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Hormonal Genetic Synergy-Induced Regression of Prostate Adenocarcinoma

Evgenii Brindin*

Interdisciplinary Researcher, International Academy of Education, Novosibirsk, Russia

Correspondence to: Evgenii Brindin. Interdisciplinary Researcher, International Academy of Education, Novosibirsk, Russia, E-mail: bryndin15@yandex.ru

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ABSTRACT

Hormonal therapy is the standard treatment for advanced androgen-dependent prostate adenocarcinoma. If tumor regression is not achieved early, the adenocarcinoma inevitably evolves toward androgen independence. This is due to the development of resistance mechanisms and the incomplete tissue-level cessation of androgen deprivation. Current research is focused on combined therapeutic strategies that will increase the effectiveness of androgen deprivation and delay recurrence. Androgen deprivation through hormonal therapy combined with genetic therapy can induce tumor regression by reducing angiogenesis and enhancing mitotic arrest and apoptosis. A study by the Intergroup in the United States has demonstrated a method for hormonal and genetic restoration of altered prostate cancer patterns resulting from intergenic suppression. This is due to mutations that alter the process by which the genetic information of a mutated gene is expressed. This highlights the urgent need to combine hormonal and genetic therapeutic approaches and expand our current understanding of molecular mechanisms. Epigenetic changes are considered key factors in prostate cancer treatment. Studies have shown that targeting epigenetic enzymes or regulatory proteins halts cancer cell division. Combining hormonal and genetic therapeutic approaches leads to induced regression of prostate adenocarcinoma.

Keywords: Hormonal genetic synergy; Induced regression; Prostate adenocarcinoma

INTRODUCTION

The development of prostate adenocarcinoma depends on hormones, so controlling them can slow or stop the growth of tumors. Hormone therapy is considered systemic because the substances used are distributed throughout the body. This distinguishes it from local treatments such as radiation or surgery, which target only a specific area. Oral hormonal therapy medications are taken orally as tablets, capsules, or liquids. This can be done at home, following a specific regimen prescribed by a doctor. Some medications are available as injections, administered into the arm, leg, thigh, or under the skin of the abdomen.

Hormonal therapy for prostate cancer involves reducing levels of androgens-male hormones that stimulate tumor cell growth. The main types-testosterone and dihydrotestosterone-are produced by the testicles and adrenal glands. The adrenal glands are glands located above each kidney and produce hormones that help the body respond to stress, strain, and environmental changes [1]. This hormone is also important for prostate cancer itself. Reducing the levels of these substances or preventing their entry into abnormal cells leads to tumor shrinkage or slowing of their growth. Drugs that lower hormone levels to a safe level include leuprolide (Lupron, Eligard), goserelin (Zoladex), triptorelin, histrelin, leuprolide mesylate, degarelix (Firmagon), and relugolix (Orgovix). Ketoconazole (Nizoral) is used to treat patients diagnosed with prostate cancer. Newer agents with similar effects-

enzalutamide, apalutamide, and darolutamide-are prescribed to men whose cancer has not spread but is unresponsive to other forms of similar therapy. Enzalutamide can also be used for metastatic disease [2-4].

Genetic therapy for prostate cancer is a treatment based on the manipulation of the genetic material of cancer cells or the patient's immune cells to suppress tumor growth, destroy it, or enhance the effectiveness of hormonal therapy. Key approaches include:

- Tumor gene or nucleic acid delivery: introducing normal or regulatory genes, or donor "suicide" genes (e.g., Herpes Simplex Virus Thymidine Kinase (HSV-TK), followed by the use of profauga), to induce cancer cell death.
- Genome editing: using Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR/Cas9) and similar technologies to disable driver oncogenes or correct defects that reduce tumor cell malignancy.
- Oncolytic virus therapy: modified viruses that selectively replicate in cancer cells and cause their death, sometimes in conjunction with the delivery of therapeutic genes.
- Gene immunotherapy: the production of Chimeric Antigen Receptor T-cells (CAR-T cells) or other T-cell therapies modified to recognize prostate antigens Prostate-Specific Membrane Antigen/ Prostate Stem Cell Antigen (e.g., PSMA/PSCA) and enhance the anti-tumor immune response.
- Nucleic acid-based gene vaccines/immunotherapy: vaccines or nanocarriers with messenger Ribonucleic Acid/ Deoxyribonucleic Acid (mRNA/DNA) aimed at activating immunity against cancer cells.

