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Use of Imaging and Biopsy in Prostate Cancer Diagnosis: A Survey From the Asian Prostate Imaging Working Group

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Objective: To elucidate the use of radiological studies, including nuclear medicine, and biopsy for the diagnosis and staging of prostate cancer (PCA) in clinical practice and understand the current status of PCA in Asian countries via an international survey.
Materials and Methods: The Asian Prostate Imaging Working Group designed a survey questionnaire with four domains focused on prostate magnetic resonance imaging (MRI), other prostate imaging, prostate biopsy, and PCA backgrounds. The questionnaire was sent to 111 members of professional affiliations in Korea, Japan, Singapore, and Taiwan who were representatives of their working hospitals, and their responses were analyzed.
Results: This survey had a response rate of 97.3% (108/111). The rates of using 3T scanners, antispasmodic agents, laxative drugs, and prostate imaging-reporting and data system reporting for prostate MRI were 21.6%–78.9%, 22.2%–84.2%, 2.3%–26.3%, and 59.5%–100%, respectively. Respondents reported using the highest b-values of 800–2000 sec/mm^2 and fields of view of 9–30 cm. The prostate MRI examinations per month ranged from 1 to 600, and they were most commonly indicated for biopsy-naïve patients suspected of PCA in Japan and Singapore and staging of proven PCA in Korea and Taiwan. The most commonly used radiotracers for prostate positron emission tomography are prostate-specific membrane antigen in Singapore and fluorodeoxyglucose in three other countries. The most common timing for prostate MRI was before biopsy (29.9%). Prostate-targeted biopsies were performed in 63.8% of hospitals, usually by MRI-ultrasound fusion approach. The most common presentation was localized PCA in all four countries, and it was usually treated with radical prostatectomy.
Conclusion: This survey showed the diverse technical details and the availability of imaging and biopsy in the evaluation of PCA. This suggests the need for an educational program for Asian radiologists to promote standardized evidence-based imaging approaches for the diagnosis and staging of PCA.
Keywords: Survey; Magnetic resonance imaging; Prostate cancer; Biopsy; Report; PET; PSMA

INTRODUCTION

Prostate multiparametric magnetic resonance imaging (mpMRI) using T2-weighted imaging, diffusion-weighted imaging (DWI), and dynamic contrast-enhanced imaging (DCE) has recently become the standard for

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detecting and localizing prostate cancer (PCA). To ensure sufficient diagnostic quality as well as consistency in the interpretation and reporting of prostate magnetic resonance imaging (MRI), the prostate imaging-reporting and data system (PI-RADS) was developed in 2012. It has now evolved to V2.1 and includes technical recommendations, guidelines for PCA assessments and scoring, and reporting [1,2]. The prostate MRI-directed biopsy pathway is a recent paradigm shift that has reduced overdiagnoses and unnecessary biopsies for biopsy-naïve patients clinically suspected of PCA [3]. Prostate-targeted biopsy after lesion detection and localization by MRI can be performed via cognitive registration, magnetic resonance (MR)-ultrasound fusion, or an MRI in bore approach; each has specific advantages and disadvantages [4-6]. Questions related to biparametric MRI (bpMRI), patient preparation issues, new pulse sequences of prostate MRI, and new imaging modalities for PCA were also included in the survey questionnaires [7-14]. The PI-RADS has been advocated for a decade and continues to evolve; however, its application and acceptance in routine clinical practice in Asia remain unclear. Similarly, the clinical use of prostate MRI, biopsy, other prostate imaging techniques, and the background status of PCA in Asia is not understood. Therefore, we developed a survey to address these questions for Asian 4 countries and explore the current practices of prostate imaging, biopsies, and PCA status in four Asian countries.

