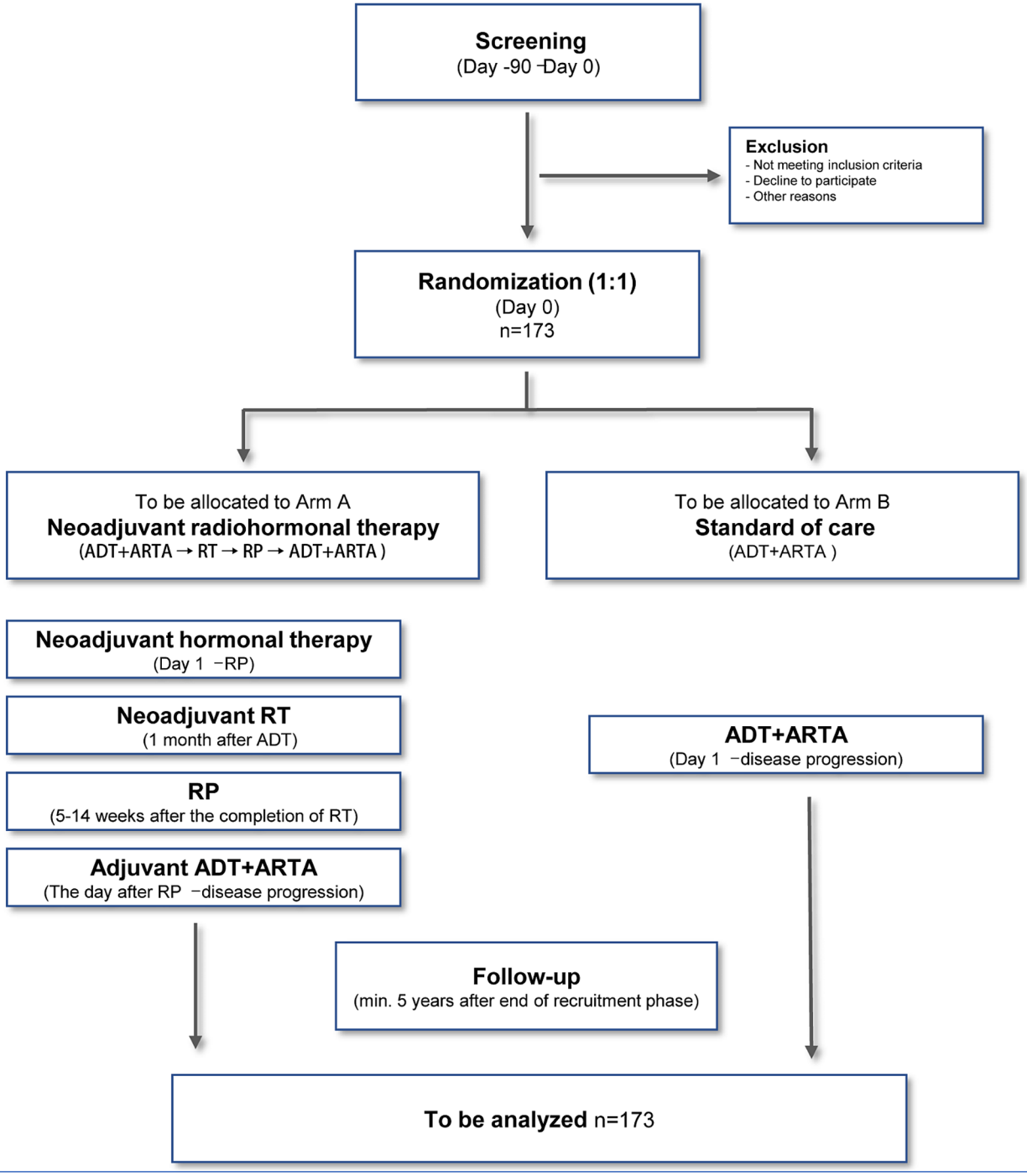

Fig. 1 Flowchart of the clinical trial protocol for oligometastatic patients. 174 patients underwent a screening period, a treatment period, and a follow-up period, and finally the collected data were analyzed

Patient

Screening assessments will be performed within 90 days before study entry. Patients who are willing to participate the trial will sign an informed consent form (see Additional file 1 for informed consent form) before undergoing the screening evaluation. Eligible participants include those with histologically confirmed, newly diagnosed, and treatment-naive OMPC. We aim to recruit approximately 174 patients with OMPC.

