Research and Reports in Urology

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CASE SERIES

Cognitive Magnetic Resonance Imaging–Transperineal Ultrasound Fusion Prostate Biopsy with Use of a Urinary Catheter After Abdominoperineal Resection: A Novel Technique and Literature Review

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Abstract: A standard prostate biopsy can be performed via a transrectal or transperineal approach using a transrectal ultrasound probe, but not in patients without a rectum. These patients pose a diagnostic challenge to urologists in terms of prostate cancer detection. We report use of a novel technique for cognitive magnetic resonance imaging (MRI)–transperineal ultrasound fusion prostate biopsy with a urinary catheter in two patients without a rectum after abdominoperineal resection. In both cases, a urinary catheter was inserted and clamped after injection of 250 mL of sterile saline into the bladder to improve visualization of the prostate. The inflated catheter balloon was placed to the level of the bladder neck to identify the base of the prostate. Cognitive MRI–transperineal ultrasound fusion biopsy was performed on the MRI-defined lesions after confirmation of anatomic landmarks, including the urethra and base of the prostate. Systemic 8-core biopsies were also obtained. In both patients, the targeted lesion was diagnosed as prostate cancer.

Keywords: cognitive magnetic resonance imaging–transperineal ultrasound fusion biopsy, prostate biopsy, urinary catheter, rectum resection

Introduction

According to the GLOBOCAN 2022 data, lung cancer was the most commonly diagnosed cancer in men worldwide (1.57 million new cases), followed by prostate cancer (1.47 million new cases), and colorectal cancer (1.04 million new cases).[1] In Japan, the 2020 census data show that prostate cancer was the most frequently diagnosed cancer in men, with an incidence of 87,756, and colorectal cancer was the second most commonly diagnosed, with an incidence of 82,809.[2] The survival of patients with rectal cancer has been improving, and the overall 5-year survival rate after abdominoperineal resection (APR) has been reported to be 67.7 ± 9.6%.[3,4] Therefore, it is not uncommon to encounter patients with an elevated prostate-specific antigen (PSA) level and a suspicion of prostate cancer on magnetic resonance imaging (MRI) who lack rectal access after APR.[5] A standard prostate biopsy can be performed via the transrectal or transperineal approach using a transrectal ultrasound (US) probe, but not in patients without a rectum.[5,6] There is no standard biopsy procedure for these patients, who present a diagnostic challenge for urologists in terms of prostate cancer detection.[7] Moreover, a lack of rectal access may result in delayed diagnosis/treatment of prostate cancer.[8]

There have been reports in which prostate biopsies were performed via the transperineal or transgluteal approach under the guidance of transperineal, transabdominal, or transurethral US,[9–11] computed tomography (CT), or MRI.[12,13]

Received: 28 February 2025
Accepted: 16 April 2025
Published: 23 April 2025

Furthermore, the most recent literature describes several novel techniques, such as grid-based cognitive transperineal biopsy without US,[8] image intensifier-guided transperineal biopsy when visualization of the prostate under transperineal US is poor,[14] and cognitive MRI–US fusion transperineal biopsy with injection of bubbled lidocaine jelly into the urethra.[3] Among these modalities, transperineal US-guided biopsy would be preferred in the case of clear prostate visualization under the transperineal US guidance. Another modality should be considered in the case of poor prostate visualization.[14] There have been four reports in which cognitive MRI-transperineal US fusion prostate biopsies were performed in patients without rectal access.[3,5–7] In three reports, a urinary catheter was not inserted before biopsy.[5–7] In one report, bubbled lidocaine jelly was injected into the urethra before biopsy to confirm the location of urethra.[3] In this report, we describe a novel practical procedure for cognitive MRI–transperineal US fusion biopsy with use of a urinary catheter, which we have performed in two patients without a rectum after APR, and we review the relevant literature.