MATERIALS AND METHODS

The Asian Prostate Imaging Working Group (APIWG) designed a questionnaire with 29 questions, using single-choice questions (SQs), multiple-choice questions (MQs), and open-choice questions (OQs), in four domains: prostate MRI, other prostate imaging, prostate biopsy, and PCA background (Table 1). The prostate MRI domain questions focused on the use of field strengths of MRI scanners, endorectal coils (ERCs), antispasmodic agents, and laxatives for patient preparation, pulse sequences, imaging parameters, and structured MRI reporting (PI-RADS), as well as indications such as examination number per month and scanning time per examination [1,2]. Other prostate imaging domain questions focused on the use of positron emission tomography (PET), radiotracers, availability of PET-MRI, and operators of transrectal ultrasonography (TRUS) of the prostate. For the prostate biopsy domain, the questions explored the use and methods for targeted biopsy, as well as the scheduled MRI timing relative to biopsy. For the PCA background domain, three questions addressed the perceptions about population-based prostate specific antigen (PSA) screening, most common presentation of PCA, and most common treatment approach.

The questionnaire was sent to 111 members of professional affiliations in Korea (n = 19), Japan (n = 43), Singapore (n = 10), and Taiwan (n = 39) who were representatives of their hospitals. The number, professional affiliations, and survey period of the respondents in each country are listed in Table 2. Responses to all questions by the professionals in the four countries were collected, aggregated, and analyzed. If the respondents did not choose any answer items for SQ and MQ, did not fill in any answer for OQ, or responded without any information addressing the questions such as "I don't know" and "I am not sure," the questionnaire was considered invalid. The counts and proportions of each answer item chosen in the SQ and MQ were calculated using valid responses as denominators. The data obtained from the OQ were described as counts and proportions for categorical variables and histogram parameters (such as minimum, maximum, mean, and standard deviation) for continuous variables.

RESULTS

Response Rates of the Survey and Results of the Prostate MRI Domain

The response rate of the survey was 97.3% (108/111, Table 2), with a 99.2% (3102/3132) valid rate for all 29 questions. Based on the prostate MRI domain responses, 3T scanners were the most used (44.4%; 48/108) across all countries, with the rate varying from 21.6% (8/37) in Taiwan to 78.9% (15/19) in Korea (Fig. 1A). ERC was not routinely used; it was only by three respondents (2.8%). Antispasmodic agents, especially buscopan (hyoscine-N-butylbromide), were seldom used (25.8%, 23/89), except in Korea (84.2%, 16/19) (Fig. 1B). Laxatives were seldom used in all countries, with rates of 2.3% (1 of 43) in Japan, 10.8% (4 of 37) in Taiwan, 11.1% (1 of 9) in Singapore, and 26.3% (5 of 19) in Korea in ascending order. mpMRI or bpMRI, including T2-weighted imaging and DWI, was used by all respondents. All respondents, except one Korean respondent, used T1-weighted imaging. DCE was used by 89.7% of the respondents (96/107); 11 respondents did not use it (7 from Japan, 2 from Korea, and 2 from Taiwan). Intravoxel incoherent motion (IVIM) was seldom used (13.5%,

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Table 1. Domains, questions and answers of the questionnaire

Domains	Questions (SQ/MQ/OQ)	Answers
Prostate MRI	1. What field of strengths of MRI scanners do you use for prostate MRI? (SQ)	1. ≤ 1T alone 2. 3T alone 3. Both 3T and 1.5T
	2. Do you use endorectal coils routinely for prostate MRI? (SQ)	1. Yes 2. No 3. Depends
	3. How many MRI examinations using an endorectal coil for prostate MRI per month? (OQ)	Number of patients
	4. Do you use anti-spasmodic agent for prostate MRI routinely? (SQ)	1. Yes 2. No
	5. If the answer is yes for the above question, what kind of anti-spasmodic agent does your hospital use for prostate MRI routinely? (SQ)	1. Buscopan 2. Glucagon 3. Other agents, please describe
	6. Do you prescribe laxatives to patients for prostate MRI routinely? (SQ)	1. Yes 2. No
	7. How many routine protocols for prostate MRI in your hospital? (SQ)	1. One 2. Two 3. Three 4. > Four
	8. Do you use mpMRI or bpMRI for prostate imaging? (SQ)	1. Yes 2. No
	9. If the answer is yes for the above question, what are the pulse sequences included of your mpMRI? (MQ)	1. DWI 2. DCE 3. MR spectroscopy 4. T1-weighted imaging 5. T2-weighted imaging 6. Others
	10. What is your highest b value (s/mm^2) used in DWI? (OQ)	Highest b value
	11. Do you use IVIM for prostate MRI? (SQ)	1. Yes 2. No 3. Others, please describe
	12. How many phases are there of your DCE protocol of mpMRI if used? (OQ)	Number of phases
	13. How long is the duration of each phase of your DCE protocol of mpMRI if used? (OQ)	Seconds per DCE phase
	14. Which of the following are the scan regions of your routine prostate MRI (MQ)?	1. Prostate and seminal vesicles 2. Upper pelvic cavity 3. Abdomen 4. Others, please describe
	15. What is FOV of scanning prostate and seminal vesicle regions on mpMRI? (OQ)	FOV (cm)
	16. Do you use structured report (i.e.: PI-RADS reporting) for prostate MRI? (SQ)	1. Yes 2. No
	17. What are the indications for prostate MRI in your hospital (MQ)	1. Health examination for prostate cancer screening 2. Suspected prostate cancer of biopsy-naïve patients