Patient and public involvement

After contacting eligible patients, the research team inquired whether they were interested in participating in the study. The team discussed the inclusion criteria

with the patients and their families, obtained informed consent (see attached), and conducted evaluations based on the individual standards and standard operating procedures of the departments of anesthesiology and urology. Patients did not participate in the development and design of the study protocol. The general public was not involved. Study results will not be specifically provided to the participants. However, if participants express interest in the findings, they will receive any related information, papers, and published research results in the future.

Study consistency management

To maintain study consistency, centers will have 1–2 surgeons experienced in over 500 robotic surgeries. An expert group of imaging, radiotherapy, pathology, and urology specialists will review patient data before the study begins. For disease progression, this group will decide on salvage treatment strategies.

Inclusion criteria

Eligible patients must meet all of the following criteria:

- Life expectancy ≥ 5 years.
- Age ≤ 75 years.
- Adenocarcinoma of the prostate diagnosed by prostate biopsy.
- Oligometastases (including bone, nonregional lymph node metastases above the level of the renal artery, number ≤ 3) ± lymph node metastases (pelvic or retroperitoneal lymph nodes not exceeding the level of the renal artery) as assessed by whole-body bone scan (ECT) and ^{68}Ga/^{18}F PSMA-PET/CT (ANY cT, N, M1b (met ≤ 3)).
- Tumors that have been jointly evaluated by a panel of experts as initially or resectable with neoadjuvant therapy.
- Patients who volunteered for this experimental study protocol after being informed of the available treatment options.

Exclusion criteria

Patients who met any of the following criteria are not eligible for this trial:

- Patients who have undergone any previous treatments related to prostate cancer, such as radiotherapy, chemotherapy, endocrine therapy, or focal therapy;
- Patients who have undergone prior transurethral resection or enucleation of the prostate;
- Pathology that includes small cell or neuroendocrine tumor components;
- Patients who have undergone other abdominal surgery within the last 3 months;
- Patients who underwent transrectal prostate biopsy less than 2 weeks ago;
- Patients on long-term anticoagulant and antiplatelet aggregation drugs (anticoagulant discontinued for less than 1 week);
- Patients with other malignancies, or in the acute phase of infection or other severe infections; Patients who are positive for immunodeficiency virus (HIV), hepatitis C virus (HCV) and/or syphilis spirochetes;
- Patients with concurrent serious systemic diseases that, in the investigator's judgment, might impede the treatment, evaluation, and compliance with this trial are excluded. These conditions encompass severe respiratory, circulatory, neurological, psychiatric, gastrointestinal, endocrine, immunological, and urological systemic disorders. Additionally, individuals deemed incapable of tolerating general anesthesia for surgery based on the pre-anesthesia evaluation are also excluded;
- Patients with contraindications related to radiotherapy;
- Patients who, in the judgment of the investigator, are deemed inappropriate for participation in this clinical trial;
- Patients unwilling to undergo RALP for PCa;

