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ISNI: 0000 0004 8495 2390

Dolna 17, Warsaw,
Poland 00-773
+48 226 0 227 03
editorial_office@rsglobal.pl

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FOCAL THERAPY FOR PROSTATE CANCER: A NARRATIVE REVIEW OF ONCOLOGICAL EFFICACY AND FUNCTIONAL OUTCOMES OF HIFU, IRE, AND CRYOABLATION METHODS

Damian Podkoscielny *(Corresponding Author, Email: podkoscielnyd@gmail.com)*
Medical University of Lodz, Lodz, Poland
ORCID ID: 0009-0007-4979-1674

Karolina Swierk
Medical University of Lodz, Lodz, Poland
ORCID ID: 0009-0003-3784-9630

Martyna Ciarkowska
Medical University of Lodz, Lodz, Poland
ORCID ID: 0009-0001-4635-378X

Wojciech Machulski
Military Institute of Medicine, Warsaw, Poland
ORCID ID: 0009-0007-6337-5909

Jan Makulski
1st Military Clinical Hospital with Outpatient Clinic, Lublin, Poland
ORCID ID: 0009-0006-7545-499X

Kamil Franczyk
10th Military Hospital with Outpatient Clinic, Independent Public Health Care Institution, Bydgoszcz, Poland
ORCID ID: 0009-0001-6294-5101

Maria Gierasimiuk
116th Military Hospital with Outpatient Clinic, Independent Public Health Care Institution, Opole, Poland
ORCID ID: 0009-0009-1450-9258

Michal Gorski
116th Military Hospital with Outpatient Clinic, Independent Public Health Care Institution, Opole, Poland
ORCID ID: 0009-0006-8762-2823

Adam Januszkiewicz
107th Military Hospital with Outpatient Clinic, Independent Public Health Care Institution, Wałcz, Poland
ORCID ID: 0009-0008-9488-2273

Wiktoria Januszkiewicz
107th Military Hospital with Outpatient Clinic, Independent Public Health Care Institution, Wałcz, Poland
ORCID ID: 0009-0005-5730-4333

ABSTRACT

This narrative review synthesizes current scientific evidence regarding oncological efficacy, functional outcomes, and safety profile of three leading focal therapy (FT) methods in the treatment of localized prostate cancer: high-intensity focused ultrasound (HIFU), irreversible electroporation (IRE), and cryoablation. The analysis is based on 28 clinical studies published between 2022–2025, including prospective cohort studies, multicenter international trials, and meta-analyses. The results indicate that all analyzed ablative techniques offer acceptable oncological control while maintaining high patient quality of life. HIFU therapy provides the most established evidence, with a median biochemical recurrence-free survival (BCR-free survival) of 63 months and a low rate of clinically significant prostate cancer (csPCa) detection in control biopsy (6.5%). Oncological outcomes for IRE are more varied, with a csPCa detection rate of 24.1% in a multicenter study, suggesting strong dependence of efficacy on the extent of ablation (hemi-ablation vs. focal ablation). Cryoablation presents promising early oncological data, with 78.6% of patients free from csPCa at 12 months, but is associated with higher risk of erectile function impairment. Functionally, FT demonstrates clear superiority over radical treatment, with urinary incontinence rates at ~2% and significantly better preservation of potency. Key success factors for focal therapy include rigorous patient qualification based on advanced imaging techniques and precise procedure planning. Focal therapy represents a real and valuable therapeutic option for carefully selected groups of men with prostate cancer, offering a compromise between oncological radicality and preservation of vital functions.

KEYWORDS

Focal Therapy, Prostate Cancer, HIFU, IRE, Cryoablation

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1. Introduction

Prostate cancer remains one of the most frequently diagnosed malignant neoplasms in men worldwide, constituting a significant clinical and social challenge. Standard treatment methods for localized prostate cancer, such as radical prostatectomy (RP) or radiotherapy, are characterized by high oncological efficacy. However, their radical nature, involving treatment of the entire prostate gland, is associated with significant risk of complications that permanently reduce patients' quality of life. The most common and burdensome side effects include urinary incontinence and erectile dysfunction (Nyk et al., 2022). Comparative studies, such as the analysis by Nyk et al. (2022), demonstrated that patients after laparoscopic radical prostatectomy (LRP) experienced an average decrease in IIEF-5 questionnaire score of 7.40 points, indicating significant deterioration of sexual function. Similar conclusions emerge from the analysis by Anceschi et al. (2025), which, despite confirming the highest oncological durability of robot-assisted radical prostatectomy (RARP), emphasizes its negative impact on functional outcomes. Growing awareness of these limitations, combined with advances in diagnostic imaging, has created demand for therapeutic strategies that could balance disease control with preservation of urological and sexual functions.

In response to this clinical need, the concept of focal therapy (Focal Therapy, FT) has developed dynamically in recent years. This is an organ-sparing strategy whose goal is selective ablation (destruction) of only identified, clinically significant prostate cancer foci (csPCa), while maximally sparing surrounding healthy gland tissue, including crucial anatomical structures such as neurovascular bundles and the urethral sphincter (Lasorsa et al., 2024). The philosophy of FT is based on the assumption that not every diagnosed prostate cancer requires aggressive treatment of the entire organ, and precise destruction of the so-called index lesion—the largest and most aggressive tumor—may be sufficient to ensure long-term oncological control while minimizing complications. This approach constitutes a bridge between active surveillance, appropriate for low-risk tumors, and radical treatment, dedicated to advanced disease.

Contemporary focal therapy utilizes various energy sources for ablation of cancerous tissue. The most established and frequently studied modalities include: high-intensity focused ultrasound (High-Intensity Focused Ultrasound, HIFU), irreversible electroporation (Irreversible Electroporation, IRE), and cryoablation. HIFU utilizes thermal energy from focused ultrasound waves to induce coagulation necrosis in the target area. IRE is a non-thermal technique that uses short electrical pulses of high voltage to induce apoptosis of cancer cells, potentially sparing the extracellular matrix and neurovascular structures (George et al., 2024). Cryoablation, in turn, is based on cycles of tissue freezing and thawing, leading to its destruction through formation of ice crystals inside and outside cells (Ramalingam et al., 2023). Each of these methods possesses a unique mechanism of action, efficacy profile, and spectrum of potential benefits and risks.

Despite growing interest and increasingly widespread use of FT, there remains a need for systematic evaluation and synthesis of the latest clinical data. Oncological and functional outcomes may differ depending on the technique employed, patient qualification criteria, and length of follow-up period. Questions arise regarding the optimal definition of treatment failure, durability of oncological effect compared to radical methods, and the impact of individual modalities on sexual function and urinary continence (Skribek et al., 2025). The aim of this narrative review is to conduct a comprehensive analysis and synthesis of current scientific evidence, published between 2022–2025, concerning oncological efficacy, functional outcomes, and safety profile of three key focal therapy methods: HIFU, IRE, and cryoablation. This work aims to provide clinicians and patients with a structured summary that will assist in making informed therapeutic decisions in the treatment of localized prostate cancer.

2. Methodology

This work is a narrative review based on systematic searching and analysis of scientific literature. The goal was to identify, evaluate, and synthesize the most current and relevant clinical studies concerning focal therapy (FT) for prostate cancer, published from 2022 to 2025. This time range was chosen to ensure that the analysis encompasses the latest reports reflecting advances in ablative techniques, patient qualification criteria, and outcome assessment methodology.

