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Transrectal and Transperineal Prostate Biopsy under Local Anesthesia with Transrectal Ultrasound Guidance Comprehensive Review of Techniques and Complications

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ABSTRACT

Background: Prostate cancer is a leading cause of cancer-related morbidity and mortality in men. Accurate diagnosis through prostate biopsy is essential for early detection and management. Transrectal ultrasound (TRUS)-guided biopsy has been the standard approach, but the transperineal route under local anesthesia has gained popularity due to potentially lower infection rates and better access to certain prostate regions. **Objective:** To compare the outcomes of transperineal and transrectal prostate biopsy under local anesthesia with TRUS guidance, focusing on feasibility, cancer detection rates, procedural times, and complication rates. **Methods:** A comprehensive literature search was conducted in PubMed, MEDLINE, EMBASE, and Cochrane Library databases for studies published from January 2000 to December 2023. Studies comparing transperineal and transrectal prostate biopsy techniques were included. Data on cancer detection rates, procedural times, and complications were extracted and synthesized narratively. **Conclusion:** Transperineal prostate biopsy under local anesthesia with TRUS guidance appears to be a viable alternative to the traditional transrectal approach, offering advantages in terms of cancer detection and reduced complication rates. Further large-scale, comparative studies are needed to confirm these findings and refine the technique.

Keywords: Transperineal prostate biopsy, Transrectal ultrasound-guided biopsy, Local anesthesia, Prostate cancer detection, Complications.

1. Introduction

Prostate cancer is the second most common cancer in men worldwide, with an estimated 1.4 million new cases diagnosed in 2020 alone. Early detection of prostate cancer is critical for improving patient outcomes, and prostate biopsy remains the gold standard for diagnosing this disease. Transrectal ultrasound (TRUS)-guided biopsy has long been the standard approach for obtaining prostate tissue samples, but it is not without its limitations, particularly in terms of infection risk and sampling errors. In recent years, transperineal prostate biopsy has emerged as an alternative approach that may offer several advantages over the transrectal approach (Cereser *et al.,* 2023).

Transperineal prostate biopsy involves accessing the prostate through the perineum, which is the area between the scrotum and the anus. This approach allows for better access to the prostate gland and may reduce the risk of infection compared to transrectal biopsy. Additionally, transperineal biopsy can be performed under local anesthesia, making it a more comfortable option for patients. However, the feasibility and efficacy of transperineal biopsy compared to transrectal biopsy remain subjects of debate (Power *et al.,* 2022).

One area of interest is the feasibility of performing transperineal prostate biopsy freehand, without the use of a template or grid system. Freehand biopsy may offer advantages in terms of cost and simplicity compared to template-guided biopsy, but its efficacy and safety need to be carefully evaluated. Another important consideration is the cancer detection rate (CDR) of transperineal biopsy

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compared to transrectal biopsy. Several studies have suggested that transperineal biopsy may offer a higher CDR, particularly in patients with anteriorly located tumors (Sivaraman *et al.,*2022).

In addition to CDR, procedural time is another important factor to consider when comparing transrectal and transperineal biopsy techniques. Procedural time includes preparation time, biopsy time, and recovery time, and it can impact patient comfort and healthcare resource utilization. Complications are also a crucial consideration when evaluating biopsy techniques. Genitourinary tract infections, urosepsis, hematuria, rectal bleeding, and the need for readmission are all potential complications of prostate biopsy, and the rates of these complications may differ between transrectal and transperineal approaches (Xue *et al.,* 2017).

The aim of this review is to assess the feasibility of freehand transperineal prostate biopsy under local anesthesia and compare the efficacy (CDR and procedural time) and complications (genitourinary tract infections, urosepsis, hematuria, rectal bleeding, and the need for readmission) of both transrectal and transperineal techniques.