Intervention

Arm A

1) ADT phase: abiraterone acetate 1000 mg orally 1/day plus prednisone 5 mg orally 2/day and LHRHa (such as goserelin acetate 3.6 mg subcutaneously for 1 month or 10.8 mg subcutaneously for 1/3 month).
2) Preoperative radiotherapy phase: One month after the start of endocrine therapy, IMRT is given the prostatic fossa, regional lymph nodes and bone metastases in irradiation area. According to the results from the phase I/II trial, 54 Gy with 30 fractions is recommended for prostatic fossa and regional lymph node metastases, 65 Gy with 25 fractions for bone metastases, 45 Gy with 25 fractions for whole pelvic. For non-pelvic oligometastatic lesions, SBRT will be administered. 6–8 Gy per fraction with 4–8 fractions is the recommended dose segmentation, which will depend on the surrounding OARs (Organs at Risk) and tumor size.
3) Surgery phase: Transabdominal multichannel robotic RP for PCa using the da Vinci Si or Xi platforms. The procedure involves intraoperative bilateral extrafascial resections with non-sexual nerve preservation. Additionally, it includes concomitant enlarged pelvic lymph node dissection, encompassing bilateral paracentral obliteration

of the obliterating nerves, paracentral internal iliac arteries, paracentral external iliac arteries, and paracentral common iliac arteries. Clinically positive retroperitoneal lymph nodes that do not extend beyond the plane of the renal arteries are also addressed during the lymph node dissection.

4) Postoperative ADT phase: Starting one month after surgery, Abiraterone and LHRHa (with dosages and dosing regimen as described above) will be administered and continued until 2 years post-surgery. In the event of disease progression to CRPC, remedial treatments will be deliberated in accordance with international and domestic guidelines. These may include the substitution of other novel endocrine therapeutic agents (such as apalutamide, enzalutamide, darolutamide, etc.), chemotherapy, remedial radiotherapy, and other targeted immunotherapies.

Arm B

Treatment initiation involves oral administration of abiraterone 1000 mg once daily + prednisone 5 mg twice daily, along with LHRHa (e.g., goserelin acetate 3.6 mg subcutaneously monthly or 10.8 mg subcutaneously every 3 months) until disease progression occurs. Subsequently, other novel ADT agents (e.g., apalutamide, enzalutamide, darolutamide, etc.), chemotherapy, remedial radiotherapy, and other targeted immunotherapies may be considered as replacements, should treatment failure occurs.

Study endpoints

Primary endpoint

Investigator-assessed 3-year Failure-Free Survival (FFS): This is defined as the proportion of patients who survive and remain progression-free at 3 years from the initiation of treatment, expressed as a ratio to the total sample size. The assessment encompasses the period from the beginning of the screening phase until the occurrence of PSA progression (confirmed by two consecutive measurements at 1-week intervals with a > 50% increase from the treatment-based value), imaging progressive disease (based on RECIST 1.1 and/or PCWG3 criteria), development of pathologic fractures attributable to disease progression, voiding obstruction, hematuria, and death from any cause, whichever transpires first.

Secondary endpoints

Efficacy indicators: Time to CRPC: Time to CRPC is defined as the duration from HSPC to the emergence of endocrine therapy resistance and progression to CRPC. CRPC is characterized by: (1) a serum testosterone level of < 50 ng/dL or 1.7 nmol/L after endocrine therapy; and (2) PSA progression: In cases where rising PSA is the sole indication of disease progression, the minimum starting PSA value is set at 1.0 ng/ml (except for small cell carcinoma alone), and a PSA value exceeding 1.0 ng/ml is utilized as the starting value. Criteria for PSA progression include two consecutive PSA elevations at 1-week intervals and a > 50% increase from the basal value; and3) progression is indicated by imaging suggesting the presence of progression in metastatic lesions in bone or soft tissue.

2-FFS: This is defined as the proportion of patients who survive and remain progression-free at 2 years from the initiation of treatment, expressed as a ratio to the total sample size. The assessment encompasses the period from the beginning of the screening phase until the occurrence of PSA progression (initiated with a PSA value exceeding 1.0 ng/ml, confirmed by two consecutive measurements at 1-week intervals with a > 50% increase from the treatment-based value), imaging progressive disease (based on RECIST 1.1 and/or PCWG3 criteria), development of pathologic fractures attributable to disease progression, voiding obstruction, hematuria, and death from any cause, whichever transpires first.