2.1 Literature Search Strategy

A systematic search of electronic databases was conducted, including PubMed/MEDLINE, Embase, and the Cochrane Library. The search process was based on a combination of keywords and MeSH (Medical Subject Headings) terms, which were carefully selected to maximize sensitivity and specificity of the query. Main terms used included: "prostate cancer," "focal therapy," "high-intensity focused ultrasound," "HIFU," "irreversible electroporation," "IRE," "cryoablation," "cryotherapy," "oncological outcomes," "functional outcomes," "erectile dysfunction," and "urinary incontinence." The search was limited to publications in English. Additionally, manual searching of reference lists of identified review articles and meta-analyses was conducted to find potentially missed relevant studies.

2.2 Inclusion and Exclusion Criteria

Studies meeting the following criteria were included in this review: (1) original publications, including prospective and retrospective cohort studies, randomized controlled trials (RCT), case series, as well as systematic reviews and meta-analyses; (2) studies evaluating at least one of three FT modalities: HIFU, IRE, or cryoablation; (3) study population consisting of patients with histologically confirmed, localized prostate cancer; (4) reporting of oncological outcomes (e.g., recurrence-free survival, control biopsy results) and/or functional outcomes (erectile function, urinary continence); (5) publication in a scientific journal in the designated period (2022–2025). According to information contained in analyzed materials, special attention was paid to studies in which patient qualification was based on contemporary standards, including advanced imaging such as multiparametric magnetic resonance imaging (mpMRI), which is consistent with recommendations by Popeneciu et al. (2024) and Tay et al. (2024).

Exclusion criteria included: (1) editorial articles, letters to the editor, single patient case reports, and conference abstracts without full publication; (2) studies concerning salvage therapy after radical treatment failure, unless they provided unique comparative data; (3) studies focusing exclusively on technical aspects of the procedure without reporting clinical outcomes; (4) publications from before 2022, to maintain review currency.

2.3 Data Extraction and Synthesis

After applying inclusion and exclusion criteria, a total of 28 publications were identified, which constituted the substantive basis of this review. Key information was extracted from each qualified study, which was structured to enable synthesis and comparison. Collected data included: author and year of publication, study type, size of studied cohort, patient population characteristics (e.g., Gleason score, PSA level), applied focal therapy method (HIFU, IRE, cryoablation), length of follow-up period, as well as primary endpoints.

Regarding oncological outcomes, special attention was paid to definitions of treatment failure, such as biochemical recurrence (BCR), need for salvage treatment, or presence of clinically significant cancer (csPCa) in control biopsy (Skribek et al., 2025; Dias et al., 2022). Regarding functional outcomes, data concerning erectile function, most commonly assessed using the IIEF-5 (International Index of Erectile Function-5) questionnaire, and urinary continence, assessed based on number of pads used daily or using dedicated questionnaires, were analyzed (Nyk et al., 2022; Rosta et al., 2025). Safety profile data included frequency and severity of postoperative complications. Collected information was then subjected to narrative synthesis, organized thematically around individual FT methods and assessed endpoints, allowing for comprehensive presentation and comparison of available evidence.

3. Results

This narrative review, based on systematic analysis of 28 studies published between 2022–2025, provides current synthesis of data concerning oncological efficacy, functional outcomes, and safety profile of three most established focal therapy (FT) methods for prostate cancer: high-intensity focused ultrasound (HIFU), irreversible electroporation (IRE), and cryoablation. Collected clinical study results confirm that all analyzed ablative modalities offer acceptable oncological control with significant preservation of quality of life, constituting a real therapeutic option for carefully selected patients (Lasorsa et al., 2024).

3.1. General Overview and Study Characteristics

The scope of this analysis encompassed a broad spectrum of clinical studies, from prospective cohort studies and international multicenter trials to systematic reviews and meta-analyses, enabling achievement of a comprehensive picture of current scientific evidence. All 28 identified and included studies focused on evaluation of FT outcomes in patients with localized prostate cancer, with dominant participation of patients with intermediate-risk disease (Gleason Grade Group 2 or 3), according to patient selection criteria formulated by Tay et al. (2024) and Popeneciu et al. (2024).

Data from studies by Anceschi et al. (2025) and Nyk et al. (2022) constituted key comparative results, juxtaposing focal therapy results directly with radical prostatectomy (RARP or LRP), allowing contextualization of FT functional benefits. Other key publications, such as the multicenter IRE study (Zhang et al., 2024) and prospective HIFU series (Rosta et al., 2025), provided detailed data on effect durability and complications associated with individual modalities. Results presented below are a collective reflection of conclusions from this diverse evidence base, considering methodological rigor and clinical specificity of each studied ablative technique.

3.2. Oncological Outcomes - Disease Control and Effect Durability

Assessment of focal therapy oncological efficacy focuses on elimination of clinically significant prostate cancer (csPCa) in the ablation zone and long-term survival free from biochemical recurrence or progression requiring salvage treatment. Results of analyzed studies indicate that each method—HIFU, IRE, and cryoablation—provides acceptable oncological control, particularly in carefully selected patient populations (Skribek et al., 2025).

3.2.1. Recurrence Rates and Treatment Failure Definitions

Systematic review by Skribek et al. (2025) demonstrated that rates of in-field recurrence and out-of-field recurrence after FT remained in the range of 5–15%. Such a low percentage suggests high ablation precision, provided strict adherence to imaging protocols and ablative techniques.

Analysis of data concerning failure-free survival (FFS) is crucial. The prospective study by Dias et al. (2022), which combined different ablative techniques, applied a rigorous definition of failure (need for additional treatment) and reported FFS of 75.6% at 2 years and 53.6% at 4 years. These results emphasize the need for realistic patient information about possible necessity of salvage treatment in the longer term, while simultaneously indicating durability of ablative effect in over half of patients after 4 years (Dias et al., 2022).

3.2.2. Oncological Outcomes for HIFU

HIFU provides the most established oncological evidence in the medium term. Meta-analysis by Yang et al. (2024) demonstrated that median biochemical recurrence-free survival (BCR-free survival) for patients undergoing primary HIFU was approximately 63 months. In the same analysis, impressive 5-year survival rates were noted, with overall survival (OS) at 88% and cancer-specific survival (CSS) at 94% (Yang et al., 2024), confirming high HIFU efficacy in treating clinically significant prostate cancer.

The latest prospective study by Rosta et al. (2025) confirmed these positive trends, reporting 2-year failure-free survival (FFS) of 94.1% in a cohort of patients undergoing HIFU focal therapy. An indicator of ablation effectiveness is the percentage of patients who had clinically significant cancer (csPCa) detected in protocol biopsy performed after treatment. In the study by Rosta et al. (2025), mandatory rebiopsy detected csPCa in only 6.5% of patients, testifying to high efficacy of tumor destruction using HIFU.

3.2.3. Oncological Outcomes for IRE

Irreversible electroporation (IRE) utilizes a non-thermal mechanism of cell destruction, and its oncological outcomes appear more varied. The largest international multicenter study by Zhang et al. (2024), evaluating IRE safety and oncological outcomes, noted that 24.1% of patients had detectable csPCa in protocol biopsy after treatment, with median follow-up of 24 months. This relatively high percentage, compared to HIFU data (6.5% csPCa), raises questions about IRE durability and radicality, particularly in cases of ablation limited only to the index lesion.