Technique for MRI–Transperineal US Fusion Prostate Biopsy with Use of a Urinary Catheter

Prostate biopsies were performed by a proficient urologist (H.S.) with experience of over 1000 cognitive MRI–transrectal US fusion prostate biopsies. After induction of general anesthesia, the patient is placed in the lithotomy position with the scrotum retracted anteriorly (Figure 1a). A 16-Fr urethral catheter is inserted into the bladder, and the catheter balloon is inflated with 10 mL of distilled water. The catheter is clamped after injection of 250 mL of sterile saline into the bladder to improve visualization of the prostate. Gentle traction is applied to the catheter, and the catheter

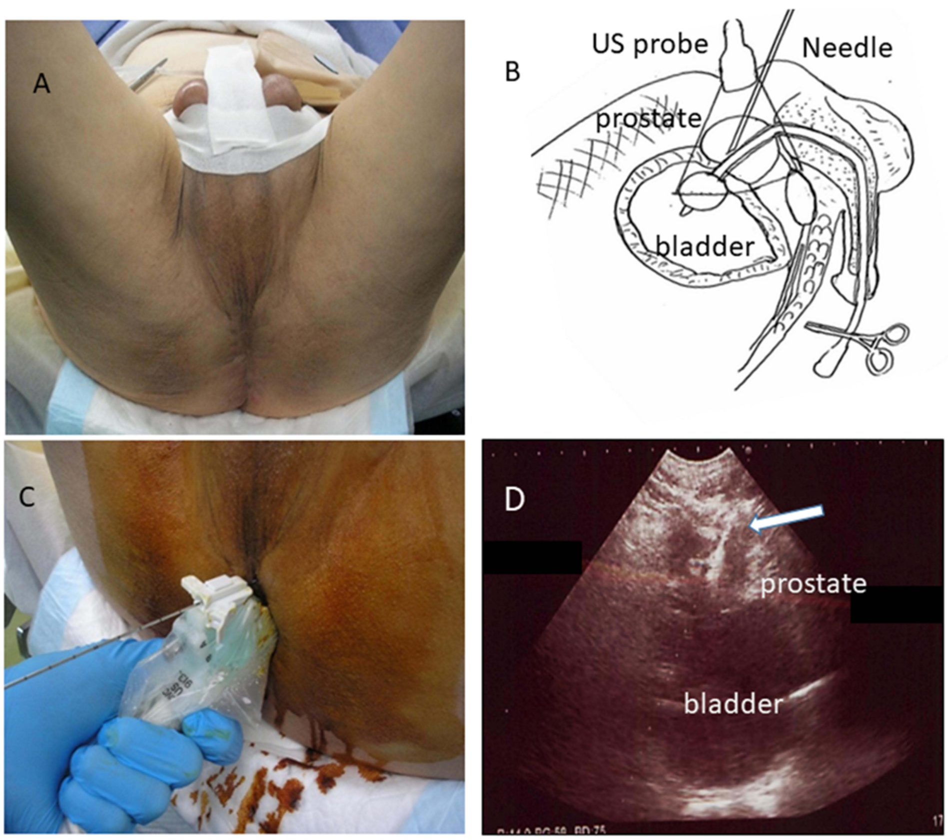

Figure 1 Cognitive MRI–US fusion transperineal prostate biopsy. (**A**) The scrotum was extracted anteriorly to expose the perineum. (**B**) A urethral catheter was inserted, and the catheter balloon was inflated with 10 mL of distilled water. The catheter was clamped after injection of 250 mL of sterile saline to improve visualization of the prostate. Gentle traction was applied to the catheter, and the catheter balloon was advanced to the level of the bladder neck to identify the base of the prostate. (**C**). The US probe was placed sagittally on the anal dimple and provided clear images of the prostate, urethra, and bladder neck. (**D**) Cognitive MRI–US fusion transperineal prostate biopsy was performed using a 25° angle of approach in conjunction with a nephrostomy grid. An 18-gauge biopsy needle (white arrow) was directed to the target area by visual registration through the nephrostomy grid.
Abbreviations: MRI, magnetic resonance imaging; US, ultrasound.