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Table 1. Domains, questions and answers of the questionnaire (continued)

Domains	Questions (SQ/MQ/OQ)	Answers
		3. Suspected prostate cancer with negative results of previous TRUS biopsy 4. Staging of proven prostate cancer 5. Proven prostate cancer under active surveillance 6. Prostate cancer prior to radiation planning 7. Recurrence of prostate cancer after treatments 8. Others, please describe
	18. How many prostate MRI examinations are performed per month in your hospital? (OQ)	Number per month
	19. How long does it take in average for each prostate MRI examination in your hospital? (OQ)	Minutes per examination
Other prostate imaging	20. Does your hospital perform prostate PET? (SQ)	1. Yes 2. No
	21. If the answer is yes for the above question, what kinds of radiotracers does your hospital use for prostate PET? (MQ)	1. Fluorodeoxyglucose 2. Choline 3. Prostate-specific membrane antigen 4. Others, please describe
	22. Does your hospital perform prostate PET-MRI? (SQ)	1. Yes 2. No
	23. Who performs TRUS of the prostate in your hospital? (SQ)	1. Radiologist 2. Urologist 3. Both
Prostate biopsy	24. Does your hospital offer targeted prostate biopsy? (SQ)	1. Yes 2. No
	25. If the answer is yes for the above question, what methods do your hospital use? (SQ)	1. Cognitive registration alone 2. MRI-ultrasound fusion alone 3. MRI in bore alone 4. Both fusion and cognitive approaches 5. All three (fusion/cognitive/in bore)
	26. What is the timing of the prostate MRI relative to the prostate biopsy timing? (SQ)	1. No time restraint 2. Before prostate biopsy only 3. 4–6 weeks after prostate biopsy only 4. Other timings, please describe
PCA background	27. Does your country perform prostate surface antigen screening test for PCA? (SQ)	1. Yes 2. No
	28. What categories of PCA patients account for the highest proportion in your hospital? (SQ)	1. Localized disease 2. Locally advanced disease 3. Others, please describe
	29. What treatment is the most commonly used for localized disease of PCA in your hospital? (SQ)	1. Transurethral resection of the prostate 2. Radical prostatectomy 3. Radiation therapy 4. Others, please describe

SQ = single-choice question, MQ = multiple-choices question, OQ = open-question questions, MRI = magnetic resonance imaging, T = tesla, mpMRI = multiparametric MRI, bpMRI = bi-parametric MRI, DWI = diffusion-weighted imaging, DCE = dynamic contrast-enhanced imaging, MR = magnetic resonance, IVIM = intravoxel incoherent motion, FOV = field of view, PI-RADS = prostate imaging-reporting and data system, TRUS = transrectal ultrasound, PET = positron emission tomography, PCA = prostate cancer

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Table 2. Number and professional affiliations of the respondents and their survey period in each country