This hypothesis is supported by the prospective series by Suberville et al. (2025), which demonstrated significant dependence between ablation extent and oncological control. Patients who underwent hemi-ablation (ablation of entire involved lobe) achieved significantly better oncological control (persistent csPCa detection at 8.6%) compared to patients who underwent only focal ablation (persistent csPCa at 25%). This result suggests that for IRE, therapeutic approach minimalism may go hand in hand with higher risk of overlooking marginal or multifocal cancer.

3.2.4. Oncological Outcomes for Cryoablation

Cryoablation, utilizing freeze-thaw cycles, provides promising early oncological data. Phase II study by Tan et al. (2023) with mandatory rebiopsy demonstrated that 78.6% of patients were free from detectable clinically significant prostate cancer at 12-month assessment. This result, while not reaching the efficacy level of HIFU (93.5% free from FFS failure at 2 years), confirms cryoablation's ability to effectively destroy cancerous tissue using improved monitoring and procedure guidance techniques (Ramalingam et al., 2023; Fuller et al., 2023).

3.2.5. Comparison of Effect Durability with Radical Treatment

In comparative context, results by Anceschi et al. (2025) clearly demonstrated that RARP (Robot-Assisted Radical Prostatectomy) was characterized by the longest oncological effect durability compared to evaluated focal therapy techniques. This conclusion positions FT as an option with higher risk of requiring salvage treatment, but offering incomparable functional benefits, which constitutes an acceptable compromise for appropriately informed patients (Nyk et al., 2022).

3.3. Functional Outcomes - Sexual Potency and Urinary Continence

The most unequivocal and consistent result in all analyzed studies is significantly better preservation of urological and sexual functions after focal therapy compared to radical whole-gland treatment methods (Nyk et al., 2022; Skribek et al., 2025).

3.3.1. Urinary Function and Incontinence

Preservation of urinary continence is one of the most important achievements of FT. Meta-analysis by Tay et al. (2024)—data from 34 study cohorts—clearly indicates very low FT impact on urinary continence, where 97.1% (33 of 34) studied cohorts reported low urinary incontinence rates. In the prospective study by Rosta et al. (2025), the percentage of clinically significant urinary incontinence after HIFU was merely ~2%. Such favorable results are incomparable with urinary incontinence percentages observed after radical treatment, clearly positioning FT as an organ-sparing method with minimal risk of permanent urethral sphincter damage (Nyk et al., 2022).

3.3.2. Sexual Function and Erectile Potency

Regarding sexual function, although results are generally better than after radical treatment, significant differences appear between FT modalities themselves.

Comparison of FT vs. Radical Treatment: Study by Nyk et al. (2022) provided direct functional comparison between HIFU-FT and laparoscopic radical prostatectomy (LRP). After 12 months of follow-up, HIFU-FT demonstrated significantly better results in sexual function measured by the IIEF-5 (International Index of Erectile Function-5) questionnaire. The mean change (decrease) in IIEF-5 score for HIFU-FT was merely ~0.03 points, meaning nearly complete preservation of erectile function. In the same period, patients after LRP experienced mean IIEF-5 score decrease of ~7.40 points, indicating significant sexual function deterioration after radical treatment (Nyk et al., 2022).

Differences Between FT Modalities (IRE vs. HIFU): IRE, due to its non-thermal mechanism, is promoted as the technique with greatest potential for potency preservation, as it theoretically minimizes damage to neurovascular fibers (George et al., 2024). Analysis by Cribbs et al. (2023) confirmed this hypothesis, reporting significant IRE advantage in potency preservation (93%) compared to HIFU (67%) in identified cohorts, which is a crucial result in patient selection process.

Results for HIFU: Prospective data by Rosta et al. (2025) concerning HIFU demonstrated transient decrease in mean IIEF score, which was approximately -3 points at 3 months post-procedure. Importantly, further follow-up noted return of erectile function to baseline or even exceeding it at 24 months, with baseline erectile function proving to be a key predictor of final outcome (Rosta et al., 2025).

Results for Cryoablation: Historically and in light of contemporary data, cryoablation is a method associated with higher impact on erectile function (Tan et al., 2023; Ramalingam et al., 2023). The damage mechanism, involving extreme cold (below -40°C) and microvascular destruction, more frequently leads to permanent potency impairment, making this method less optimal for patients for whom sexual function preservation is the main priority.

Functional Durability Compared to RARP: Comparative study by Anceschi et al. (2025) demonstrated that potency recovery was comparable between all three FT techniques, with faster return in some patients after HIFU. However, authors emphasized that statistically confirmed superiority of focal therapies over RARP in sexual function after two years of follow-up could not be proven.

3.4. Safety Profile, Complications, and Patient Satisfaction

Safety profile analysis in all studies confirms that focal therapy is generally a safe minimally invasive procedure, with the vast majority of complications classified as mild and transient.

3.4.1. HIFU Complications

Prospective study by Rosta et al. (2025) concerning HIFU noted that 27% of patients (14 of 51) experienced at least one adverse event during follow-up period. The most common complication was acute urinary retention, which occurred in 7% of patients, consistent with data from other large HIFU series (Mala et al., 2023). The study by Rosta et al. (2025) noted no grade 4 Clavien–Dindo complications, confirming low rate of serious adverse events. Results by Mala et al. (2023) clearly document significant learning curve in HIFU therapy, indicating clear reduction in complications with increasing team experience.

3.4.2. IRE Complications

Safety data for IRE, including from the large multicenter study by Zhang et al. (2024), are also positive, as no grade 4 or 5 complications were reported (George et al., 2024; Zhang et al., 2024). IRE, as a non-thermal method, allows precise ablation without risk of extensive thermal damage. However, IRE is associated with unique risk: electrical pulse generation may induce cardiac arrhythmias, necessitating absolute requirement for pulse synchronization with patient's heart rhythm and use of general anesthesia and strict cardiological monitoring during the procedure (Zhang et al., 2024).

3.4.3. Cryoablation Complications

Cryoablation is associated with a somewhat different complication profile. Patients more frequently report perineal pain and transient prostate gland swelling, directly related to tissue freezing and thawing mechanism (Ramalingam et al., 2023). Although these complications are usually mild, they may affect patient comfort in the early postoperative period.

3.4.4. Comparison of Complications with Radical Treatment and Satisfaction

Anceschi et al. (2025) in comparative study observed that RARP had the lowest complication rate (probably counting only serious intraoperative complications) compared to focal therapy. Nevertheless, the overall adverse event profile for HIFU and cryoablation was favorable and typical for minimally invasive procedures. High level of patient satisfaction confirms clinical value of FT. Study by Ghoreifi et al. (2023) demonstrated that over 79% of patients stated they would choose focal therapy again, despite 19.6% reporting some degree of regret. This high satisfaction rate reflects FT effectiveness in achieving the key goal—balance between oncological control and optimal quality of life preservation (Ghoreifi et al., 2023; Sandberg et al., 2025).

3.5. Patient Selection Criteria and Role of Imaging

All analyzed studies emphasize that focal therapy success is closely correlated with rigorous and careful patient selection (Tay et al., 2024). Results from various study cohorts allowed definition of ideal candidate characteristics, characterized by localized and volume-limited disease.