OS: Defined as the time from treatment until death from any cause.

TRG rating after neoadjuvant therapy: This is defined as the degree to which tumor cells remain oncologically active, as observed histopathologically in radical PCa specimens after neoadjuvant radiotherapy + endocrine therapy (based on MD-Anderson criteria).

Safety indicators: Adverse events were primarily documented in a statistical manner. Radiotherapy-related complications were meticulously recorded and graded according to the RTOG/EORTC scale. Perioperative complications were tallied using the Clavien-Dindo grading system, while endocrine therapy and quality of life-related complications were assessed based on the CTCAE 5.1 scale. The scope of adverse events, their duration in relation to interventions, and any regression were analyzed on a case-by-case basis. The incidence and frequency of adverse events and reactions, along with the number of cases, were calculated for each group. Regarding laboratory safety data, abnormal values outside the normal range and clinically significant abnormalities are listed separately, providing a detailed account of various adverse events.

Quality of life (QoL): measured by EuroQol EQ-5D-5 L, Brief Pain Inventory-Short Form(BPl- SF), Functional Assessment of Cancer Therapy-Prostate(FACT-P).

Data collection and follow-up

Screening phase

Screening procedures to evaluate subject eligibility for the study will be conducted within 3 months prior to randomization. A signed informed consent must be obtained from each patient before any study-specific assessments

are performed. In this phase, inclusion criteria and exclusion criteria are checked and validated. The complete pre-therapeutic work-up includes a physical examination, medical history, electrocardiogram (ECG), demography, vital signs, body weight, standard laboratory tests, PSA and testosterone levels, prostate biopsy, bone scan, 68Ga-PSMA PET/CT and mpMRI for prostate and quality of life questionnaires. For patients with a history or symptoms of heart and/or lung disease, additional cardiological reexamination/echocardiography must be performed to ensure that the patient's cardiopulmonary function can tolerate subsequent radical surgery and radiotherapy.

Radiation therapy phase

Before radiation therapy, patients in arm A need to re-examine vital signs, body weight, standard laboratory tests, ^{68}Ga-PSMA PET/CT, PSA and testosterone levels. After the beginning of treatment, radiotherapy-related complications encompass acute and late genitourinary (GU) toxicity, gastrointestinal (GI) toxicity and erectile dysfunction (ED) should be recorded in detail. After radiotherapy, GU, GI, ED and other complications assessed by the CTCAE 5.0 grading scale along with PSA and testosterone will be recorded every month.

Radical prostatectomy phase

Preoperatively, clinical re-staging of the tumor is carried out by 68Ga PSMA-PET/CT. Vital signs, body weight, standard laboratory tests, PSA and testosterone levels should also be re-examined. On the day of discharge from hospital after surgery, post-operative data as well as quality of life questionnaires are assessed. Intraoperative and 30-day postoperative morbidities are assessed by the Clavien-Dindo Complication system.

Follow-up phase

The patients in arm A entered the follow-up phase after the operation and the patients in arm B entered the follow-up phase since receiving ADT therapy. Follow-up is conducted every 3 months or when necessary in the first 3 years, every 6 months in the next 2 years, and annually thereafter. PSA and testosterone levels of the participants were checked monthly. 68Ga-PSMA PET/CT or bone scan should be conducted when necessary. In case of disease progression, salvage treatment (e.g., other ARTA, re-radiation, chemotherapy, targeted therapy) was advised according to the European Association of Urology (EAU) guidelines after being evaluated by multi-disciplinary teams. The schedule of activities is outlined in Table 1.

Sample size

Assuming a superiority design with a two-sided significance level (α) of 0.05 and power (1-β) of 85%, we used a 1:1 allocation ratio. Based on data from the LATITUDE [17] and STAMPEDE [18, 19]trials and pre-tests of our subject group, it was assumed that there would be a 20–25% improvement in the test group relative to the control group, and it was estimated that 75 cases would be needed in each of the test and control groups. Taking into account the actual possibility of dislodgement/loss of visits (15%), it is proposed to recruit 87 cases in each of the trial and control groups, for a total of 174 cases.