Country	Number	Status of professional affiliations	Survey period	Response number (response rate)
Korea	19	Certificated radiologists of Korean Society of Urogenital Radiology Society	1st September to 17th September 2021	19 (100%)
Japan	43	Councilors of the Japanese Society of Abdominal Radiology	14th September to 20th September 2022	43 (100%)
Singapore	10	Certificated abdominal radiologists of tertiary hospitals and major outpatient radiology clinics or certificated urologist of the Singapore Urological Association	20th August to 31th October 2021	9 (90.0%)
Taiwan	39	Certificated abdominal radiologists of Taiwan Radiological Society, working at residency training hospitals	19th August 2021 to 6th December 2021	37 (94.9%)

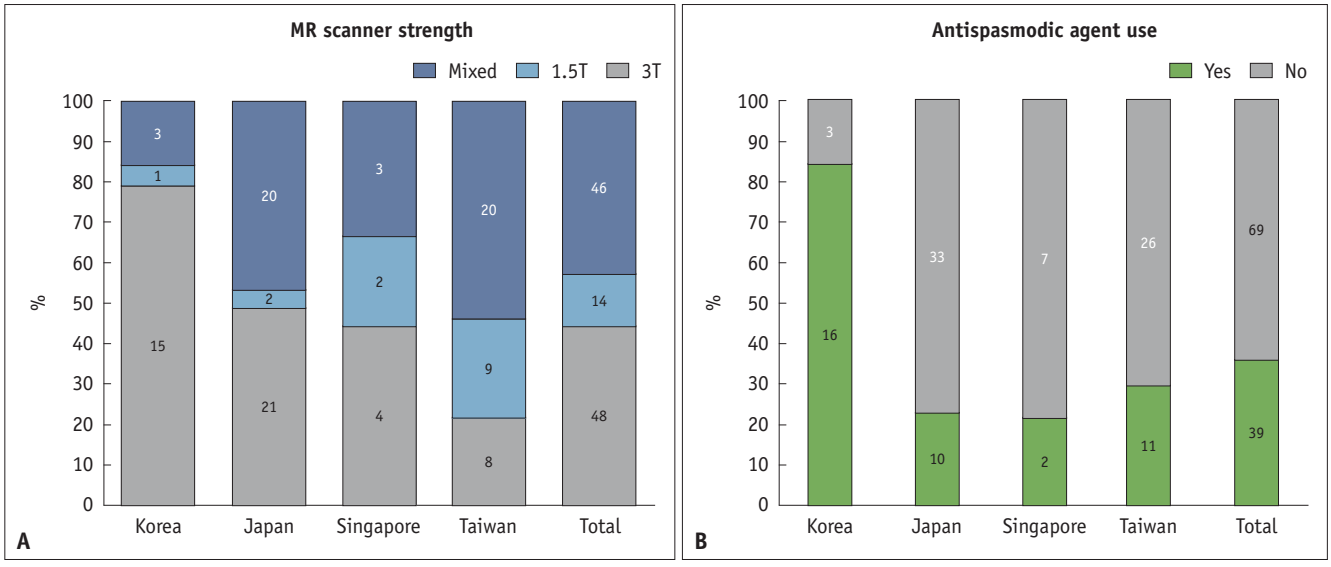

Fig. 1. The distribution of scanner strengths and antispasmodic agent uses for prostate magnetic resonance imaging (MRI) in the four Asian countries. **A:** The rates of use of various scanner strengths for prostate MRI; 44.4% (48 of 108), 42.6% (46 of 108), and 13.0% (14 of 108) used 3T, 1.5T and 3T, and 1.5T, respectively. None used 1T or below for prostate MRI. **B:** The overall rate of use of antispasmodic agents was 36.1% (39 of 108), ranging from 22.2% (2 of 9) in Singapore and 84.2% (16 of 19) in Korea. MR = magnetic resonance