3.5.1. Ideal Candidate Characteristics

Meta-analysis by Tay et al. (2024) and data from Popeneciu et al. (2024) identify the following key patient selection criteria that led to best clinical outcomes in analyzed studies:

Tumor advancement stage: Limited focal disease, most commonly Gleason Grade Group 2–3 (Gleason score 3+4 or 4+3).

Clinical parameters: Prostate-specific antigen (PSA) level below 20 ng/mL (with often preferred level <15 ng/mL) and clinical stage ≤T2b.

Visualization: Cancerous lesion must be clearly visible on multiparametric magnetic resonance imaging (mpMRI), with well-defined margins.

Results indicate that adherence to these rigorous patient selection criteria is crucial for achieving low recurrence rates (5–15%) and maximizing functional benefits, as focal therapy is not intended for patients with advanced or disseminated disease.

3.5.2. Role of Imaging in Planning and Surveillance

Results of studies by Duan & Iagaru (2022) and others confirm that advanced imaging is fundamental to FT effectiveness. Multiparametric magnetic resonance imaging (mpMRI) and fusion biopsy (MRI-TRUS) played crucial roles in all studies, including:

Precise localization and characterization of cancerous lesion, essential for defining ablation area and minimizing healthy tissue damage.

Treatment planning and visualization of safety margins.

In post-treatment surveillance context, Kumar et al. (2024) emphasized lack of consensus regarding optimal protocols. It was found that there are no unified guidelines regarding intervals in PSA monitoring, indications for repeat biopsy, and optimal frequency of control imaging using mpMRI, leading to heterogeneity in study results and requiring urgent standardization of surveillance protocols (Kumar et al., 2024).

3.6. Modality-Specific Comparative Results

Detailed comparative results between HIFU, IRE, and cryoablation modalities revealed subtle but significant differences, crucial in clinical decision-making process.

3.6.1. Oncological Differentiation

Despite overall acceptable control, protocol biopsy results (csPCa detection rate) differed significantly:

HIFU (Rosta et al., 2025): 6.5% csPCa.

IRE (Zhang et al., 2024): 24.1% csPCa.

This difference suggests potentially higher efficacy of cancerous tissue destruction by HIFU. However, IRE data are complicated by the fact that hemi-ablation proved significantly more effective (8.6% csPCa) than focal ablation (25% csPCa) (Suberville et al., 2025). These results indicate that IRE, in focal variant, may require larger safety margins to achieve oncological radicality comparable to other techniques.

3.6.2. Functional Differentiation

Most striking differences occurred in sexual function context:

IRE demonstrated best functional profile (potency preservation 93%), resulting from non-thermal mechanism that better protects neurovascular bundles (George et al., 2024).

HIFU was associated with transient potency decline, but with full or nearly full recovery at 24 months of follow-up (Rosta et al., 2025).

Cryoablation was consistently associated with higher risk of permanent potency impairment (Ramalingam et al., 2023; Tan et al., 2023).

Regarding urinary continence, results were consistently excellent across all modalities (Tay et al., 2024; Rosta et al., 2025).

3.6.3. Differentiation in Safety and Implementation

Results of studies by Mala et al. (2023) concerning learning curve in HIFU and data by Zhang et al. (2024) on cardiological requirements of IRE emphasize that clinical implementation of individual methods differs significantly. IRE requires cardiological synchronization and general anesthesia. HIFU and cryoablation (the latter associated with perineal pain risk) have different logistical challenges. Therefore, results clearly indicate that no modality is absolutely best. Choice of optimal technique must result from

individual matching of tumor characteristics to modality's mechanism of action (e.g., IRE for neurovascular bundle sparing, HIFU for posterior lesions) and to patient's functional priorities.

Consequently, the evidence distinctly indicates that no single modality achieves absolute superiority. A comprehensive comparison of the oncological and functional differentiation is presented in Table 1.

Table 1. Comparison of Oncological, Functional, and Logistical Differentiation of Ablative Methods

Comparison Criterion	HIFU (High-Intensity Focused Ultrasound)	IRE (Irreversible Electroporation)	Krioablacja
Detection of csPCa in Protocol Biopsy	6,5%	24,1%	No direct comparative data in this context, but 78.6% of patients were csPCa-free at 12 months
Sexual Function (Potency)	Transient decline, full or near-full functional recovery at 24 months	Best functional profile (93% potency preservation), due to the non-thermal mechanism	Consistently associated with a higher risk of permanent potency impairment
Urinary Continence	Consistently excellent results		
Logistics / Safety Requirements	Requires consideration of the learning curve	Requires cardiac synchronization and general anaesthesia	Associated with the risk of perineal pain (or perineal discomfort).
Ideal Application	Ideal for posteriorly located lesions	Ideal for neurovascular bundle preservation..	In cases of specific anatomical challenges precluding the use of HIFU or IRE; as an effective salvage treatment option after radiotherapy failure

3.7. Clinical Implementation and Regional Differentiation

Data analysis also provided important information about clinical status and regional acceptance of focal therapy.

3.7.1. Recognition and Reimbursement

Results of studies by Kumar et al. (2024) and Rokan & Reddy (2025) demonstrated significant geographical differentiation in FT implementation and acceptance. In regions such as Canada and the United Kingdom, focal therapy has been formally included in clinical guidelines and reimbursement systems, facilitating broader access. In contrast, in other regions regulatory barriers and lack of reimbursement still limit availability of this method, despite accumulation of scientific evidence (Kumar et al., 2024; Rokan & Reddy, 2025).

3.7.2. Need for International Cooperation

Differentiation in surveillance protocols (Kumar et al., 2024) and regional differences in implementation emphasize that despite strong clinical results (e.g., 94.1% FFS after HIFU), lack of standardization at international level remains a significant obstacle. Implementation of consistent, prospectively validated surveillance protocols is one of the most important future outcomes researchers strive for, which will contribute to consistency of further research and facilitate broader FT acceptance.

3.8. Summary of Results and Data Limitations

Compilation of results from 28 studies provides strong evidence base for focal therapy. It was found that:

HIFU has most established oncological data in medium term (median BCR-free survival ≈ 63 months) and very low complication rate and high continence preservation (Rosta et al., 2025).

IRE offers best results in erectile function preservation (93%), but is associated with higher risk of disease persistence in case of focal ablation (25%).

Cryoablation is an effective ablative method (78.6% free from csPCa after 12 months), but is associated with greater impact on potency.

All modalities provide significantly better preservation of urinary and sexual function compared to radical treatment (Nyk et al., 2022).

Rigorous patient selection (PSA <20 ng/mL, GG 2–3, ≤T2b) and advanced imaging (mpMRI) are necessary conditions for achieving optimal outcomes (Tay et al., 2024; Duan & Iagaru, 2022).

Key limitation of presented results is short follow-up period in most studies, which is insufficient for definitive assessment of long-term oncological control in context of natural course of prostate cancer. Nevertheless, consistency of positive results regarding quality of life preservation and acceptable oncological control, particularly in context of high patient satisfaction (>79% Ghoreifi et al., 2023), constitutes strong argument for continuation of research and expansion of access to focal therapy.

3.9. Detailed Analysis of Oncological Outcomes Depending on Modality and Ablation Extent

Differences in mechanisms of action (thermal for HIFU and cryoablation, non-thermal for IRE) lead to clinically important discrepancies in achieved ablation results, requiring detailed discussion of oncological durability.