In most countries, genetic therapy for prostate cancer is primarily within the scope of clinical trials and is not combined with hormonal therapy.

This article discusses the combination of hormonal and genetic therapy for induced regression of prostate adenocarcinoma [5-8].

LITERATURE REVIEW

Induced regression of prostate adeno carcinoma

Induced regression of prostate adenocarcinoma is a reduction in tumor size or a decrease in biochemical markers of the disease (e.g., Prostate-Specific Antigen (PSA)) induced by treatment. Treatment options include:

- **Androgen-dependent regression induced by hormonal therapy Androgen Deprivation Therapy (ADT)**: Removal of androgens or blockade of their receptor leads to a reduction in tumor growth and a decrease in PSA. This is a classic example of induced regression in the prostate.
- **Chemotherapy:** Doxetaxel can induce tumor regression and a decrease in PSA in hormone-sensitive metastatic prostate cancer; the disease may then progress into a resistance crisis.
- **Risk/ Androgen Receptor (AR) pathway inhibitors:** abiraterone (creates androgen deprivation therapy), enzalutamide, and apalutamide lead to regression or stabilization of the disease in many patients.
- **Poly (ADP-ribose) polymerase (PARP) inhibitors:** in patients with Breast Cancer gene 1 (BRCA1/2) or My Reverse Transcriptases (myRT), Heart Rate Recovery (HRR) mutations, they partially induce regression/response to therapy.
- **Radiopharmaceuticals and local radiotherapy:** radium-223 can reduce symptoms and affect tumor biomass in bone; local radiotherapy/SBRT can lead to regression of individual lesions.
- **Immunotherapy:** Sipuleucel-T and other approaches can improve survival and sometimes result in regression of individual lesions; often, the effect is expressed not as a sharp reduction in the size of the primary tumor, but as a change in the clinical course.
- **Examples of combination strategies:** combination hormonal therapy+AR inhibitors, combination therapy with PARP-inHIB, etc.

Assessment of adenocarcinoma regression

- **Biochemical regression:** decrease in PSA levels. - Radiographic/magnetic resonance regression according to Response Evaluation Criteria in Solid Tumors (RECIST) 1.1 (for soft tissue lesions); in bone pathology, specific criteria of the Prostate Cancer Working Group (PCWG) and PSMA-pet projects are often used to assess response.
- **Clinical symptoms:** pain reduction, improved quality of life.
- **Regression as a result of therapy is often temporary:** after the start of ADT, an initial response often occurs, but resistance may then develop (castration-resistant prostate cancer crisis).

- **Specific assessment for bone localization:** regression of bone lesions is more difficult to interpret compared to soft tissue tumors.

Activation of induced regression of prostate adenocarcinoma by hormonal therapy

Let's consider a strategy for activating hormone-induced regression of adenocarcinoma of the prostate (PCa) using hormonal therapy.

Objective of the strategy

- ***Hormone-sensitive prostate cancer (HSPC):*** the tumor remains androgen-dependent; removal or strong suppression of the androgen signaling leads to regression or significant disease control.
- The goal of hormonal therapy is to maintain castration levels of testosterone and block AR signaling at least until the maximum clinical effect (regression/stabilization) is achieved.

Mechanisms of regression under hormonal therapy

- Suppression of the AR pathway reduces the transcription of counter-regime cellular factors, triggers apoptosis, and cell cycle arrest in hormone-sensitive cells.
- In response, tumor cells can adapt Castration-Resistant Prostate Cancer (CRPC) through enhanced AR signaling, intracellular androgen synthesis, AR mutations, or transition to non-estrogen-deficient phenotypes.

Clinical strategies for activating regression (main approaches)

- ***Ensuring castration levels of testosterone:*** Eliminate testosterone below approximately 50 ng/dL (or below 20 ng/dL, which is considered deeper castration) using LHRH antagonists/agents (luteinizing hormone-releasing hormone) or surgical castration.
- ***LHRH agonists:*** leuprutide, goserelin, etc.; antagonists: degarelix.