14/104). Overall, the highest b-values for DWI ranged from 800 to 2000 sec/mm^2; the most common was 2000 sec/mm^2, followed by 1500 sec/mm^2, but they varied across countries (Fig. 2A). The phase number and durations of DCE ranged from 2 to 90 and from 3.0 to 60.0 seconds for all respondents, respectively, with the highest mean phase number of 41.9 for Korea and the shortest mean phase duration of 7.1 seconds for Singapore. All prostate MR images covered regions of the prostate and seminal vesicles. Of these, 73% had additional coverage of the upper pelvic cavity, and 19.4% had additional coverage of the abdomen, most commonly in Taiwan (100% and 40.5%, respectively) (Fig. 2B). Of the respondents, 73.1% used PI-RADS for MRI reports; this was most common in Singapore (100%) and least common in Taiwan (59.5%) (Fig. 3). Table 3 shows the distribution of the indications for prostate MRI in each country. It was most commonly indicated for biopsy-naïve patients with clinical suspicion of PCA in all countries (95.4%), as well as in Japan and Singapore (both 100%). However, staging of proven PCA is the most common indication in Korea and Taiwan. In contrast, PCA screening was the least common indication. The number of MRI examinations per month and the duration of each MRI varied widely across the four countries, ranging from 1 to 600 examinations per month and from 15 to 60 minutes, respectively (Table 4).

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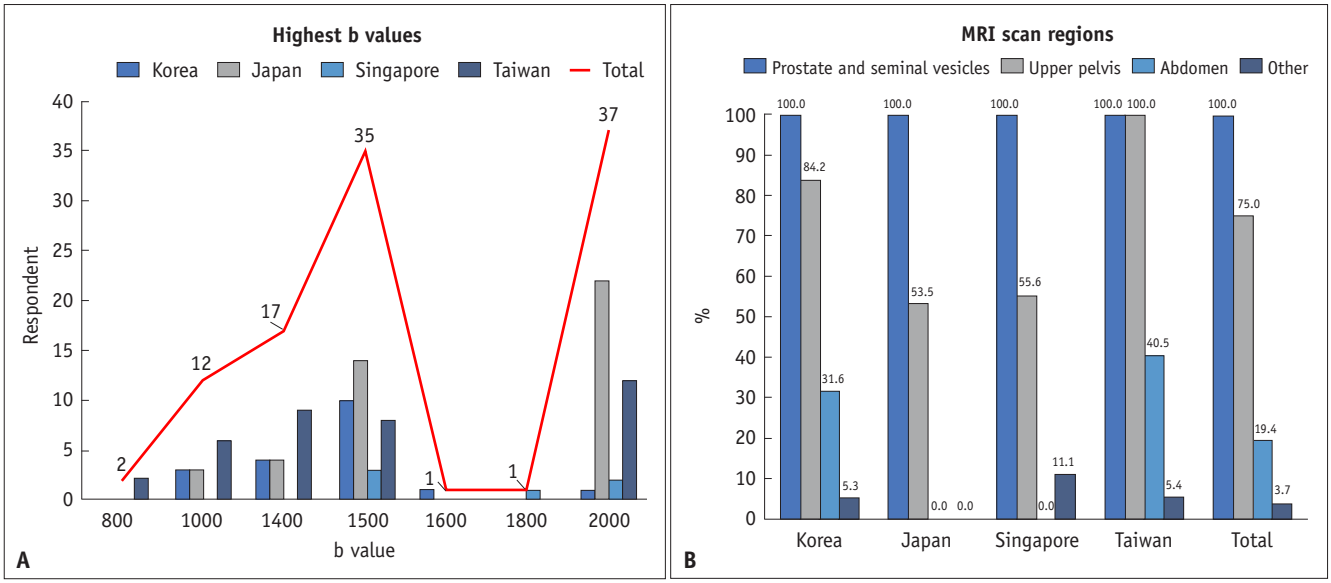

Fig. 2. The distribution of the highest b-values used for diffusion-weighted images (DWIs) and the regions covered by prostate MRI of the four Asian countries. **A:** The overall distribution of the highest b-values of DWI shows a bi-peak distribution at 2000 sec/mm^2 (35.2%, 37 of 105) and 1500 sec/mm^2 (33.3%, 35 of 105). In Japan and Taiwan, 51.2% (22 of 43) and 32.4% (12 of 37) reported the highest b-value of 2000 sec/mm^2, respectively; in contrast, 52.6% (10 of 19) and 50.0% (3 of 6) reported 1500 sec/mm^2 in Korea and Singapore, respectively. **B:** The overall scanned regions by prostate MRI cover the prostate gland and seminal vesicles, upper pelvic cavity, and abdomen, accounting for 100% (108 of 108), 75.0% (85 of 108), and 19.4% (21 of 108), respectively. The upper cavity coverage rates in the 4 countries ranged from 53.5% (23 of 43) in Japan to 100% (37 of 37) in Taiwan. The abdomen coverage rates ranged from none in Japan and Singapore to 40.5% (15 of 37) in Taiwan. MRI = magnetic resonance imaging