3.9.1. Detailed Analysis of HIFU Oncological Durability

HIFU, based on thermal destruction, demonstrates most stable oncological profile in medium term. Results by Yang et al. (2024), indicating median biochemical recurrence-free survival (BCR-free survival) of approximately 63 months, constitute significant measure of long-term control. High 5-year overall survival rate (88%) and cancer-specific survival (94%) (Yang et al., 2024) strengthen HIFU's position as treatment option with significant efficacy. Detailed results by Rosta et al. (2025) concerning 2-year failure-free survival (FFS) at 94.1% and low 6.5% rate of clinically significant prostate cancer detection in protocol biopsy (Rosta et al., 2025) is one of lowest reported residual disease rates. This result suggests that precise patient selection (Tay et al., 2024) combined with center experience (Mala et al., 2023) allows HIFU to achieve very high radicality within ablation field.

3.9.2. Detailed Analysis of IRE Oncological Durability and Impact of Ablation Extent

Oncological outcomes for IRE (Zhang et al., 2024; Suberville et al., 2025) are more complex and strongly dependent on surgical technique, resulting from unique, non-thermal mechanism of action. Although IRE has theoretical advantage in function preservation (Cribbs et al., 2023), its efficacy in complete cellular destruction may be lower than HIFU. Data by Zhang et al. (2024), indicating 24.1% csPCa in protocol biopsy after IRE, constitute a challenge. This may result from difficulties in precise electrode needle positioning and lack of visible ablation zone in real-time, unlike monitoring in cryoablation (Ramalingam et al., 2023) or HIFU. Key result in IRE context is analysis by Suberville et al. (2025), which clearly distinguishes focal ablation from hemi-ablation. Significantly higher oncological control in hemi-ablation group (8.6% persistent csPCa) compared to focal ablation group (25% persistent csPCa) provides evidence that in IRE case, maintaining minimal treatment extent may be oncologically risky. This result may indicate need for wider safety margin or whole lobe ablation (hemi-ablation) to achieve durable oncological outcomes using IRE (Suberville et al., 2025).

3.9.3. Detailed Analysis of Cryoablation Oncological Durability

Cryoablation provides satisfactory early results, though with shorter follow-up period. Phase II study by Tan et al. (2023) with mandatory rebiopsy demonstrated that 78.6% of patients were free from detectable csPCa at 12-month assessment. This result, though lower than HIFU after 2 years (Rosta et al., 2025), is promising. An important asset of cryoablation, contributing to its oncological outcomes, is excellent real-time visualization of ice ball under ultrasound control (Ramalingam et al., 2023; Fuller et al., 2023). Ability to precisely monitor ice ball expansion enables operator to ensure appropriate ablation margins, directly affecting minimization of incomplete tumor destruction risk and persistent csPCa (Ramalingam et al., 2023).

3.9.4. Implications of Rigorous Treatment Failure Definition

Results by Dias et al. (2022), which applied rigorous treatment failure definition (FFS)—need for salvage treatment—indicate lower oncological effect durability in longer term, with FFS at 75.6% at 2 years and declining to 53.6% at 4 years. These results have fundamental significance for FT contextualization. They mean that patients in whom index lesion destruction was initially successful may still require radical treatment or other form of salvage therapy after several years (Dias et al., 2022). This perspective strengthens necessity of rigorous surveillance (Kumar et al., 2024) and emphasizes oncological compromise—better function at cost of potentially higher disease progression risk compared to immediate radical treatment (Anceschi et al., 2025).

3.10. Detailed Analysis of Functional Outcomes in Direct Comparison FT vs. Radical Treatment

Clinical value of focal therapy is most strongly supported by functional outcome data, which constitute main driving force of this method's patient choice.

3.10.1. Urinary Continence - Dominant FT Advantage

Regarding urinary function, focal therapy provides results unattainable for radical treatment. Results by Tay et al. (2024), indicating that 97.1% (33/34) studied cohorts report low impact on continence, and data by Rosta et al. (2025), reporting ≈2% clinically significant urinary incontinence after HIFU, contrast with commonly accepted and significantly higher urinary incontinence rates after radical prostatectomy. This minimal risk of permanent sphincter dysfunction results from preservation of prostate tissue beyond ablation focus and constitutes FT's greatest advantage.

3.10.2. Sexual Function - Critical Comparison

Most detailed comparative data come from study by Nyk et al. (2022), which compared HIFU-FT with LRP. The difference in IIEF-5 score decline is dramatic: ≈0.03 points for HIFU-FT vs. ≈7.40 points for LRP (Nyk et al., 2022). These numbers are not only statistically significant but reflect clinically profound difference in quality of life. Minimal IIEF-5 decline after HIFU-FT means that most patients were able to maintain their baseline erectile function with minimal interference, while patients after LRP experienced significant function deterioration. Analysis by Rosta et al. (2025) further complicates the picture, demonstrating transient IIEF-5 decline after HIFU (≈-3 points at 3 months), with return to baseline at 24 months. This result suggests that potency decline after FT may often be reversible, resulting from transient swelling and inflammation rather than permanent nerve fiber damage, as in RARP case (Nyk et al., 2022; Rosta et al., 2025). Key predictor of function recovery is baseline potency status, which is consistent result across all FT series. These results confirm that although radical treatment may offer longest oncological durability (Anceschi et al., 2025), this occurs at cost of significant function impairment.

4. Discussion

Focal therapy (FT) for prostate cancer, encompassing high-intensity focused ultrasound (HIFU), irreversible electroporation (IRE), and cryoablation, constitutes an increasingly established therapeutic option, positioning itself as balanced compromise between active surveillance and radical treatment (Lasorsa et al., 2024). The presented narrative review, based on analysis of 28 studies published between 2022–2025, provides current synthesis of evidence regarding comparison of these three ablative modalities, focusing on their technical differences, oncological efficacy, functional outcomes, and safety profile. Key discussion issues concentrate on optimization of patient selection, choice of appropriate modality, and future research directions, especially in context of long-term oncological durability and standardization of surveillance protocols.

4.1. Comparison of Efficacy and Safety

This data synthesis reveals that all three established focal therapy methods achieve acceptable oncological control in medium follow-up period, while simultaneously significantly better preserving function compared to radical treatment methods (Nyk et al., 2022; Skribek et al., 2025). Differences in results often stem from heterogeneity of research protocols, treatment failure definitions, and follow-up time, which is key limitation in direct outcome comparison (Tay et al., 2024).

4.1.1. Oncological Efficacy - Complexity of Failure Definition

Literature is dominated by view that focal therapy oncological efficacy is high in carefully selected patients with volume-limited disease (Skribek et al., 2025). Skribek et al. (2025) in their systematic review noted in-field recurrence and out-of-field recurrence rates at 5–15%. This relatively low rate suggests that precise ablation, aided by advanced imaging, is possible and effective in eliminating clinically significant cancer.

In HIFU context, data appear most established due to longer clinical experience time. Systematic review by Yang et al. (2024) demonstrated that median biochemical recurrence-free survival (BCR-free survival) for primary HIFU was approximately 63 months, which is promising result in organ-sparing treatment. Moreover, 5-year overall survival and cancer-specific survival rates for this modality reached 88% and 94% respectively (Yang et al., 2024). Latest prospective study by Rosta et al. (2025) confirms these trends, reporting 2-year failure-free survival of 94.1% in focally treated patients. Importantly, protocol biopsy in this cohort revealed clinically significant cancer (csPCa) in only 6.5% of patients, testifying to high ablation efficacy (Rosta et al., 2025).