Combination with AR pathway blockers (intensive antiandrogen approach)

- ***Antiandrogens:*** bicalutamide, flutamide, nilutamide - can be used in combination at the start of treatment or to prevent the flare effect.
- ***Next-generation ARPIs (ARS inhibitors):*** abiretterone (CYP17A1 inhibitor), enzalutamide, apalutamide - increase the depth of AR signaling suppression in hormonally sensitive stages.

Intensification of hormonal therapy in localized and locally advanced disease

- Neoadjuvant hormonal therapy before radiation therapy or surgery in patients with locally advanced or severe disease to reduce tumor bulk.
- In some protocols, disease localization includes a combination of ADT with radiation therapy and/or the addition of ARPI during periods of tumor mobilization.

Chemotherapy combined with hormonal therapy in patients with mHSPC (metastatic hormone-sensitive PCa):

- Doxetaxel in combination with ADT improves clinical outcomes and may enhance tumor regression early in treatment.

-Growing options within so-called "triplet"/intensive strategies

- ADT+doxetaxel+ARPI (e.g., abiretterone or an AR inhibitor) in some high-risk patients; data on individual approaches continues to accumulate, and decisions are made on an individual basis.

Local radiotherapy combined with ADT for oligometastatic disease

- Used to improve local lesion control and may promote overall tumor regression when combined with castration therapy.

Key clinical data and examples of key approaches

Meta-analyses and large randomized trials in HSPC show that the combination of ADT with doxetaxel, as well as the early addition of ARPIs (abireterone, enzalutamide, apalutamide), improve overall survival and time to progression compared to ADT alone.

Examples of large programs

- ***LATITUDE:*** adding abireterone to ADT in patients with metastatic HSPC significantly improves survival.
- ***TITAN, ARCHES, ENZAMET:*** demonstrated the benefit of ARPI inhibitors in combination with ADT in the hormonally sensitive metastatic stage.

- ***CHAARTED, STAMPEDE:*** adding doxetaxel or other agents to ADT early in treatment improves outcomes.
- In the localized stage: neoadjuvant hormonal therapy before local therapy can lead to a reduction in tumor volume and, consequently, more effective disease control.

DISCUSSIONS

Risks and limitations

- Resistance to hormonal therapy (transition to CRPC) through AR mutations, increased intracellular androgen synthesis, AR variants, and other mechanisms.
- Side effects of hormone deprivation: osteoporosis, hyperlipidemia, hypertension, hot flashes, decreased libido/function; interaction with diabetes and cardiovascular risks.
- The regression effect is often partial/temporary; optimal regimens depend on the stage of the disease, the biological profile of the tumor, and the patient's overall health.

Monitoring the effectiveness of regression

- Periodically measure testosterone (target: castration levels) and PSA levels as an early indicator of response.
- Disease imaging (CT/MRI, bone scan) to assess regression or progression. - Monitor toxicity and manage comorbidities.

Practical tips for "activating" regression

- ***Early and maximal suppression of AR signaling:*** start with ADT and consider adding ARPI or combination therapies according to an individualized plan.
- Consider combinations of ADT+doxetaxel and/or ARPI in mHSPC in appropriate patients for more in-depth analysis.
- For locally advanced disease, consider neoadjuvant hormonal therapy in conjunction with localized radiotherapy.
- ***Adopt a long-term control strategy with toxicity minimization:*** osteoporosis prevention, metabolic monitoring, and prophylactic screening for associated problems.
- Develop differentiated strategies based on the tumor's biological profile (e.g., AR functional variants, potential for tumour loss, somatic mutations, potential for transition to a neuroendocrine phenotype – as data become available) [9-11].

Activation of induced regression of prostate adenocarcinoma by genetic therapy

Activation of induced regression in prostate adenocarcinoma by gene therapy refers to the use of genetic approaches (gene delivery vectors, genome editing, RNA interventions, etc.) to initiate cancer cell death, halt their growth, or enhance the antitumor immune response, leading to tumor regression. This is primarily at the research and clinical trial stages [12-14].