2. Methodology of the Review

This comprehensive review was conducted to assess the outcomes of transperineal and transrectal prostate biopsy under local anesthesia with transrectal ultrasound guidance. The following methodology was employed:

I. Literature Search:

A systematic search was conducted in electronic databases including PubMed, MEDLINE, EMBASE, and Cochrane Library. The search was performed using a combination of keywords and MeSH terms such as "transperineal prostate biopsy," "transrectal prostate biopsy," "local anesthesia," "transrectal ultrasound-guided biopsy," "prostate cancer detection," "complications," and "feasibility." The search was limited to studies published in English from January 2000 to December 2023.

3. Applied Anatomy of Prostate Biopsy:

I. Prostate Zonal Anatomy

The prostate is divided into four zones: central (CZ), transitional (TZ), peripheral (PZ), and anterior fibromuscular stroma (AFMS). The PZ, accounting for 75% of cancers, is where 70% of glandular tissue is found. BPH typically develops in the TZ, which also accounts for 20% of cancer, while the CZ accounts for 5–8% of cancer (Żurowska *et al.,* 2023).

II. Ultrasonographic Anatomy

Ultrasonographic anatomy shows age-related changes in prostate shape, with a more ovoid shape in younger patients and a roundish or pear-like shape after 50. In TRUS, the PZ is easily recognizable as more homogeneous and mildly hyperechoic compared to the central zone. The central area, including the central and transitional zones, appears relatively hypoechoic and nonhomogeneous (Lotti *et al.,* 2022).

III. TRUS for Prostate Evaluation

TRUS is highly accurate in measuring prostate volume, with results comparable to MRI. It is cost-effective and widely available, making it preferred for mapping prostate size and shape. Current AUA guidelines recommend preoperative assessment of prostate size and shape via TRUS or MRI (Panzone *et al.,* 2022).

4. Prostate Cancer Imaging

Prostate cancer imaging on TRUS has limited diagnostic accuracy. Most cancers appear hypoechoic, but some are isoechoic or hyperechoic. Lesions are better visualized in the PZ than in the TZ due to the latter's heterogeneous pattern. Additional findings suggestive of malignancy include capsule irregularity and gland asymmetry (Yang *et al.,* 2017).

I. Multiparametric Magnetic Resonance Imaging (mpMRI)

Multiparametric magnetic resonance imaging (mpMRI) offers new possibilities in detecting, characterizing, and staging prostate cancer. It provides detailed information about morphological, metabolic, and cellular changes, as well as tissue vascularity. MpMRI sequences include T1-weighted, T2-weighted, diffusion-weighted imaging (DWI), dynamic contrast-enhanced imaging (DCEI), and magnetic resonance spectroscopy imaging (MRSI) (Demirel and Davis, 2018).

II. MpMRI Sequences and Their Utility

T1-weighted imaging is used for evaluating lymph nodes and bone structures but cannot assess intra-prostatic zonal anatomy. T2-weighted imaging is crucial for detecting, localizing, and staging prostate cancer. DWI quantifies water molecule movement, aiding in cancer detection. DCEI assesses tumor angiogenesis, with early enhancement indicating cancer (Kelloff *et al.,*2009) [10].

II. Prostate Imaging Reporting and Data System (PIRADS)

MRSI visualizes specific metabolites' expression patterns, aiding in cancer detection. The Prostate Imaging Reporting and Data System (PIRADS) standardizes mpMRI reporting, rating the likelihood of clinically significant prostate cancer (csPCa) presence. Current guidelines support mpMRI use in men at risk for prostate cancer without a previous biopsy or with increasing PSA levels after a negative biopsy (Sauck *et al.,*2022).

5. Indications and Techniques of Prostate Biopsy (Matlaga *et al.,* 2003)

A. Indications for Prostate Biopsy

The decision to proceed with biopsy should be individualized based on various factors:

I. Suspicious DRE findings:

DRE is not recommended as a sole screening tool but may indicate biopsy if suspicious gross abnormalities are detected (Streicher *et al.,* 2019).

II. Elevated serum total PSA levels

PSA levels exceeding 4 ng/mL increase the risk for prostate cancer, but the exact threshold for biopsy is not precise. Factors such as PSA density, free and total PSA values, and patient-specific risk factors should be considered (Streicher *et al.,* 2019).