Randomization

Approximately 174 eligible subjects will be included in the study, utilizing a central randomization system. Subjects will be stratified according to pathological grade (ISUP ≤ 3 or ISUP ≥ 4) and then randomly assigned in a 1:1 ratio to either the experimental group or the control group, with approximately 87 subjects in each group. Enrollment will be competitive across centers.

Statistical analysis

All data will be managed using a dedicated clinical trial database, with baseline characteristics compared using descriptive statistics, such as means, medians, and proportions. The primary and secondary endpoints will be evaluated using survival analysis methods, including logistic regression models, Kaplan-Meier survival curves, and Cox proportional hazards models. The Full Analysis Set (FAS) is defined as all randomized subjects who received at least one dose of study medication and had at least one post-baseline efficacy assessment. The Per Protocol Set (PPS) is defined as subjects who fully complied with the protocol requirements, demonstrated good compliance, had no major protocol violations, and completed the primary efficacy endpoint assessment. Categorical variables will be analyzed using chi-square tests or Fisher's exact tests, while continuous variables will be assessed using t-tests or non-parametric tests. To handle missing data, the intention-to-treat (ITT) principle will be applied, with the last observation carried forward (LOCF) method used for patients withdrawing early due to adverse events or other reasons. Sensitivity analyses will be conducted to assess the robustness of results by evaluating the impact of different assumptions on sample size calculations and outcomes. All statistical analyses will be performed using SAS software (version 9.4 or higher) or R language, ensuring accuracy and reliability.

Discussion

In recent years, OMPC has garnered widespread attention, with the anticipation that clinical benefits can be derived from multidisciplinary treatment involving systemic therapy and focal therapy [18]. Previous studies had indicated that OMPC may exhibit a survival benefit with direct radical surgery compared to drug therapy alone. However, direct surgery still requires further

Table 1 The schematic diagram for data collections and assessment

	Neoadjuvant radiohormonal therapy arm (arm A)						Standard of care arm (arm B)
	Screening	Neoadjuvant hormonal therapy	Before radiation therapy	During radiation therapy	Radical prostatectomy	Adjuvant ADT + ARTA	ADT + ARTA
Timepoint	Day − 90 –Day 0	Day 14	1 month	Every week During RT	5–14 weeks after RT	Every 3 months (first 3 years) 6 months (next 2 years)	Every 3 months (first 3 years) 6 months (next 2 years)
Informed Consent	·						
Demographics	·						
Medical History	·						
Physical Exam	·		○	○	·	○	○
Prostate Biopsy	·						
Translational Sample Collection	·		·		·	○	○
Vital Signs	·	·	·	·	·	·	·
PSA	·	·	·	○	·	·	·
Testosterone	·	·	·	○	·	·	·
Bone Scan	·					○	○
Chest CT/X-ray	·				·	○	○
PSMA PET/CT	·		·		·	·	·
Blood Routine	·	·	·	·	·	○	○
Urine Routine	·	·	·	·	·	○	○
Blood Biochemistry	·	·	·	·	·	○	○
Coagulation Function	·	·	·	·	·	○	○
Prostate-enhanced MR	·				○	○	○
AE Evaluation		·	·	·	·	·	·
Quality of Life Questionnaires	·	·		·	·	·	·
Combined Drug Record	·	·	·	·	·	·	·

refinement in terms of safety [19]. Hence, preoperative neoadjuvant therapy has been advocated with the objective of reducing tumor activity, enhancing rates of downstaging and downgrading, and improving surgical safety. However, in the context of progressive PCa, preoperative neoadjuvant endocrine therapy has been advocated for many years. Nevertheless, its impact on prognostic improvement remains unclear, and the value of its application has been a subject of controversy. Therefore, there is a need to continue exploring alternative neoadjuvant treatment options. In 2021, the definitive STAMPEDE study published results demonstrating a significant benefit from radiotherapy to primary and metastatic foci in patients with a low tumor load [20]. This group is akin to patients with OMPC, who could theoretically benefit from this treatment strategy as well. This could lead to better tumor volume reduction, improved surgical resection rates, and enhanced treatment sensitivity.