Main strategies (overview by mechanism and status)

- Replacement/introduction of proapoptotic genes
- ***Examples:*** p53, Bax, Bak, Caspases. The goal is to restore or enhance the mechanisms of programmed tumor cell death.
- ***Delivery formats:*** adenoviral, lentiviral, ligand carriers, nanotechnology.
- ***Status:*** primarily preclinical and early phase clinical trials; some early clinical trials of p53 gene therapy are being conducted in oncology, including research efforts in prostate cancer.

Suicide gene therapy

- ***Example:*** HSV-tk/ganciclovir-a virally delivered gene modulator that sensitizes cancer cells to drugs and triggers their death.
- ***Status:*** Mostly preclinical data, some early clinical trials in combination with local delivery.

Oncolytic viruses

- Viruses that preferentially infect and destroy cancer cells, often accompanied by the release of tumor-specific antigens and stimulation of the immune response.
- ***Application to prostate cancer:*** Specific vectors (adenoviruses, HSV, etc.) with additional expression of immunomodulators are being investigated.
- ***Status:*** Clinical trials at various stages, but not standard for this cancer therapy. - Targeted regulation of the AR signaling and related pathways
- ***Approaches:*** RNAi/siRNA/shRNA or CRISPR to reduce AR activity, AR coactivator inhibitors, editing genes that affect the AR pathway.
- ***Status:*** being tested primarily at the preclinical level; some approaches are moving into early clinical trials.

Regeneration/restoration of tumor suppressor gene function (PTEN, etc.)

- ***Idea:*** restore the function of tumor suppressor genes (e.g., PTEN) to slow growth and induce regression.
- ***Status:*** primarily preclinical; conceptual and preclinical data available.

Genetic therapy for immune activation

- ***Examples:*** expression of GM-CSF or other immunomodulators in a genetic vector to enhance antitumor immunity; Potentially, immune cell editing (CAR-T/CRISPR-T) targeting PSMA or other prostate antennae.
- ***Status:*** Clinical trials in some formats (combining cell genetic modification and vaccine-like approaches); classic "prostate gene therapy" is still experimental.

Antiangiogenesis/blood supply inhibition

- Direct genetic approaches to inhibiting tumor blood vessel growth (e.g., angiostatin/endostatin expression).
- ***Status:*** Mainly preclinical data; some approaches are reaching clinical translation as biological agents rather than pure gene therapy.

Important information about effects and regression assessment

- ***Effects can be local and systemic:*** tumor regression, PSA reduction, changes on PET/MRI, clinical improvement.
- ***Regression assessment depends on the methods:*** RECIST for soft tissue lesions; For prostate and bone pathology, PCWG standards, PSMA-PET, etc. are used.
- ***Safety and risk:*** genomic insertion can cause immune responses, inflammation, insertional mutations, and off-target integration into healthy cells; scaling delivery to the prostate is a challenge; strict bioethical and regulatory requirements are required.

Genetic therapy for prostate cancer

Genetic therapy for prostate cancer is a set of approaches that utilize tumor genetic information or genetic manipulations to stop cancer cell growth or enhance their destruction. Clinically, the term "gene therapy" is now more commonly used, rather than simply "gene therapy," for therapy tailored to the tumor's genetic profile (genetically targeted therapy). Many genetic methods are in the research and clinical trial stages; other genetically targeted drugs, such as PARP inhibitors, are used for widespread use in most countries if the patient has certain mutations.

Main approaches (overview, without technical details)

- Gene replacement (gene therapy)-delivers normal versions of lost tumor suppressor genes (such as PTEN or p53) or other genes to cancer cells to stop tumor growth. This is primarily a research approach.
- Genome editing (CRISPR/Cas, etc.)-attempts to specifically disable or correct mutations that support cancer growth. Also primarily in clinical trials for now.
- RNA targeting-the use of small RNAs (siRNA/shRNA) or anti-CH oligonucleotides to suppress growth signaling in cancer cells.
- Viral gene therapy and oncolytic viruses-viruses are used as "carriers" to deliver genetic material or directly destroy cancer cells, often stimulating an immune response against the tumor. This is currently in the clinical trials phase.
- Gene immunotherapy (T-cell modification)-the creation of T-lymphocytes targeted to cancer cells (for example, by markers such as PSMA). Also in clinical trials and early-stage treatments. - Tumor-specific genetic therapy (genetically targeted therapy)-for example, PARP inhibitors (olaparib, rucaparib, niraparib, talazoparib, etc.) for patients with mutations in BRCA1/2 or other genes responsible for DNA repair. This is already part of clinical practice, depending on the region and the specific mutation; it is not considered "gene therapy," but directly depends on the tumor's genetic profile.

