ANATOLIAN JOURNAL OF MEDICAL SCIENCES

Research Note

Robotic-Assisted Perineal Fusion Prostate Biopsy: Technique, Advantages, and Clinical Considerations

Ali Haydar YILMAZ[1], Ali Barbaros BAŞESKİOĞLU[2]

[1]Bilecik Seyh Edebali University, Faculty of Medicine, Department of Urology, Bilecik, TÜRKİYE, ORCID ID: 0000-0001-5797-0655
[2]Private Clinic, Eskişehir, TÜRKİYE, ORCID ID: 0000-0002-6965-4745
Corresponding Author: Ali Haydar YILMAZ, ali.yilmaz@bilecik.edu.tr

ABSTRACT

Introduction: Prostate cancer is the second most common cancer worldwide and the fifth leading cause of cancer-related mortality in men. A prostate biopsy not only provides a diagnosis but also gives an idea about the characterization of the tumor, its pathological staging, and its localization on the prostate. Accurate diagnosis, staging, and localization are essential for optimal treatment planning. Multiparametric MRI (mpMRI) prior to biopsy improves the detection of clinically significant prostate cancer by increasing both sensitivity and specificity. The biopsy is performed rectally or using a perineal technique. When taken transrectal route, there is a risk of rectal bleeding and life-threatening sepsis. **Methods:** Asymptomatic patients with a life expectancy of ≥10–15 years, abnormal PSA levels, abnormal digital rectal examination, or positive family history underwent mpMRI screening. Lesions classified as PI-RADS 3–5 are targeted for biopsy using MRI–ultrasound fusion guidance. The procedure is performed under general, spinal, regional, or local anesthesia, with prophylactic antibiotics administered 60 minutes prior. Robotic perineal biopsy enables precise needle placement, with only two perineal insertions regardless of the number of samples obtained. **Results:** Robotic perineal biopsy reduces false-negative rates and facilitates sampling from anterior and apical prostate regions, which are challenging in conventional transrectal biopsies. Compared to transrectal approaches, the perineal route significantly lowers the risk of post-biopsy sepsis. Unlike classical brachytherapy template-based biopsies requiring multiple punctures, the robotic method minimizes tissue trauma, pain, and complication risk, thereby preserving patient quality of life. **Conclusion:** Robotic perineal MRI–ultrasound fusion biopsy is a safe, accurate, and patient-friendly technique that offers superior lesion targeting, reduced infection risk, and fewer complications compared to conventional methods. It represents an effective approach for the diagnosis and characterization of clinically significant prostate cancer.
Keywords: Fusion, perineal biopsy, prostate biopsy, robotic

Robotik Destekli Perineal Füzyon Prostat Biyopsisi: Teknik, Avantajlar ve Klinik Değerlendirmeler

Ali Haydar YILMAZ[1], Ali Barbaros BAŞESKİOĞLU[2]

[1]Bilecik Şeyh Edebali Üniversitesi, Tıp Fakültesi, Üroloji Bölümü, Bilecik, TÜRKİYE, ORCID ID: 0000-0001-5797-0655
[2]Özel Klinik, Eskişehir, TÜRKİYE, ORCID ID: 0000-0002-6965-4745
[3]Sorumlu Yazar: Ali Haydar YILMAZ, ali.yilmaz@bilecik.edu.tr