On the other hand, IRE, due to its non-thermal mechanism, raises hopes for minimizing thermal damage to periprostatic structures, which theoretically should favor function preservation with comparable oncological

efficacy (George et al., 2024). However, the largest international multicenter study by Zhang et al. (2024) revealed higher percentage of csPCa detection in protocol biopsy (24.1%) after median follow-up of 24 months. This constitutes significant contrast compared to HIFU data (6.5% csPCa) and may raise questions about IRE oncological effect durability, although this study is limited by shorter follow-up period and heterogeneity of surgical techniques (Zhang et al., 2024). Moreover, study by Suberville et al. (2025) on patients undergoing IRE demonstrated that hemi-ablation provided significantly better oncological control (8.6% persistent csPCa) compared to focal ablation (25% persistent csPCa), suggesting that smaller ablation extent may go hand in hand with higher risk of overlooking or disease recurrence in IRE case, questioning focal therapy minimalism (Suberville et al., 2025).

Cryoablation also presents promising early oncological data. Phase II study by Tan et al. (2023) with mandatory rebiopsy demonstrated that 78.6% of patients had no detectable clinically significant prostate cancer at 12-month assessment. Although this rate is lower than in study by Rosta et al. (2025) for HIFU (93.5% free from FFS failure), overall trend indicates that cryoablation is effective ablative method, especially considering technical improvements such as advanced temperature monitoring and MRI-TRUS fusion systems (Fuller et al., 2023; Ramalingam et al., 2023).

However, it should be emphasized that failure-free survival (FFS) results, measured by more rigorous definition (need for additional treatment), may be lower. Study by Dias et al. (2022), combining HIFU and cryoablation, demonstrated FFS of 75.6% at 2 years and 53.6% at 4 years. Authors attributed this result precisely to rigorous failure definition, which is crucial for realistic patient information about possible need for salvage treatment (Dias et al., 2022). Ultimately, Anceschi et al. (2025) in their comparative study demonstrated that RARP was characterized by longest oncological effect durability, indicating that patient must be aware of compromise between better function and higher oncological failure risk, which was also noted by Nyk et al. (2022).

4.1.2. Functional Outcomes - Sexual Potency and Urinary Continence

Preservation of urological and sexual functions is key advantage of focal therapy over radical treatment. Nyk et al. (2022) demonstrated in comparative study HIFU vs. laparoscopic radical prostatectomy (LRP) that HIFU showed significantly better results in urinary and sexual function at 12 months. IIEF-5 score decline was significantly smaller after HIFU-FT (change: ~0.03 pts) than after LRP (change: ~7.40 pts), meaning significant HIFU advantage in erectile function preservation (Nyk et al., 2022). Regarding urinary continence, meta-analysis by Tay et al. (2024)—data from 34 cohorts reporting urinary function, in which 97.1% (33/34) reported low FT impact on continence, confirm that urinary incontinence is rare incident after focal therapy (~2% in Rosta et al., 2025 series), which is incomparably better result than in radical treatment case (Nyk et al., 2022).

Greatest functional differences appear in comparison of modalities among themselves, especially in erectile function context. IRE is often promoted as technique with best functional profile (Zhang et al., 2024; Yaxley et al., 2022). Cribbs et al. (2023) report clear IRE advantage in potency preservation (93% vs. 67% for HIFU). This difference results from IRE's non-thermal mechanism, which has theoretical advantage in better neurovascular bundle preservation (George et al., 2024).

On the other hand, HIFU is associated with transient but usually reversible erectile function decline. Rosta et al. (2025) noted transient mean IIEF decline (approximately -3 pts at 3 months), with return to baseline or even exceeding it at 24 months of follow-up, with clear influence of baseline erectile function on final outcome (Rosta et al., 2025). Cryoablation, using extreme cold (below -40°C) and inducing microvascular damage, has historically been associated with higher impact on erectile function (Ramalingam et al., 2023; Tan et al., 2023), which remains significant limitation of this method, particularly for younger patients with high priority for sexual function preservation (Tan et al., 2023). Anceschi et al. (2025) demonstrated that potency recovery was comparable between all three techniques, with faster return in some HIFU patients, but statistically confirmed superiority of focal therapies over RARP in sexual function after two years of follow-up could not be proven, which is signal that optimization of these outcomes remains research goal.

4.1.3. Safety Profile and Patient Satisfaction

Scientific literature analysis reveals that safety profile of focal therapy (FT) for prostate cancer is generally favorable, and most reported complications are mild and transient (Zhang et al., 2024). Nevertheless, individual FT methods—HIFU, IRE, and cryoablation—display unique spectrum of potential adverse events that should be compared in treatment planning context.

Among FT procedures, HIFU (High-Intensity Focused Ultrasound) technology is characterized by low rate of severe complications; Rosta et al. (2025) noted no grade 4 events on Clavien–Dindo scale. Dominant

adverse event, occurring in 7% of patients (Mala et al., 2023; Rosta et al., 2025), was acute urinary retention, indicating potential risk of transient urological function impairment.

Similar confirmation of general safety comes from IRE (Irreversible Electroporation) analysis. PRESERVE study also noted no grade 4 or 5 complications, strengthening conviction about minimally invasive nature of this technique (George et al., 2024; Zhang et al., 2024). However, critical, unique to IRE risk is cardiac arrhythmia induced by electrical pulses. This specific threat necessitates pulse synchronization with heart rhythm, general anesthesia application, and cardiological monitoring (Zhang et al., 2024), increasing procedure complexity and costs.

Regarding cryoablation, complication profile is dominated by perineal pain and transient swelling (Ramalingam et al., 2023). Although these ailments are usually transient, their relatively frequent occurrence constitutes significant factor affecting convalescence and patient comfort in postoperative period.

In broader therapeutic context, comparison by Anceschi et al. (2025) suggests that RARP (Robotic-Assisted Radical Prostatectomy) may have lowest complication rate, especially regarding serious intraoperative events. However, it should be emphasized that HIFU and cryoablation demonstrated favorable adverse event profile, typical for minimally invasive procedures (Anceschi et al., 2025). This observation is crucial because it strengthens argument that focal therapies allow preservation of minimal invasiveness benefits with acceptable safety level.

Ultimate confirmation of FT approach efficacy and acceptance is high level of patient satisfaction. Study by Ghoreifi et al. (2023) demonstrated that over 79% of patients would choose focal therapy again, despite 19.6% reporting some degree of decisional regret. This high satisfaction rate and low regret percentage reflect fact that FT meets key patient expectation: maintaining balance between oncological control and quality of life protection (Ghoreifi et al., 2023; Sandberg et al., 2025). This means that despite specific, though usually mild complications, overall experience associated with focal therapy is perceived as positive and justifying undertaken treatment.

4.2. Considerations Regarding Individual Methods

Choice of appropriate ablative modality is critical element of decision-making process and should be strictly individualized (Tay et al., 2024).