balloon is placed to the level of the bladder neck to identify the base of the prostate. In both of the cases described here, transperineal US was performed using an US transducer (ARIETTA70, C22K probe, Hitachi-Aloka, Tokyo, Japan). The US probe was placed sagittally on the anal dimple and provided clear images of the prostate, urethra, and bladder neck (Figure 1b). Before biopsy, the magnetic resonance image was inverted, and the monitor was placed next to the US machine to aid the cognitive MRI–US fusion target biopsy, as described previously.[3] The US probe facility enabled two angles of needle approach (10°, 25°). A 25° angle of approach was chosen for operator to be able to confirm the biopsy insertion path clearly. Cognitive MRI–US fusion transperineal prostate biopsy was performed in conjunction with the nephrostomy grid. An 18-gauge biopsy needle was directed to the target area by visual registration through the grid (Figure 1c and d). Four biopsies were obtained for each lesion that was suspicious on MRI. The locations of the prostate base and the urethra were confirmed by jiggling the urinary catheter before each biopsy. Systemic 8-core biopsies were performed (6 cores from the apex, middle, and base of the right and left peripheral zones and 2 from the right and left transitional zones). The catheter was then unclamped. Both patients were discharged on the day after the biopsy procedure. There were no intraoperative or postoperative complications. This study was approved by the institutional review board of the Tama-Hokubu Medical Center.

Outcomes

Patient 1

The patient was a 59-year-old man had a history of rectal cancer who had undergone APR 8 years earlier. His PSA level was initially 4.50 ng/mL and had risen to 8.06 ng/mL. Multiparametric MRI indicated a PI-RADS (Prostate Imaging-Reporting and Data System) 3 lesion in the right transitional zone (Figure 2a). The prostate had a volume of 21.8 mL and a PSA density of 0.36 ng/mL/mL. The biopsy procedure time was 11 minutes. All of four targeted biopsies taken from the right transitional zone showed Gleason grade 4+3 adenocarcinoma (Figure 2b). Systemic biopsies revealed Gleason 4+3 adenocarcinoma in the right peripheral zone, Gleason 3+4 adenocarcinoma in the right and left transitional zones, and Gleason 3+4 adenocarcinoma in the left peripheral zone. The patient was satisfied with the results of prostate biopsy. No metastasis was identified on CT or bone scans. The patient was treated with androgen deprivation therapy for 6 months and external beam radiotherapy.

Patient 2

The patient was a 77-year-old man with a history of rectal cancer who had undergone APR 17 years earlier. His PSA level was initially 13.1 ng/mL and had risen to 24.3 ng/mL. Multiparametric MRI indicated two PI-RADS 3 lesions: one in the left peripheral zone and the other in the right peripheral zone (Figure 3a). The prostate had a volume of 24.2 mL and a PSA density of 1.0 ng/mL/mL. The biopsy procedure time was 20 minutes. Two of four targeted biopsies taken from the left peripheral zone revealed Gleason 3+4 adenocarcinoma (Figure 3b), and two taken from the right peripheral