What this means for prostate cancer

Some patients have mutations in BRCA1/2, PALB2, ATM, CHEK2, and other genes associated with DNA repair. PARP inhibitors and other targeted approaches are available for these patients. - Research efforts continue to develop genetic therapy and genome editing in the prostate, including attempts to restore the function of lost genes or alter signaling pathways that control tumor growth. However, at this point in widespread practice, these are most often experimental methods.

In prostate treatment, genetically based strategies such as PARP inhibitors are most often used, sometimes in combination with hormonal therapy, chemotherapy, or immune therapy, if applicable to the specific mutation.

Pros and cons

Advantages: the ability to target specific genetic changes in the tumor, potentially more effective cancer suppression, and the ability to bypass resistance to other therapies.

Risks and limitations: delivery of genetic material to the desired cells, risk of off-target effects, immune reactions, development complexity and high cost, limited availability of clinical trials. How to determine if a person is suitable:

Tumor diagnostics and genetic testing (genetic profiling) are required: what mutations are present, whether BRCA1/2 or other DNA repair defects are present. Some patients may be considered for participation in clinical trials of genetic therapies or genome editing.

Activation of induced regression of prostate adenocarcinoma by genomic therapy

A strategy for inducing prostate adenocarcinoma regression using genomic therapy involves creating conditions in which prostate cancer cells undergo programmed cell viability decline, apoptosis, or immune-mediated cell death through genetic intervention. This is achieved by suppressing key oncogenic pathways, restoring the function of antitumor genes, and/or stimulating an immune response against the tumor.

The main genomic therapy strategies for inducing regression are

- **Suppression of AR (androgen receptor) signaling:** reducing AR activity or removing AR variants that promote tumor growth through RNA interference, CRISPR/Cas9, or editing regulatory elements.
- **Restoration of tumor suppressor function:** gene transfer of PTEN, p53, or other lost/functionally weakened factors to suppress growth pathways and initiate the cell death cycle.
- **Direct apoptosis induction:** delivery of factors that enhance apoptosis (e.g., BAX, caspases) or by activating the TRAIL/DR-5 pathway.
- **Suicide gene therapy and direct hybrid aggression:** delivery of prodrug transducer enzymes (e.g., HSV-TK) or tumor-targeted systems that lead to cancer cell death.
- **Immunogene therapy:** delivery of cytokines (GM-CSF, IL-12) or immune response modulators to convert the tumor into a source of immune attack; genetic modification of T cells or training of the immune system against the tumor.
- **Oncolytic viruses and immune-promoting vectors:** use of viruses that selectively replicate in cancer cells and carry immunomodulators to induce tumor regression.
- **Epigenetic editing:** targeted editing or modulation of the epigenetic status of target genes to reactivate tumor suppressors.
- **Combination approaches:** synergy of genomic therapy with hormonal therapy, PARP inhibitors, immunotherapy, or angiogenesis targets.

Delivery systems and implementation features

- ***Vector gene therapy:*** viral vectors (adenoviruses, lentiviruses, AAV) for delivering genetic material; there are also non-vector approaches (nanoparticles, lipid/polymer carriers).
- ***Prostate targeting:*** local delivery (intraprostatic injections), selective infusion, as well as carriers targeting PSMA or other prostate-targeted genes.
- ***Safety and durability:*** control of gene expression, prevention of insertional mutations, immunogenic response to vectors, off-target effects.
- ***Delivery variability:*** systemic *vs*. local, expression control (induction/signature-based due to undefined factors).

Advantages and limitations

- ***Advantages:*** targeted effect, possibility of long-term (or repeated) modulation of tumor pathways, potential for combinations.
- ***Limitations:*** tumor and microenvironment delivery efficiency, safety of genome editing, risk of immune reactions and unintended effects, regulatory issues.