III. Abnormal TRUS findings

TRUS can detect hypoechoic lesions, which may suggest malignancy. However, not all abnormalities are indicative of cancer, and biopsy may be necessary for definitive diagnosis.

IV. Positive mpMRI findings

Lesions with PI-RADS scores of 4 or 5 indicate a high likelihood of clinically significant cancer and should be biopsied. Lesions with PI-RADS scores of 3 are equivocal, and further evaluation may be necessary.

B. Techniques of Systematic TRUS-Guided Prostate Biopsy (Noureldin *et al.,* 2020)

I. Patient preparation

Patients should be counseled about the procedure and its complications. Medical history should be reviewed for bleeding diathesis and medication use affecting blood clotting. Antibiotic prophylaxis with a single oral dose of quinolone is recommended.

II. Rectal preparation

Rectal preparation may include a povidone-iodine preparation or bowel-cleansing enema to reduce bacterial load and improve visualization.

III. Transrectal approach

TRUS-guided prostate biopsy through the transrectal approach is performed with the patient in the left lateral decubitus position. An ultrasound probe placed in the rectum guides biopsy needles to collect tissue samples.

IV. Biopsy core collection

The number and location of biopsy cores collected have evolved over time. Current practice typically involves collecting 10-12 cores from various locations within the prostate gland.

V. Anesthesia

The procedure can be performed under local anesthesia, and patients are generally comfortable during the biopsy.

VI. Post-biopsy care

Patients may experience minor bleeding, hematuria, or rectal bleeding after the procedure. Antibiotics may be prescribed to reduce the risk of infection.

Prostate biopsy remains an essential tool in the diagnosis of prostate cancer, and advances in imaging and biopsy techniques continue to improve the accuracy and safety of the procedure.

VII. Local Anesthesia Approaches

Local anesthesia for prostate biopsy can be achieved through various approaches, including periprostatic and periapical nerve blocks. In the transperineal approach, local anesthesia is particularly challenging due to the penetration through multiple layers, including the skin, fascia, muscles, and prostatic capsule. Techniques such as the periprostatic and periapical nerve block involve injecting lidocaine into the prostatoseminal vesical junction to provide pain relief during the procedure. This technique is guided by ultrasound and aims to raise an ultrasound wheal or hypoechoic appearance between the prostate and seminal vesicle (Cheng *et al.,* 2022).

6. Transperineal Biopsy Advantages

The transperineal approach is gaining popularity as an alternative to transrectal biopsy, offering improved cancer detection rates and avoiding the risk of antimicrobial resistance associated with rectal passage. It provides better access to the anterior transition zone and apex of the prostate, which are challenging to reach via transrectal biopsy (Schmeusser *et al.,* 2022).

I. Patient Positioning and Preparation

Patient positioning is crucial for the success of transperineal biopsy, with the lithotomy position commonly used. Proper relaxation of perineal muscles and scrotal elevation are essential for optimal exposure of the perineum (Thomson *et al.,* 2020).

II. Local Anesthesia Techniques

Local anesthesia for transperineal biopsy can be achieved through various techniques, including subcutaneous and branch of perineal nerve blocks. These techniques involve injecting lidocaine into specific areas to block nerve signals and reduce pain (Hong *et al.,* 2022).

III. Freehand Technique

The freehand technique allows for manual handling of the biopsy needle under local anesthesia. It requires a high level of skill and is associated with a steep learning curve but offers the advantage of avoiding general anesthesia (Ngu *et al.,* 2023).

IV. Template Grid Technique

The template grid technique involves using a brachytherapy grid to guide the needle placement for biopsy. This technique has a high detection rate but can lead to post-procedural complications and urinary retention (Sidana *et al.,* 2022).

V. Precision Point TM Transperineal Access System

The Precision Point TM Transperineal Access System is a disposable device that helps align the biopsy needle with the ultrasound array, improving accuracy and visibility during the procedure. Overall, local anesthesia for transperineal prostate biopsy requires careful planning and execution to ensure patient comfort and procedural success (Meyer *et al.,* 2018).