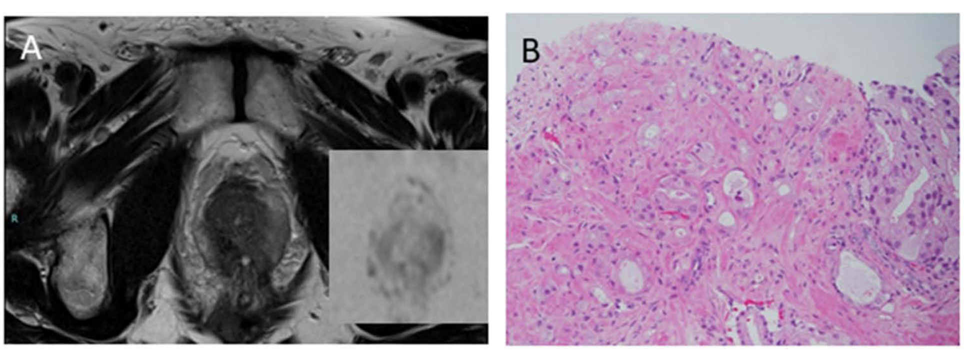

Figure 2 Images of multiparametric MRI and pathological diagnosis (**A**) Transverse T2-weighted and diffusion-weighted images. Multiparametric MRI showed a PI-RADS 3 lesion in the right transitional zone. This lesion was diffusely hypointense on T2-weighted images and showed restricted diffusion. (**B**) Targeted biopsies taken from the right transitional zone revealed Gleason grade 4+3 adenocarcinoma.

Abbreviations: MRI, magnetic resonance imaging; PI-RADS, Prostate Imaging-Reporting and Data System.

 https://doi.org/10.2147/RRU.S523114

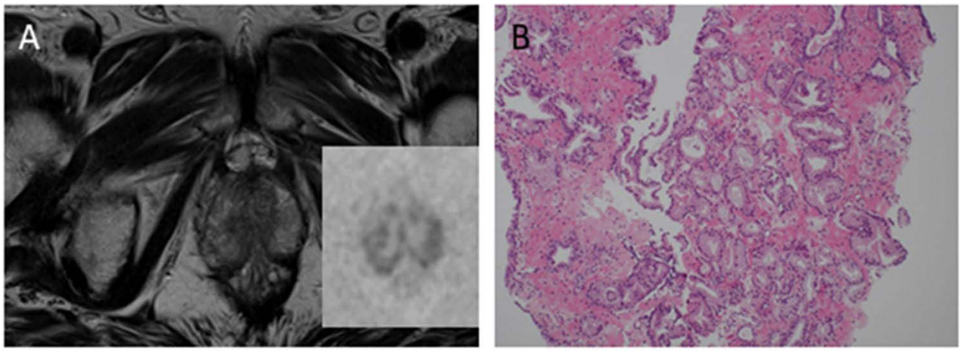

Figure 3 Images of multiparametric MRI and pathological diagnosis (**A**) Transverse T2-weighted and diffusion-weighted images. Multiparametric MRI indicated two PI-RADS 3 lesions, one in the left peripheral zone and the other in the right peripheral zone. The lesions were diffusely hypointense on T2-weighted images and showed moderately restricted diffusion. (**B**) Targeted biopsies taken from the left peripheral zone revealed Gleason grade 3+4 adenocarcinoma.
Abbreviations: MRI, magnetic resonance imaging; PI-RADS, Prostate Imaging-Reporting and Data System.

zone showed Gleason 3+3 adenocarcinoma. Systemic biopsies revealed Gleason 3+3 adenocarcinoma in the left peripheral zone and Gleason 3+4 adenocarcinoma in the right peripheral zone. The patient was satisfied with the results of prostate biopsy. No metastasis was detected on CT or bone scans. The patient was treated with androgen deprivation therapy for 2 years and external beam radiotherapy.

Discussion

There is no international consensus on the optimal prostate biopsy technique in patients without rectal access after surgery such as APR or total proctocolectomy.[6] The inability to perform conventional transrectal US poses a diagnostic challenge for urologists and may result in delayed detection of prostate cancer.[8] A search of PubMed identified 19 relevant reports,[3,5–22] which are summarized in Table 1. Before 2000, only systematic prostate biopsies were performed under transperineal US or CT guidance. Since then, multiparametric MRI has been performed to identify a suspicious lesion before biopsy and targeted biopsy is performed to obtain samples from the lesion.[21] The biopsy needle can be inserted into the targeted intraprostatic lesion using a cognitive MRI–US fusion technique,[3,5–7] real-time CT guidance,[12] or real-time MRI guidance.[13,21] De Vulder et al reported performing real-time MRI–US fusion transperineal prostate biopsy using the software and pre-imported magnetic resonance images in the US system.[22] In our two cases, we do not have any software suitable for real-time MRI–US fusion biopsy. Therefore, cognitive MRI–US fusion biopsy was performed with use of a urinary catheter.