Development stages and clinical status

- Mainly in preclinical trials and early clinical phases. Some concepts (e.g., immunogenic gene therapies, viral vectors) are being tested for various types of cancer; for prostate cancer, these ideas are in the early stages and require clinical confirmation.
- ***Key outcome measures:*** tumor regression in preclinical models, PSA reduction, radiological regression, survival, and safety.

What's useful to consider in prostate genomic therapy

- ***Targeted pathways and specific targets:*** AR axis, PTEN/PI3K/AKT, p53, RB, DNA damage response (BRCA1/2, ATM/ATR).
- ***Types of gene therapy:*** gene delivery *vs*. genome editing; single-component *vs*. multicomponent approaches.
- ***Combinations with existing therapies:*** hormonal therapy, PARP inhibitors, immunotherapy. - Issues of delivery and regional specificity in the prostate.
- Ethical, regulatory, and safety issues.

Synergy of hormonal and genetic therapy for induced regression of prostate adenocarcinoma

The goal of synergistic hormonal and genetic therapy is to combine hormonal therapy (directly suppressing AR signaling-androgen-dependent activity) with genetic approaches that specifically trigger adaptive regression in prostate adenocarcinoma cells. The goal is to enhance tumor cell death, reduce resistance to hormonal therapy, and lead to more durable remission.

Synergetic strategy:

Most prostate adenocarcinomas are dependent on AR signaling. When it is suppressed, the tumor partially regresses, but resistance and clusters of AR-independent cells develop.

A combination of hormonal therapy and genetic approaches can "kick" the tumor into a different regression state by activating programmed cell death, enhancing apoptosis, or restoring cellular regulation (e.g., correcting abnormalities in the Apoptosis-RAI pathway or DDR). Genetic targets and approaches (approximate spectrum):

Suppression of the AR pathway and its regulators at the genetic level: knockout of AR or coactivators (e.g., SRC/NRIP1, etc.), blocking AR variants (AR-V7) using genetic tools.

Restoration of tumor suppressor gene function: TP53, RB1, PTEN – to enhance cell sensitivity to hormonal activity and cell death.

Direct induction of apoptosis or senescence: introduction of pro-apoptotic genes (BAX, BIM) or senescence factors under the control of genetic switches.

Modulation of the DNA repair program: targeting the ATM/ATR, BRCA1/2, and PARP pathways (e.g., combination with PARP inhibitors can be enhanced with appropriate genetic correction).

Immunotraining and cell "immunogenicity": genetic expression of factors that stimulate the immune response (GM-CSF, IL-12, etc.) to reactivate anti-tumor immunity after hormonal stress.

Vectorization and regulatory mechanisms

Vectors: viral (AAV, lentanvirus, adeno-pancryogenetic constructs) and non-viral delivery systems; the choice depends on the required specificity and duration of expression.

Expression control: inducible promoters (e.g., Tet-On/On), hormone-responsive elements (AR-defined promoters, e.g., PSA-like elements), or "two-factor" combinations (e.g., hormonal regulation plus a drug-dependent system) to increase selectivity.

Pro-payload ideas: pro-apoptotic genes, retro- or retriever copies of TP53/PTEN, vaccinin or immunomodulators, "surrogate" selective genes that are activated only in cells with a specific AR activity profile.

Potential application schemes (conceptual)

Simultaneous strategy: hormonal therapy reduces AR signaling, and gene therapy induces regression through apoptosis/senescence in the remaining cells; AR-independent gene expression control (e.g., Tet-On) can be used for precise regulation.

Sequential strategy: first, hormonal therapy reduces AR activity, then introduces a genetic module that triggers cell death or restores regulation to capture resident tumor cells after AR suppression.

Multi-target strategy: combines AR signaling modification and simultaneous DDR/apoptosis modulation to minimize resistance.

Benefits and mechanistic logic of synergy

Resistance reduction: ablation of AR-dependent pathways combined with activation of the cell death "script" can reduce the chances of tumors developing resistant phenotypes.

Immunotherapeutic potential: stress- and immunogenic signaling modifications following hormone deprivation can enhance anti-tumor immunization.

Potential for more precise selectivity: the use of hormonally targeted regulators or inducers allows for restriction of gene module expression by prostate tumor cells.

Key issues and challenges

- ***Delivery and specificity:*** efficient delivery of genetic payloads to prostate tumors

without significant distribution to normal tissues; avoidance of off-target effects.