An increasing body of evidence substantiates the efficacy of neoadjuvant radiotherapy in the management of PCa. In the HORRAD trial [21], 432 patients were randomized to receive ADT alone or ADT in combination with prostate IMRT. Although there was no statistically significant difference in OS (HR: 0.9; 95% CI: 0.7–1.14), the radiotherapy group exhibited a significantly prolonged median time to PSA progression (HR: 0.78; 95% CI: 0.63–0.97). The results of CHAARTED [22] also demonstrated that prostate radiotherapy significantly improved OS in a low-load subgroup ($n = 819$). Simultaneously, equal emphasis should be placed on radiotherapy for metastases, and metastasis-directed therapy (MDT) with SBRT appears to be a promising approach for treating metastatic lesions. Results from randomized trials and prospective studies have shown that MDT achieves a very high local control rate with low toxicity (≥ grade 2 toxicity ~ 0–15%, grade 3 toxicity ~ 0–3%) [23].

Our team has successfully conducted the world's first Phase I/II clinical trial employing a 3 × 3 dose-escalation design for pre-radical neoadjuvant radiotherapy combined with endocrine therapy for OMPC, yielding favorable outcomes. All patients included achieved complete recovery of urinary control at 18 months postoperatively. Furthermore, all four radiotherapy dose groups exhibited excellent tolerance without DLT or grade 3 or higher

toxic side effects. Meanwhile, a significant improvement in imaging efficiency, preoperative downstaging downgrade rate, and pathologic tumor activity were observed upon reviewing whole-body magnetic resonance or PSMA-PET/CT scans after neoadjuvant radiotherapy [17]. In a subsequent study, cases were included based on the revised criteria, and all patients have been followed up for over 3 years. The recurrence-free survival rate stands at 91.7% (unpublished data), indicating a substantial prognostic benefit. Building on the findings of the preceding study, we have preliminarily demonstrated the effective control of oligometastatic foci progression through local radiotherapy. This neoadjuvant treatment exhibits high efficacy and safety, providing a theoretical foundation for the ongoing pursuit of multicenter randomized controlled studies.

In the NEAR-TOP trial, our planned approach involves a more aggressive treatment strategy comprising neoadjuvant radiation hormone therapy followed by RP. The EAR-TOP study has the following advantages: (1) This study represents the world's first RCT utilizing the "sandwich" therapy approach involving "neoadjuvant radiotherapy plus radical surgery plus novel endocrine therapy" for the treatment of OMPC; (2) This study has a solid foundation of prior research and a high degree of certainty about the experimental conditions; (3) Complete pre-patient follow-up data, significant benefit on outcome indicators, and high feasibility of follow-up studies; (4) The participating research centers are all leading units in clinical diagnosis and treatment and scientific research, and the credibility of the trial is high.

In conclusion, our study aims to investigate the safety and feasibility of the "sandwich" therapy, combining neoadjuvant radiotherapy, radical surgery, and novel endocrine therapy, in patients with OMPC. Additionally, we seek to further assess the prognostic benefits of neoadjuvant radiotherapy and endocrine therapy compared to prolonged endocrine therapy alone in patients with OMPC before undergoing radical surgery. This evaluation will contribute to a more comprehensive understanding of the safety, feasibility, and prognostic implications of the "sandwich" therapy approach in the management of OMPC. In our scholarly assessment, we posit that a comprehensive strategy encompassing localized therapy, MDT, and systemic hormone therapy could serve as the optimal course of action for individuals afflicted with OMPC. By adopting this multimodal approach, the aim is to effectively mitigate the likelihood of disease relapse while simultaneously fostering the potential for attaining enduring OS advantages.