Several modalities, including CT, MRI, US, fluoroscopy, and a grid, can be used to facilitate prostate biopsy in patients without rectal access. These are summarized in Table 2. Real-time CT-guided biopsy makes it possible to obtain samples from the MRI-defined lesion by direct visualization. However, this approach is time-consuming, involves exposure to radiation, must be performed by an experienced radiologist, and is relatively costly to perform.[12] Real-time MRI-guided biopsy enables precise target sampling by direct visualization of the prostate but requires a long procedure time, use of MRI-safe equipment, an experienced radiologist, and higher cost.[13] US-guided biopsy is useful, with several methods available depending on the route. Transperineal US-guided transperineal biopsy requires no special equipment and allows MRI–US fusion biopsy.[5–7] However, depending on the case, transperineal US images may not allow adequate visualization of the prostate.[14] Transurethral US-guided transperineal biopsy allows good visualization, but views of the prostate are limited to the transverse plane. Furthermore, this method requires passage of the US probe through the resectoscope sheath.[11] Transabdominal US-guided transperineal biopsy requires no special equipment. However, depending on the case, transabdominal US images may not allow adequate visualization of the prostate, and transabdominal prostate biopsy is associated with a high risk of injury to the dorsal vein complex and bowel.[9] Image intensifier-guided transperineal biopsy uses fluoroscopy and a urinary catheter. The patient is catheterized and a measured volume of contrast is inserted into the catheter balloon. The traction on the catheter brings the balloon to the level of the bladder neck. This method makes it possible to obtain samples from an MRI-defined lesion even if transperineal US is

Table 1 Reports of Prostate Biopsy Without Rectal Access

Report, Year	Sample Size (n)	Age, Years, Median, Range	PSA (ng/mL), Median, Range	Surgical History	Anesthesia	Patient Position	Technique	Approach	Biopsy Cores, n	Biopsy Results, % with Cancer Detected	Grade Group, (n)	Treatment, (n)
Schapira,[15] 1982	1	77	NA	APR	NA	Lithotomy	IVU–US guided	Transperineal	NA	100% (1/1)	NA	Hormonal therapy
Krauss et al,[16] 1993	1	67	13.5	Total proctocolectomy	Local	Prone	CT-guided	Transbuttock	Systemic 6 cores	100% (1/1)	1	NA
Twidwell et al,[17] 1993	10	NA	4.1–10.5	APR	Local	Left lateral decubitus	Transperineal US-guided	Transperineal	1 to 4 cores	20% (2/10)	NA	NA
Filderman et al,[18] 1993	5	62 (54–78)	11.7 (6.5–42)	APR	NA	Lithotomy	Transperineal US-guided	Transperineal	Systemic 4 cores	40% (2/5)	NA	Prostatectomy 1, radiation 1
Fornage et al,[19] 1995	1	71	17	APR	Local	Dorsal decubitus	Transperineal US-guided	Transperineal	Random 7 cores	100% (1/1)	GG4	NA
Seaman et al,[11] 1996	5	66 (58–73)	10.5 (5.6–35)	APR/total colectomy	Local	Lithotomy	Transurethral US-guided	Transperineal	Systemic sextant biopsy, hypoechoic lesion	60% (3/5)	NA	NA
Papanicolaou et al,[20] 1996	10	67 (58–75)	7.9 (5.3–175)	Proctocolectomy	Local	NA	CT-guided	Transgluteal	Systemic 6 cores	60% (6/10)	NA	Hormonal therapy 3, radiation 3
D`Amico et al,[21] 2000	1	74	43.5	Proctocolectomy	General	Lithotomy	MRI-guided	Transperineal	Systemic sextant biopsy, MRI-defined lesions	100% (1/1)	GG1	NA
Shinohara et al,[9] 2003	28	65 (48–78)	9.5 (4.1–237)	APR	Local	Lithotomy	Transperineal US-guided	Transperineal	Random 6–12 cores	82.1% (23/28)	GG1/ more than 2, 11/12	Hormonal therapy 7, radiation 7, prostatectomy 8, WW 1
Morlacco et al,[10] 2013	2	85, 63	17.28, 5.6	APR	Local	Lithotomy	Suprapubic-transperineal US-guided	Transperineal	6 cores	50% (1/2)	NA	Hormonal therapy
Kongnyuy et al,[13] 2016	1	75	7.2	Total colectomy	Sedation	Supine	MRI-guided	Transperineal	Targeted 4 cores	100% (1/1)	GG4	NA
Hansen et al,[5] 2016	9	66 (63–77)	9.4 (3.2–60)	APR	General	Lithotomy	Cognitive MRI–US fusion-guided	Transperineal	Systemic 11–27 cores + MRI–defined lesions 3–7 cores	77.8% (7/9)	GG1/2/3/4/5, 1/1/1/1/3	Hormonal therapy 1, radiation 2, prostatectomy 2, AS 2
Caglic et al,[12] 2016	2	63, 69	18.3, 10.2	APR	Local	Prone	CT-guided	Transgluteal	Targeted 4 cores on MRI-defined lesion	100% (2/2)	GG3/4, 1/1	NA
Amin et al,[7] 2019	1	75	NA	Total colectomy	General	Lithotomy	Cognitive MRI–US fusion-guided	Transperineal	Targeted 3–4 cores on each MRI-defined lesion	100% (1/1)	GG2-3	NA