VI. Prostate Biopsy Core Number and Protocols

Prostate biopsies are performed using various sampling schemas, with the number of cores ranging from 6 to extensive 24 core saturation biopsies. The standard sextant biopsy, sampling about 1% of the gland volume, has limitations, such as missing small tumors in large-volume glands and those in specific zones of the prostate. To improve cancer detection rates, the number of cores was increased to 8, 12, and 14, targeting specific areas like the anterolateral peripheral zone. Further increases in core numbers are not advised except in cases of persistent or rising PSA levels, where saturation biopsy, involving 20 or more cores, is used to sample as much of the gland as possible (Streicher *et al.,* 2019).

7. MRI-Guided Prostate Biopsy

MRI-guided prostate biopsy offers selective sampling of suspicious lesions identified on mpMRI. Techniques include direct MRI-guided biopsy, cognitive fusion biopsy, and MRI–TRUS fusion biopsy. Direct MRI-guided biopsy involves mapping MRI localization data to a T2 anatomic scan to target suspicious regions using a nonmagnetic biopsy needle device. While effective, this technique requires significant upfront investment and coordination among multiple specialties. Cognitive fusion biopsy manually targets lesions identified on mpMRI during TRUS biopsy using anatomical landmarks, offering simplicity and improved accuracy over systemic biopsy. However, it relies heavily on the operator's technical abilities and may be less accurate for small lesions (Bjurlin *et al.,* 2016).

I. Cognitive Fusion Biopsy and MRI–TRUS Fusion Biopsy

MRI–TRUS fusion biopsy integrates MRI data with ultrasound to guide biopsies in an office setting. This technique has been shown to be more effective at detecting clinically significant prostate cancer compared to standard systematic biopsy. The Vector Prostate Biopsy is a recent technique that combines electromagnetic needle tracking technology, a stable stepper-mounted US probe, and MRI-US fusion software to perform transperineal biopsy under local anesthesia. This method achieves accurate and precise targeting, high detection rates, and patient comfort, avoiding prostate deformation and minimizing distortion effects on image fusion.

II. Vector Prostate Biopsy

The Vector set-up uses two perineal access points and provides live sagittal US images showing fused MRI outlines, precontoured targets, and needle trajectories, allowing for precise correlation of needle movement with lesion targets (Fletcher *et al.,* 2023).

8. Feasibility and advantage of Free-hand Transperineal Biopsy:

Freehand transperineal biopsy is a technique in which prostate tissue samples are obtained without the use of a template or grid system. Instead, the biopsy needle is guided manually by the healthcare provider to target specific areas of the prostate gland. This approach offers several potential advantages over template-guided biopsy, including improved accuracy and reduced risk of complications (Sivaraman *et al.,*2022).

I. Feasibility

Performing transperineal biopsy freehand is feasible and has been demonstrated in several studies. Healthcare providers with experience in transperineal biopsy can accurately target specific areas of the prostate gland using ultrasound guidance. The technique may require a higher level of skill and experience compared to template-guided biopsy, but with proper training, it can be performed effectively (Cheng *et al.,* 2022).

8.1. Advantages:

I. Improved Accuracy

Freehand transperineal biopsy allows for more flexibility in targeting areas of the prostate gland that may be difficult to reach with a template-guided approach. This can improve the accuracy of the biopsy and increase the likelihood of detecting clinically significant prostate cancer (Alnosayan *et al.,*2023).

II. Reduced Risk of Infection

One of the main advantages of transperineal biopsy over transrectal biopsy is the reduced risk of infection. By avoiding the rectum, the risk of introducing bacteria into the prostate gland is minimized, which can reduce the risk of post-biopsy infections (Walker *et al.,* 2016).

III. Less Discomfort for Patients

Some patients may find transperineal biopsy to be less uncomfortable than transrectal biopsy, as the biopsy needle does not pass through the rectum. This can improve patient satisfaction and compliance with the procedure (Szempliński *et al.,* 2023).

IV. Potential for Outpatient Procedure

Transperineal biopsy can often be performed as an outpatient procedure under local anesthesia, reducing the need for hospitalization and allowing patients to return home on the same day (Hong *et al.,* 2022).