OMPC: oligometastatic prostate cancer; RCT: randomized controlled trial; IMRT: intensity-modulated radiotherapy; SBRT: stereotactic body radiotherapy; RP: radical prostatectomy; FFS: failure-free survival; PSA: prostate specific antigen; CRPC: castration-resistant prostate cancer; OS: overall survival; TRG: tumor regression grade; RECIST: The Response Evaluation Criteria in Solid Tumors; PCWG: Prostate Cancer Working Group; CTCAE: Common Terminology Criteria for Adverse Events; PCa: Prostate cancer; LAPC: locally advanced prostate cancer; ADT: androgen deprivation therapy; mHSPC: metastatic hormone-sensitive prostate cancer; RARP: Robotic-assisted Radical Prostatectomy; NEAR-TOP: NEoAdjuvant Radiohormonal Therapy for OMPC; ARTA: androgen receptor axis-targeted therapeutic agent; ECT: Emission Computed Tomography; wbmpMRI: whole-body multiparameter magnetic resonance imaging; HIV: immunodeficiency virus; HCV: hepatitis C virus; LHRHa: luteinizing hormone-releasing hormone agonist; ECG: electrocardiogram; GU: genitourinary; GI: gastrointestinal; ED: erectile dysfunction; EAU: the European Association of Urology; MDT: metastasis-directed therapy.

Abbreviations

OMPC	Oligometastatic prostate cancer
RCT	Randomized controlled trial
IMRT	Intensity-modulated radiotherapy
SBRT	Stereotactic body radiotherapy
RP	Radical prostatectomy
FFS	Failure-free survival
PSA	Prostate specific antigen
CRPC	Castration-resistant prostate cancer
OS	Overall survival
TRG	Tumor regression grade
RECIST	The Response Evaluation Criteria in Solid Tumors
PCWG	Prostate Cancer Working Group
CTCAE	Common Terminology Criteria for Adverse Events
PCa	Prostate cancer
LAPC	Locally advanced prostate cancer
ADT	Androgen deprivation therapy
mHSPC	Metastatic hormone-sensitive prostate cancer
RARP	Robotic-assisted Radical Prostatectomy
NEAR-TOP	NEoAdjuvant Radiohormonal Therapy for OMPC
ARTA	Androgen receptor axis-targeted therapeutic agent
ECT	Emission Computed Tomography; wbmpMRI: whole-body multiparameter magnetic resonance imaging
HIV	Immunodeficiency virus
HCV	Hepatitis C virus
LHRHa	Luteinizing hormone-releasing hormone agonist
ECG	Electrocardiogram
GU	Genitourinary
GI	Gastrointestinal
ED	Erectile dysfunction
EAU	The European Association of Urology
MDT	Metastasis-directed therapy

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12885-024-13201-w.

Supplementary Material 1

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Author contributions
FZG, RSC and CYF: conceived and designed the experiments. LDC and YS: performed the experiments.WY, YL and XWD: analyzed the data. FZG and ZXZ: wrote the paper. ZHJ, CYF and RSC: critical review. All authors read and approved the final manuscript.

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Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
The study protocol, along with any amendments, informed consent, and the patient information brochure, underwent thorough review and received approval. Ethical approval for this study has been granted by the review committee (CHEC2022-226) and has been documented with the ethics committees of the participating centers. The study will be conducted in strict adherence to local laws and regulations, following the ethical principles outlined in the Declaration of Helsinki, and in accordance with the Good Clinical Practice (GCP) principles for clinical trials.

Patient and public involvement
Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Informed consent
Potential participants will be notified by the urologist. Informed consent(Supplementary Material S1) will be obtained from all participants and co-signed by the clinician providing the patient information.

Competing interests
The authors declare no competing interests.

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