ÖZ

Giriş: Prostat kanseri, dünya çapında en sık görülen ikinci kanser türüdür ve erkeklerde kansere bağlı ölümlerin beşinci nedenidir. Prostat biyopsisi sadece tanı koymakla kalmaz, aynı zamanda tümörün karakterizasyonu, patolojik evresi ve prostattaki lokalizasyonu hakkında da fikir verebilir. Optimal tedavi planlaması için doğru tanı, evreleme ve lokalizasyon esastır. Biyopsi öncesinde yapılan multiparametrik MRG (mpMRG), hem duyarlılığı hem de özgüllüğü artırarak klinik olarak önemli prostat kanserinin saptanmasını iyileştirir. Biyopsi teknik olarak rektal veya perineal olarak alınır. Rektal olarak alındığında, rektal kanama ve hayatı tehdit eden sepsis riski vardır **Yöntemler:** Yaşam beklentisi ≥10–15 yıl olan, anormal PSA düzeyleri, anormal dijital rektal muayene veya pozitif aile öyküsü olan asemptomatik hastalar mpMRI taramasından geçirilebilir. PI-RADS 3–5 olarak sınıflandırılan lezyonlar, MRI–ultrason füzyon kılavuzluğu kullanılarak biyopsi için hedeflenebilir. İşlem genel, spinal, bölgesel veya lokal anestezi altında gerçekleştirilebilir ve 60 dakika önce profilaktik antibiyotikler uygulanabilir. Robotik perineal biyopsi, numune sayısına bakılmaksızın sadece iki perineal girişle iğnenin hassas bir şekilde yerleştirilmesini sağlayabilir. **Bulgular:** Robotik perineal biyopsi, yanlış negatif oranlarını azaltır ve geleneksel transrektal biyopsilerde zor olan anterior ve apikal prostat bölgelerinden örnek almayı kolaylaştırır. Transrektal yaklaşımlarla karşılaştırıldığında, perineal yol biyopsi sonrası sepsis riskini önemli ölçüde azaltır. Klasik brakiterapi şablon tabanlı biyopsilerde birden fazla ponksiyon gerektiren durumların aksine, robotik yöntem doku travmasını, ağrıyı ve komplikasyon riskini en aza indirerek hastanın yaşam kalitesini korur. **Sonuç:** Robotik perineal MRI-ultrason füzyon biyopsisi, geleneksel yöntemlere kıyasla üstün lezyon hedefleme, azaltılmış enfeksiyon riski ve daha az komplikasyon sunan güvenli, doğru ve hasta dostu bir tekniktir. Bu yöntem klinik olarak önemli olan prostat kanserinin tanı ve karakterizasyonu için etkili bir yaklaşımdır.
Anahtar Kelimeler: Füzyon, perineal biopsi, prostat biyopsisi, robotik

INTRODUCTION

Prostate cancer is the second most common type of cancer in the world and ranks fifth in cancer-related mortality in men (Bray et al., 2018). Prostate cancer screening is recommended if life expectancy is more than seven to ten years (Mottet et al., 2017). Screening is recommended in patients with a clinical history of prostate cancer and abnormal PSA test and digital rectal examination. Diagnosis is made by prostate biopsy. However, according to recent guidelines, if available, multiparametric prostate MRI (mpMRI) should be performed before biopsy. MpMRI increases the sensitivity of prostate biopsy as well as the specificity of clinically significant prostate cancer (Ahmed et al., 2017). Prostate biopsy is performed in more than two million people worldwide annually, and it is essential to perform such an interventional procedure safely, with high specificity and low morbidity, using the most appropriate technique for the patient (Borghesi et al., 2017).

A prostate biopsy not only provides a diagnosis but also gives us an idea about the characterization of the tumor, its pathological staging, and its localization on the prostate. The biopsy is technically taken rectally or using a perineal technique. When performed via the transrectal route there is a risk of rectal bleeding and life-threatening sepsis (Hadway et al., 2009). Conventional and fusion biopsy methods are available; however, fusion biopsy is generally recommended due to its targeted approach. At the same time, it is difficult to take a biopsy from anterior and apical lesions when biopsy is taken with the conventional method, and up to 30% false negative results may occur (Levine et al., 1998). Moreover, the cores obtained in conventional biopsy not sampled from the target area.

MATERIALS AND METHODS

After asymptomatic patients are adequately informed about the detection of clinically significant prostate cancer and overtreatment, these patients with a life expectancy of 10–15 years or more should be performed prostate screening and imaging. Family history, abnormal PSA test, and abnormal digital rectal examination are used in screening. In imaging, mpMRI is used, and staging is performed with PI-RADS v2.1 version. Patients with PI-RADS 3, 4, and 5 are candidates for biopsy. Suspicious lesions on MR images are marked on a three-dimensional model of the prostate and combined with computer program–supported USG, and targeted fusion biopsy is taken under USG guidance (shown as Figure 1). Standard biopsy is also recommended. General anesthesia, spinal, regional, or local anesthesia can be applied before the procedure. Prophylactic antibiotherapy is also given 60 minutes before the procedure. Transurethral catheter, bowel preparation, and enema are not required. The angle and depth of needle insertion are done automatically with the robot arm.

How do I do it?

Perineal robot-assisted prostate fusion biopsy is based on the principle of obtaining targeted biopsies from lesions identified on MRI under USG guidance with robotic support. The patient is placed in the lithotomy position. Lesions previously identified on MRI are fused with USG using a dedicated software program. Under USG guidance, robotic arms direct the biopsy needle. Unlike the conventional method, the biopsy is obtain using a perineal technique. The risk of infection in the perineal approach is much lower compared to the rectal route, leading to lower complication rates (Hara et al., 2008). From a cost-effectiveness perspective, avoiding complications also reduces healthcare burden. Since the patient is under anesthesia, this method is more advantageous than the conventional one in terms of pain and patient comfort (Lee et al., 2021).