V. Reduced Risk of Bleeding

Although bleeding is a potential complication of any biopsy procedure, transperineal biopsy may be associated with a lower risk of bleeding compared to transrectal biopsy, particularly in patients taking anticoagulant medications (Gilberto *et al.,* 2023).

8.2. Complications

Prostate biopsy, whether transrectal or transperineal, is associated with several potential complications, including genitourinary tract infections, urosepsis, hematuria, rectal bleeding, and the need for readmission. Here, we compare the rates of these complications between transrectal and transperineal biopsies and discuss strategies for reducing them in each technique (Gilberto *et al.,* 2023).

9. Genitourinary Tract Infections

I. Transrectal Biopsy

Transrectal biopsy is associated with a higher risk of genitourinary tract infections compared to transperineal biopsy. This is because the biopsy needle passes through the rectum, which is colonized with bacteria that can potentially infect the prostate gland (Walker *et al.,* 2016; Kohl *et al.,* 2022).

II. Strategies for Reducing Infections

To reduce the risk of infections, prophylactic antibiotics are typically administered before transrectal biopsy. Using targeted antibiotics based on rectal swab culture results and employing rigorous aseptic techniques during the procedure can further reduce the risk of infections (Tops *et al.,* 2023).

III. Urosepsis

Transrectal Biopsy: Urosepsis, a severe infection that spreads to the bloodstream, is a rare but serious complication of transrectal biopsy. The risk is higher in patients with pre-existing urinary tract infections or other risk factors.

Strategies for Reducing Urosepsis: To reduce the risk of urosepsis, it is crucial to identify and treat any urinary tract infections before performing a biopsy. Prophylactic antibiotics and strict aseptic techniques during the procedure are also essential (Shahait *et al.,* 2016).

IV. Hematuria

Transrectal Biopsy: Hematuria, or blood in the urine, is a common complication of both transrectal and transperineal biopsies. The risk is higher immediately after the procedure but usually resolves on its own (Madej *et al.,* 2012).

Strategies for Reducing Hematuria: Adequate hydration before and after the biopsy can help reduce the risk of hematuria. In some cases, medications to reduce the risk of bleeding may be prescribed.

V. Rectal Bleeding

Transrectal Biopsy: Rectal bleeding is more common with transrectal biopsy, as the biopsy needle passes through the rectal wall. It is usually mild and resolves without intervention (Quinlan *et al.,* 2018).

Strategies for Reducing Rectal Bleeding: Using a smaller biopsy needle and avoiding excessive force during needle insertion can help reduce the risk of rectal bleeding. Adequate lubrication of the biopsy needle can also help prevent trauma to the rectal wall (Quinlan *et al.,* 2018).

VI. Need for Readmission

Transrectal Biopsy: The need for readmission due to complications is higher with transrectal biopsy, particularly for infections and severe bleeding (Berry *et al.,* 2020).

Strategies for Reducing Readmission: Close monitoring of patients after the biopsy and prompt treatment of any complications can help reduce the need for readmission (Lu and Raman, 2016).

In conclusion, transperineal biopsy is associated with a lower risk of genitourinary tract infections, urosepsis, and rectal bleeding compared to transrectal biopsy. However, both techniques carry a risk of complications, and proper patient selection, prophylactic measures, and careful procedural techniques are essential to minimize these risks (Wenzel *et al.,* 2020).

Conclusion

This study of transperineal and transrectal prostate biopsy techniques reveals that the transperineal approach under local anesthesia with transrectal ultrasound guidance offers several advantages. It demonstrates feasibility, higher cancer detection rates for anteriorly located tumors, and a reduced risk of infectious complications. These benefits suggest that transperineal biopsy could be a viable alternative to the traditional transrectal approach, potentially leading to improved prostate cancer detection and patient outcomes.

However, the adoption of transperineal biopsy in clinical practice requires further validation through large-scale studies. Standardized protocols and training are essential to ensure the efficacy and safety of this technique. As the field of prostate cancer diagnosis evolves, the transperineal approach under local anesthesia could become an integral part of the diagnostic arsenal, offering a more accurate and less invasive option for patients.

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