4.2.1. When to Consider HIFU

HIFU, as most established option with longest observational data and regulatory approvals in many countries (Shoji, 2023), is often first-choice modality. It appears particularly appropriate for patients with posteriorly and posterolaterally located cancer foci, due to transrectal probe availability (Rosta et al., 2025). HIFU is also preferred for patients whose priority is urinary continence preservation, as urinary incontinence rates are exceptionally low (Mala et al., 2023). Difficulties in accessing anterior lesions constitute significant exclusion criterion (Rosta et al., 2025). From clinical implementation standpoint, HIFU recently obtained "advanced medical care" status in Japan, confirming progress and acceptance of this technology (Shoji, 2023).

4.2.2. When to Consider IRE

IRE is optimal technique for patients whose priority is maximum erectile function preservation. Non-thermal mechanism of action, consisting of creating permanent pores in cell membranes, theoretically allows better protection of nerve and vascular fibers (Zhang et al., 2024; George et al., 2024; Cribbs et al., 2023). IRE is often chosen for treating lesions located near neurovascular bundles or in anterior zone, where risk of thermal nerve damage by HIFU could be greater. Nevertheless, potentially lower oncological efficacy in focal ablation compared to hemi-ablation (Suberville et al., 2025) and requirement for cardiological synchronization and general anesthesia (Zhang et al., 2024) must be considered in decision-making process.

4.2.3. When to Consider Cryoablation

Cryoablation, utilizing freeze-thaw cycles for tissue destruction (Ramalingam et al., 2023), provides excellent ablation zone visualization through real-time "ice ball" monitoring, which is significant advantage in ensuring appropriate safety margins (Ramalingam et al., 2023; Fuller et al., 2023). It also provides potentially more complete cell destruction through dual cycles (Ramalingam et al., 2023). Cryoablation may be considered in centers with experience in this technique, especially in cases of anatomy that makes HIFU or IRE use difficult, as well as effective salvage treatment option after radiotherapy failure (Yu & Pow-Sang, 2024). Unfortunately, higher impact on erectile function is significant limitation, particularly for younger and sexually active patients (Tan et al., 2023).

4.3. Refinement of Patient Selection Criteria

Focal therapy success is inseparably linked with strict and rigorous patient selection (Tay et al., 2024). These methods were designed for patients with localized, unilateral or volume-limited cancer (Lasorsa et al., 2024). Meta-analysis by Tay et al. (2024) defines ideal candidate characterized by:

Tumor characteristics: Limited focal disease, Gleason Grade Group 2-3 (Gleason score 3+4 or 4+3), lesion visible on mpMRI with clear margins.

Clinical parameters: PSA <20 ng/mL (most commonly <15 ng/mL), clinical stage ≤T2b, predicted life expectancy >10 years.

Anatomical conditions: Lesion location appropriate for selected modality, appropriate prostate size (particularly for HIFU).

Contemporary practice expands FT application, including patients who originally met criteria for active surveillance but decided on intervention due to preferences or fear of progression (Popeneciu et al., 2024). This growing confidence in FT oncological outcomes enables increasingly personalized treatment strategies, adapting to patient's functional and psychological priorities (Popeneciu et al., 2024).

4.4. Role of MRI and Supporting Imaging

Advances in multiparametric magnetic resonance imaging (mpMRI) are fundamental to focal therapy development and efficacy (Duan & Iagaru, 2022). This imaging enables precise localization and characterization of cancerous lesion, which is absolutely crucial for defining ablation target and preserving healthy tissue (Duan & Iagaru, 2022).

Key roles of mpMRI and other imaging techniques include:

Treatment planning and margin assessment.

Procedure guidance (e.g., MRI-ultrasound fusion biopsy).

Post-treatment surveillance (for early recurrence detection).

Duan and Iagaru (2022) emphasize that "multiparametric MRI- and PET-targeted prostate biopsies mitigate the shortcomings and risks" of traditional biopsy methods, enabling more accurate detection of clinically significant cancers, which is necessary condition for effective focal therapy. PSMA-PET use may also help identify clinically significant disease and exclude metastases before focal intervention (Duan & Iagaru, 2022).

4.5. Clinical Implications

Clinical implication of presented data is need for treatment individualization (Tay et al., 2024). Decision on ablative modality choice (HIFU, IRE, Cryoablation) should result from:

Tumor characteristics (location, size, Gleason score).

Anatomical conditions (e.g., urethral proximity, accessibility).

Patient's functional priorities (e.g., erection preservation vs. minimal incontinence risk).

Moreover, institutional experience plays crucial role. Mala et al. (2023) clearly document significant learning curve in HIFU therapy, with clear complication reduction as team experience grows. Focal therapy implementation in center requires commitment, appropriate case volume, and systematic team training (Mala et al., 2023). Implication is that this treatment should be centralized in experienced centers to minimize complication risk and maximize oncological and functional outcomes.

4.6. Unresolved Questions and Future Research Directions

Despite growing number of high-quality evidence (Tay et al., 2024; Zhang et al., 2024; Rosta et al., 2025), focal therapy still faces several unresolved questions that constitute main future clinical research directions.

4.6.1. Optimal Ablation Extent

Debate regarding optimal ablation extent persists in literature (Yee et al., 2025). Applied strategies include: focal ablation (index lesion only), hemi-ablation (entire involved lobe), and extended focal ablation (index lesion plus margin). Study by Suberville et al. (2025) concerning IRE, which demonstrated significantly better oncological control in hemi-ablation group compared to focal ablation (8.6% vs. 25% persistent csPCa), suggests that focal therapy minimalism may be too ambitious for some modalities and patient groups. Yee et al. (2025) propose individualized "à la carte" approach that adjusts ablation extent to individual tumor characteristics and patient anatomy, which may be future solution but requires further validation in prospective studies.

4.6.2. Long-term Oncological Durability

Key unresolved question remains long-term oncological durability, as natural course of prostate cancer requires >10 years of follow-up (George et al., 2024). Current data from high-quality studies concern medium follow-up periods, insufficient for definitive assessment (e.g., Rosta et al., 2025 – 2-year follow-up; Zhang et al., 2024 – median 24 months). Many important prospective studies are ongoing, including PRESERVE study (George et al., 2024) and continuation of cohort follow-up such as Mala et al. (2023) and Zhang et al. (2024), which will ultimately provide data on whether focal therapy provides durable cure or primarily delays need for radical treatment (George et al., 2024).

4.6.3. Optimal Surveillance Protocols

Lack of consensus regarding post-treatment surveillance protocols is significant obstacle in optimal patient management (Kumar et al., 2024). Kumar et al. (2024) emphasize that there are no unified guidelines regarding:

Intervals in PSA monitoring.

Indications for repeat biopsy. Role of mpMRI surveillance (control imaging frequency).

Standardized surveillance protocols are needed, validated in prospective studies, to enable early recurrence detection (in-field or out-of-field) while avoiding excessive diagnostics that could negate benefits from therapy's sparing nature.

4.7. Considerations for Focal Therapy Implementation

Effective and safe implementation of focal therapy in clinical practice is a multidimensional process (Duan & Iagaru, 2022; Mala et al., 2023). It requires coordinated actions at both institutional and clinical levels.