RESULTS AND CONCLUSION

In robotic perineal biopsy, there are only two needle insertions in the perineum regardless of the number of biopsy cores, differing from template-based mapping biopsy, which requires multiple punctures (Merrick et al., 2007, 2008). This reduces potential pain and complications. Another major advantage is that perineal biopsy significantly lowers the risk of post-biopsy sepsis compared to the transrectal route (Hara et al., 2008). Furthermore, it enables sampling of anterior and apical regions, which are difficult to reach in transrectal biopsies (Taira et al., 2010).

The diagnosis of prostate cancer should be balanced between acceptable specificity and sensitivity and patient morbidity (Thomson et al., 2020). Oberlin et al.

(2016), in a study involving 150 patients used visually targeted imaging without computer assistance. Researchers reported a 17% detection rate of clinically significant prostate cancer via the transrectal route.In contrast, Pepe et al. (2017) reported a 93% detection rate with the transperineal route using a fusion approach without computer infrastructure. However, in a recent systematic review, Uleri et al. (2023) compared MRI-targeted transperineal versus transrectal approaches and found no significant difference in overall detection rates. Still, they concluded that the transperineal approach provides advantages in detecting anterior and apical tumors and should be preferred when tumors are located in these zones.

Drăgoescu et al. (2023) reported that targeted fusion biopsy had a significantly higher detection rate for clinically significant prostate cancer compared to systematic biopsy. Similarly, Lee et al. (2016) showed in a prospective study with 433 patients that robot-assisted transperineal biopsy was a reliable and accurate method with minimal morbidity. In another narrative review, Erbin et al. (2023) emphasized that while the exact role of robotic systems in prostate biopsies is still being clarified, they appear clinically safe and effective with high sensitivity in detecting clinically significant cancers and low urosepsis rates.

Thaiss et al. (2022) compared biparametric versus multiparametric MRI before robot-assisted transperineal fusion biopsy and concluded that mpMRI has higher sensitivity and specificity, thus being superior for detecting clinically significant prostate cancer.

Accurate diagnosis alone is insufficient for optimal prostate cancer management. Critical factors include tumor staging, lesion localization, accurate core sampling, and, most importantly, minimizing false negatives. As an invasive procedure, it must be performed with care to minimize post-biopsy complications and preserve patient quality of life.

DECLARATION OF CONTRIBUTION RATE OF RESEARCHERS

Authors' contribution rates to the study are equal.

CONFLICT OF INTEREST DECLARATION

There is no conflict of interest between any institution, person, or author within the scope of the study.

ETHICAL STATEMENT

Ethical approval was not required.

REFERENCES

Borghesi, M., Ahmed, H., Nam, R., Schaeffer, E., Schiavina, R., Taneja, S. S., Weidner, W., & Loeb, S. (2017). Complications after systematic, random, and image-guided prostate biopsy. European Urology, 71(3), 353–365. https://doi.org/10.1016/j.eururo.2016.08.004

Bray, F., Ferlay, J., Soerjomataram, I., Siegel, R. L., Torre, L. A., & Jemal, A. (2018). Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA: A Cancer Journal for Clinicians, 68(6), 394–424. https://doi.org/10.3322/caac.21492

Drăgoescu, P. O., Drocaș, A. I., Drăgoescu, A. N., & Pătru, L. (2023). Transperineal prostate biopsy targeted by magnetic resonance imaging cognitive fusion. Diagnostics, 13(8), 1373. https://doi.org/10.3390/diagnostics13081373

Erbin, A., Çağlar, U., & Türkay, R. (2023). Evaluating the effectiveness and safety of robotic-assisted MRI/TRUS fusion transperineal prostate biopsy systems: A narrative review based on current literature. Eurasian Journal of Medicine, 55(1), 125–130. https://doi.org/10.5152/eurasianjmed.2023.23370

Hadway, P., Barrett, L. K., Waghorn, D. J., Hasan, K., Bdesha, A., & Gillatt, D. A. (2009). Urosepsis and bacteraemia caused by antibiotic-resistant organisms after transrectal ultrasonography-guided prostate biopsy. BJU International, 104(11), 1556–1558. https://doi.org/10.1111/j.1464-410X.2009.08641.x

Hara, R., Jo, Y., Fujii, T., Kondo, N., Yokoyoma, T., Miyaji, Y., & Nagai, A. (2008). Optimal approach for prostate cancer detection as initial biopsy: Prospective randomized study comparing transperineal versus transrectal systematic 12-core biopsy. Urology, 71(1), 191–195. https://doi.org/10.1016/j.urology.2007.09.027

Kaufmann, S., Mischinger, J., Amend, B., et al. (2017). First report of robot-assisted transperineal fusion versus off-target biopsy in patients undergoing repeat prostate biopsy. World Journal of Urology, 35, 1023–1029. https://doi.org/10.1007/s00345-016-1970-8