(*Continued*)

Table 1 (Continued).

Report, Year	Sample Size (n)	Age, Years, Median, Range	PSA (ng/mL), Median, Range	Surgical History	Anesthesia	Patient Position	Technique	Approach	Biopsy Cores, n	Biopsy Results, % with Cancer Detected	Grade Group, (n)	Treatment, (n)
De Vulder et al,[22] 2021	1	75	NA	APR	Local	Lithotomy	Real-time MRI–US fusion-guided	Transperineal	Targeted 6 cores on MRI-defined lesion	100% (1/1)	GG4	Hormonal therapy
Kailavasan et al,[6] 2021	3	69 (68–75)	7.7 (6.5–14)	APR	General	Lithotomy	Cognitive MRI–US fusion-guided	Transperineal	Targeted 13 (range 12–15) cores on MRI-defined lesion	100% (3/3)	GG2/4, 2/1	Radiation 3
Miyajima et al,[3] 2024	1	75	5.85	APR	Spinal	Lithotomy	Cognitive MRI–US fusion-guided	Transperineal	Systemic 6 cores + MRI-defined lesion 2 cores	100% (1/1)	GG5	NA
Nicholas et al,[14] 2024	2	67, 68	19.5, 7.2	Proctocolectomy	General	Lithotomy	Image intensifier-guided without US	Transperineal	Systemic 4 cores (two cores from each lobe)	100% (2/2)	GG3/4, 1/1	Hormonal therapy 1, radiation 1
Sahni et al,[8] 2024	15	70 (56–81)	12.8 (4.3–40)	APR/ proctocolectomy	Local/ general	Lloyd–Davis	Grid-based (without US)	Transperineal	Targeted biopsy, median 11 cores (4–25)	93% (14/15)	GG1/2/3/4/5, 1/7/2/1/3	NA
Our case	2	59, 77	8.0, 24.3	APR	General	Lithotomy	Cognitive MRI–US fusion-guided	Transperineal	Systematic 8 cores + MRI-defined lesion 4 cores	100% (2/2)	GG2/3, 1/1	Radiation 2

Abbreviations: APR, abdominoperineal resection; AS, active surveillance; GG, grade group; MRI, magnetic resonance imaging; NA, not available; US, ultrasound; WW, watchful waiting.