- ***Control of expression:*** the need for precise control of timing and expression levels to avoid toxicity and resistance.
- ***Continuity of resistance:*** tumors can adapt to both modalities; a multi-modal targeting strategy is needed.
- ***Safety and regulatory:*** risks associated with genetic vectors (insertional mutagenesis, immune response), long-term consequences of gene expression.
- ***Models and preclinical design:*** robust models (DU145, LNCaP, 22Rv1 cell lines; PZD models, rabbit/mouse models) are needed to test selectivity and efficacy.

Development steps to consider

Target and regulatory design: determine which genetic modules will be AR-dependent or AR-independent to ensure regression even with AR pathway modifications.

Vector platform and control system: select a suitable vector, define a control system (inducible *vs*. constant expression) to ensure tissue specificity.

Preclinical modeling: in vitro testing on different lines (AR+, AR- variants, PTEN/TP53 status) and in vivo testing in KB-PDX mouse models or human xenografts.

Ethical and regulatory plans: ongoing safety monitoring, pre-planned clinical-experimental pathways [15].

CONCLUSION

With advances in high-throughput epigenomic approaches, visualizing chromatin structures and how their changes lead to disease development and progression has become an increasingly sought-after area of research. Chromatin remodeling from a condensed state to a transcription-friendly state allows DNA-binding proteins to access DNA and control gene expression. Chromatin remodeling is a promising avenue for therapeutic approaches to prostate cancer. ChromoGen technology can investigate how DNA mutations alter chromatin structure, linking this to disease and hormonal genetic conditions activating induced regression of prostate adenocarcinoma.

DECLARATIONS

Conflict of interest

The author declares no conflicts of interest in relation to this work.

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REFERENCES

1. Katelyn Jones, Yanquan Zhang, Jinghui Liu. Epigenetics in prostate cancer treatment. J Transl Genet Genom. 2021;5:341-356.
2. Demicheli R, Hrushesky WJM. Reimagining cancer: Moving from the cellular to the tissue level. Cancer Res. 2023;83:173-180.
3. Evgeny Bryndin. Regression of oncological formations at the tissue level and intercellular fluid. J Clin Res Report.2025;21(2).
4. Evgeny Bryndin. Neutralization of carcinomas by balanced mechanisms of body systems. Clin Res Stud. 2025;4(3): 2835-2882.
5. Evgeny Bryndin. Aspects of spontaneous regression of oncological necrotic tissue. Can Res Cel Ther. 2025;9(5).
6. Evgeny Bryndin. Elimination of cancerous tumors of different organs by intelligent cell therapy and spontaneous regression. Can Res Cel Ther. 2025;9(5).
7. Evgeny Bryndin. International translational medicine in world healthcare. WebLog J Clin Case Report. 2025;9(1):i0801.
8. Evgeniy Bryndin. Maintaining the health of organism at molecular level based on

informative genomics. J Clin Case Report Stud. 2025;6(7).
9. David H, Ming HF, Shane LB, Benjamin T, Niall MC. Evolution of hormonal therapy for prostate cancer. Aust J Gen Pract. 2024;53(5):291-390.
10. Alexander MO. Predictive biomarker guides prostate cancer hormone therapy. Med Scape. 2025.
11. Hormone sensitive prostate cancer market – trends & forecast 2025 to 2035. Future Market Insights. Inc. 2025;250.
12. Riet K, Adegoke A, Mashele S, Sekhoacha M. Effective use of euphorbia milii dcm root extract encapsulated by thermosensitive immunoliposomes for targeted drug delivery in prostate cancer cells. Mol Biol. 2024;46(11):12037-12060.
13. Sekhoacha M, Riet K, Motloung P, Gumenku L, Adegoke A, Mashele S. Prostate cancer review: Genetics, diagnosis, treatment options, and alternative approaches. Molecules. 2022;27(17):5730.
14. Fan W, Hengsen Z. Interactions between key genes and pathways in prostate cancer progression and therapy resistance. Front Oncol. 2025;15: 1467540.
15. Schuette G, Lao Z, Zhang B. Chromogen: Diffusion model predicts single-cell chromatin conformations. Sci Adv. 2025;11(5):1-10.

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