Lee, A. Y., Chen, K., Law, Y. M., et al. (2021). Robot-assisted magnetic resonance imaging-ultrasound fusion transperineal targeted biopsy. Urology, 155, 46–52. https://doi.org/10.1016/j.urology.2021.06.008

Lee, D. J., Recabal, P., Sjoberg, D. D., Thong, A., Lee, J. K., Eastham, J. A., Scardino, P. T., Vargas, H. A., Coleman, J., & Ehdaie, B. (2016). Comparative effectiveness of targeted

prostate biopsy using magnetic resonance imaging ultrasound fusion software and visual targeting: A prospective study. Journal of Urology, 196(3), 697–702. https://doi.org/10.1016/j.juro.2016.03.149

Levine, M. A., Ittman, M., Melamed, J., & Lepor, H. (1998). Two consecutive sets of transrectal ultrasound guided sextant biopsies of the prostate for the detection of prostate cancer. Journal of Urology, 159(2), 471–476. https://doi.org/10.1016/S0022-5347(01)63944-5

Merrick, G. S., Gutman, S., Andreini, H., Taubenslag, W., Lindert, D., Curtis, R., Allen, Z., Adamovich, E., & Butler, W. M. (2007). Prostate cancer distribution in patients diagnosed by transperineal template-guided saturation biopsy. European Urology, 52(3), 715–723. https://doi.org/10.1016/j.eururo.2007.03.032

Merrick, G. S., Taubenslag, W., Andreini, H., Lindert, D., Curtis, R., Allen, Z., Adamovich, E., & Butler, W. M. (2008). The morbidity of transperineal template-guided prostate mapping biopsy. BJU International, 101(12), 1524–1529. https://doi.org/10.1111/j.1464-410X.2008.07525.x

Mischinger, J., Kaufmann, S., Russo, G. I., Harland, N., Rausch, S., Amend, B., & Kruck, S. (2018). Targeted vs systematic robot-assisted transperineal magnetic resonance imaging–transrectal ultrasonography fusion prostate biopsy. BJU International, 121(5), 791–798. https://doi.org/10.1111/bju.14089

Mottet, N., Bellmunt, J., Briers, E., Bolla, M., Bourke, L., Cornford, P., De Santis, M., Henry, A., Joniau, S., Lam, T., Mason, M., Matveev, V., van der Poel, H., van der Kwast, T. H., Rouvière, O., Wiegel, T., & van den Bergh, R. C. (2017). EAU–ESTRO–ESUR–SIOG guidelines on prostate cancer. Arnhem, The Netherlands: EAU Guidelines Office.

Oberlin, D. T., Casalino, D. D., Miller, F. H., Matulewicz, R. S., Perry, K. T., Nadler, R. B., Kundu, S., Catalona, W. J., & Meeks, J. J. (2016). Diagnostic value of guided biopsies: Fusion and cognitive-registration magnetic resonance imaging versus conventional ultrasound biopsy of the prostate. Urology, 92, 75–79. https://doi.org/10.1016/j.urology.2016.02.041

Pietro Pepe, Antonio Garufi, Giandomenico Priolo, Michele Pennisi,(2017). Transperineal Versus Transrectal MRI/TRUS Fusion Targeted Biopsy: Detection Rate of Clinically Significant Prostate Cancer,Clinical Genitourinary Cancer,Volume 15, Issue 1

Taira, A. V., Merrick, G. S., Galbreath, R. W., Andreini, H., Taubenslag, W., Curtis, R., Butler, W. M., Adamovich, E., & Wallner, K. E. (2010). Performance of transperineal template-guided mapping biopsy in detecting prostate cancer in the initial and repeat biopsy setting. Prostate Cancer and Prostatic Diseases, 13(1), 71–77. https://doi.org/10.1038/pcan.2009.45

Thaiss, W. M., Moser, S., Hepp, T., et al. (2022). Head-to-head comparison of biparametric versus multiparametric MRI of the prostate before robot-assisted transperineal fusion prostate biopsy. World Journal of Urology, 40(10), 2431–2438. https://doi.org/10.1007/s00345-022-04120-1

Thomson, A., Li, M., Grummet, J., & Sengupta, S. (2020). Transperineal prostate biopsy: A review of technique. Translational Andrology and Urology, 9(6), 3009–3017. https://doi.org/10.21037/tau.2019.12.40

Uleri, A., Baboudjian, M., Tedde, A., et al. (2023). Is there an impact of transperineal versus transrectal magnetic resonance imaging-targeted biopsy in clinically significant prostate cancer detection rate? A systematic review and meta-analysis. European Urology Oncology, 6(6), 621–628. https://doi.org/10.1016/j.euo.2023.08.001