Table 2 Methods for Prostate Biopsy in Patients Without Rectal Access

Modality	Approach	Patient Position	Advantage	Disadvantages
CT	Transguteal	Prone	Target sampling by direct visualization	Radiation exposure, requirement for an experienced radiologist, higher cost, time-consuming
MRI	Transperineal	Supine	Target sampling by direct visualization	Long procedure time, MRI-safe equipment, requirement for an experienced radiologist, higher cost
US				
Transperineal US	Transperineal	Lithotomy	No requirement for special equipment, MRI–US fusion biopsy	Poor visualization by US depending on the case
Transurethral US	Transperineal	Lithotomy	Good visualization of the prostate	Requirement for transurethral US, transverse plane only as a prostate view, invasive procedure
Transabdominal US	Transperineal	Lithotomy	No requirement for special equipment	Poor visualization by US depending on the case
Fluoroscopy	Transperineal	Lithotomy	No requirement for special equipment, no use of US	Difficulty in precise target sampling
Grid (no use of imaging equipment)	Transperineal	Lithotomy	No requirement for special equipment, no use of US	Requirement for a highly experienced surgeon

Abbreviations: CT, computed tomography; MRI, magnetic resonance imaging; US, ultrasound.

not possible because of poor visualization. However, this method does not allow precise target sampling.[14] Grid-based cognitive prostate biopsy uses only a spinal needle and a biopsy needle. This method allows samples to be taken from the MRI-defined lesion without US guidance, but must be performed by an experienced surgeon because of the need to be able to sense accurately when the biopsy needle is in contact with the prostate gland.[8] Our MRI–US fusion biopsy technique is safe and practical technique and does not require any special equipment. This method could be considered when the prostate is visualized clearly under transperineal US guidance.

There is no consensus regarding an algorithm for prostate cancer detection in patients without rectal access. McNicholas and Parr suggest that multiparametric MRI should be performed before biopsy.[14] When no suspicious lesion is identified and PSA density is low, PSA screening can be offered. Transperineal US should be performed when a suspicious lesion is detected and/or the PSA density is increased. When the prostate is visualized clearly, transperineal US-guided biopsy would be preferred.[14] However, another modality should be considered for obtaining biopsy samples from MRI-defined lesions when the prostate is not clearly visualized. McNicholas and Parr propose image intensifier-guided transperineal biopsy as a next diagnostic step. CT-guided or MRI-guided biopsy could be considered if the result of image intensifier-guided biopsy is negative.[14] In our opinion, cognitive MRI–US fusion transperineal biopsy or real-time MRI–US fusion transperineal biopsy using software should be considered when the prostate is visualized clearly under transperineal US guidance. Real-time CT-guided or MRI-guided biopsy could be considered as the next diagnostic tool if the prostate is not visualized clearly by transperineal US and the surgeon does not have enough experience of image intensifier-guided biopsy.

Our biopsy method could lead to the successful detection of prostate cancer and the diagnostic accuracy rate was 100%. However, this method was performed in only two cases. A multi-institutional prospective trial in a large cohort should be required to confirm the accuracy of this method.

Conclusions

There is no international consensus on the optimal prostate biopsy technique in patients without rectal access. Cognitive MRI–transperineal US fusion prostate biopsy with use of a urinary catheter could be a practical technique and provide an accurate tissue diagnosis in patients with an MRI-defined lesion in the prostate that is clearly visualized by transperineal US. A multi-institutional prospective trial in a large cohort is required to clarify the accuracy of this biopsy method.

Ethical Standards

This study was approved by the appropriate ethics committee of Tama-Hokubu Medical Center.

Informed Consent

The patients gave informed consent for the publication of their case details and any accompanying images.

Acknowledgments

I would like to thank Y. Kitamura, A. Asano and S. Suzuki for useful discussions.

Funding

There is no funding to report.

Disclosure

The authors report no conflicts of interest in this work.

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