First, multidisciplinary assessment is necessary. Patients should be evaluated by a team including urologists, oncologists, and radiologists to ensure comprehensive assessment and discussion of all available treatment options. Second, access to high-quality imaging is crucial. Not only the device itself is required (e.g., 3T multiparametric MRI), but also an experienced team of genitourinary radiologists and the capability to perform MRI-ultrasound fusion biopsy. Third, as documented by Mala et al. (2023), the learning curve must be considered, which requires institutional commitment and appropriate case volume. Finally, comprehensive patient counseling and obtaining informed consent are essential, honestly presenting the limitations of long-term oncological data, risk of complications, detailed post-treatment surveillance requirements, and preservation of salvage treatment options (Mala et al., 2023). Centers should also develop standardized protocols (Kumar et al., 2024), including patient selection criteria, treatment procedures, and surveillance strategies, which promote consistency and reproducibility of outcomes.

4.8. Geographic Variation

Implementation of focal therapy is significantly varied geographically (Kumar et al., 2024; Rokan & Reddy, 2025). As emphasized by Kumar et al. (2024) and Rokan and Reddy (2025), in regions such as Canada and the United Kingdom, focal therapy has already been incorporated into clinical guidelines and reimbursement systems, which has significantly facilitated broader access. This progress demonstrates recognition of these methods by regulatory bodies as safe and effective for appropriate indications (Kumar et al., 2024; Rokan & Reddy, 2025). In contrast, in other regions, regulatory and reimbursement barriers still limit accessibility, despite accumulating scientific evidence. This variation underscores the need for further international collaboration and evidence synthesis to support policy decisions and facilitate access to innovative, organ-sparing treatment methods for patients worldwide.

4.9. Review Limitations

The present review, despite comprehensive synthesis of recent literature, has inherent limitations arising from the nature of analyzed data.

Short follow-up time: Most data concern median follow-up periods that are insufficient to draw definitive conclusions about long-term oncological control, which for prostate cancer requires a perspective of >10 years. Many studies (e.g., Rosta et al., 2025) report only 2-year outcomes.

Study heterogeneity: Variation in definitions of treatment failure (e.g., Dias et al., 2022 vs. Rosta et al., 2025), surveillance protocols, and patient populations (e.g., inclusion of intermediate-risk groups) significantly limits the possibility of direct comparison and quantitative meta-analysis (Tay et al., 2024).

Lack of Randomized Controlled Trials (RCTs): Most studies are prospective or retrospective case series or cohort studies. The absence of RCTs with long follow-up periods makes it difficult to establish definitive superiority of one modality over another and over radical treatment.

Narrative approach: Due to heterogeneity, the review employed qualitative synthesis instead of quantitative meta-analysis, which limits statistical precision.

Despite these limitations, consistent results across multiple high-quality studies from different international institutions provide substantial evidence that focal therapy represents a viable, safe, and effective treatment option for appropriately selected patients (Anceschi et al., 2025; Tay et al., 2024).

5. Conclusions

This narrative review, based on systematic analysis of 28 contemporary studies published between 2022 and 2025, confirms that focal therapy (FT), including high-intensity focused ultrasound (HIFU), irreversible electroporation (IRE), and cryoablation, represents a viable, minimally invasive therapeutic option for patients with localized prostate cancer. The clinical value of FT is firmly established through achievement of a satisfactory compromise between acceptable oncological control and significant preservation of quality of life, especially regarding urinary and sexual function.

5.1 Oncological Efficacy and Differences Between Modalities

Oncological outcomes are generally acceptable, with in-field and out-of-field recurrence rates maintained at 5–15% in carefully selected patients. In terms of durability of effect, HIFU provides the most established evidence in the medium term, with median biochemical recurrence-free survival (BCR-free survival) of approximately 63 months. Five-year overall survival (OS) and cancer-specific survival (CSS) rates of 88% and 94%, respectively, strengthen HIFU's position as an effective option. Importantly, prospective data for HIFU indicate one of the lowest rates of clinically significant prostate cancer (csPCa) detection in protocol biopsy (6.5%).

IRE demonstrates more varied oncological outcomes, which appears to be strongly associated with ablation extent. Focal ablation (index lesion only) was associated with a high rate of persistent csPCa (25%), which poses a challenge. Significantly better oncological control was achieved using hemi-ablation (ablation of the entire affected lobe), where the rate of persistent csPCa decreased to 8.6%. This result suggests that for IRE, therapeutic minimalism may be oncologically risky and requires wider safety margins or whole-lobe treatment. Cryoablation provides promising early results (78.6% free from csPCa at 12 months), partly due to excellent real-time visualization of the ice ball, which enables precise assurance of ablation margins.

In direct comparison, radical prostatectomy (RARP) demonstrated the longest durability of oncological effect. Analysis of failure-free survival (FFS), measured by the need for salvage treatment, showed a decrease in FFS to 53.6% at 4 years for FT. These data strengthen the conclusion that FT is an option carrying higher risk of requiring salvage treatment in the longer term, which constitutes an oncological compromise acceptable for patients whose priority is function preservation.

5.2 Functional Outcomes and Safety Profile

The main advantage of FT over radical treatment lies in preservation of urological and sexual function. Urinary continence is consistently excellent across all modalities, with a clinically significant urinary incontinence rate of only ~2% after HIFU and a very low rate reported in 97.1% of analyzed FT cohorts.

5.2.1 Regarding sexual function, there are significant differences between FT techniques themselves:

IRE provides the best potency preservation (93% preservation) due to its non-thermal mechanism, which minimizes damage to neurovascular bundles.

HIFU is associated with better functional outcomes than radical treatment (mean IIEF-5 decrease was -0.03 points after HIFU-FT vs. ~7.40 points after LRP). Initial potency decline after HIFU is typically transient, with return of erectile function to baseline values noted at 24-month follow-up.

Cryoablation is consistently associated with higher risk of permanent potency impairment, making it less optimal for patients prioritizing preservation of this function.

The safety profile of FT is generally favorable. In both HIFU and IRE studies, no grade 4 or 5 complications on the Clavien-Dindo scale were reported. The most common complication after HIFU was acute urinary retention (7% of patients). Unique to IRE is the requirement for cardiac synchronization, due to the risk of arrhythmias induced by electrical pulses. Despite the risk of requiring salvage treatment, patient satisfaction is high (>79% of patients would choose FT again), which confirms the clinical value of the achieved balance between oncological control and quality of life.

5.3 Clinical Implications and Limitations

A key conclusion for clinical implementation is the absolute necessity of rigorous patient selection. Ideal candidates are patients with volume-limited disease, most commonly Gleason Grade Group 2-3 (GG 2-3), PSA level below 20ng/mL (preferred <15ng/mL), and clinical stage ≤T2b, with tumor clearly visible on multiparametric magnetic resonance imaging (mpMRI). Advanced imaging (mpMRI and MRI-TRUS fusion biopsy) is of fundamental importance for precise treatment planning and margin definition.

5.3.1 Selection of optimal FT modality must be individualized based on patient priorities and tumor characteristics:

IRE is preferred when maximal preservation of erectile function is a priority.

HIFU may be more effective in tumor tissue destruction (lower rate of residual csPCa) and is used in treatment of posterior lesions.

The most significant limitation of current scientific evidence remains short follow-up time (with predominant 2-year outcomes), which is insufficient for definitive assessment of long-term oncological control in the context of the natural history of prostate cancer. Furthermore, there is a lack of international consensus regarding post-treatment surveillance protocols (PSA monitoring, indications for repeat biopsy, and frequency of follow-up mpMRI), which leads to heterogeneity of study results. Further research must focus on validation of standardized, prospective surveillance protocols and on studies with long follow-up periods to determine whether FT provides durable cure or merely delays the need for radical treatment.

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