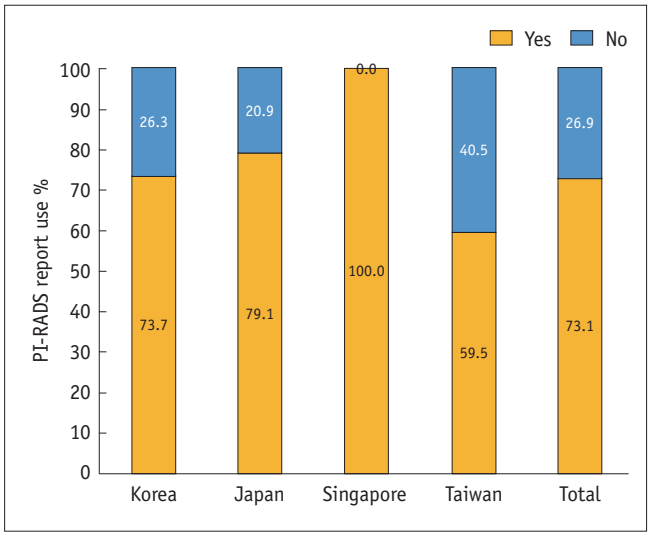

Fig. 3. The rate of use of PI-RADS for reporting: 59.5% (22 of 37) in Taiwan, 73.7% (14 of 19) in Korea, 79.1% (34 of 43) in Japan, 100% (9 of 9) in Singapore, and 73.1% (79 of 108) in the 4 Asian countries. PI-RADS = prostate imaging-reporting and data system

Results of Other Prostate Imaging, Prostate Biopsy, and PCA Background Domains

PET use was common in Korea (66.7%) and Singapore (77.8%) but uncommon in Japan (27.9%) and Taiwan (43.1%) (Fig. 4A). The prostate-specific membrane antigen (PSMA) radiotracer was the most commonly used in Singapore and fluorodeoxyglucose (FDG) was the most commonly used in the other three countries (56.3%–91.7%) (Fig. 4B). Nearly all hospitals, except 4 (two in Singapore and two in Taiwan), did not perform prostate PET/MRI examinations. Radiologists most commonly performed TRUS in Korea (52.6%, 10 of 19), which was in contrast to urologists in the other three countries (88.9%–97.6%, Fig. 5). Prostate-targeted biopsies were performed by 63.8% of the respondents in the four countries and up to 94.7% in Korea (Fig. 6A); the MRI-US fusion method was the most commonly used (Fig. 6B).

Prostate MRI is usually performed before biopsy in Japan and Singapore (64.3% and 55.6%, respectively), in contrast to 4–6 weeks after biopsy in Taiwan (48.6%) and other timings in Korea (89.5%) (Fig. 7A). Based on the 27 responses on other timings, prostate MRI was most commonly performed before biopsy or within 4 weeks after biopsy in Korea (76.5%, 13 of 17), contrasted with within 4 weeks after biopsy (30.0%, 3 of 10) and before biopsy and within 4–6 weeks after biopsy (30.0%, 3 of 10) in Taiwan (Fig. 7B).

PSA screening for PCA was performed by all respondents in Korea and Singapore, in contrast with 74.4% (32 of 43) in Japan and 83.8% (31 of 37) in Taiwan. Nearly all (93.4%,

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Table 3. Indications of prostate MRI in the 4 Asian countries

Indications	Korea (n = 19)	Japan (n = 43)	Singapore (n = 9)	Taiwan (n = 37)	Total (n = 108)
Cancer screening at the health examination	5 (26.3)	4 (9.3)	3 (33.3)	19 (51.4)	31 (28.7)
Biopsy naïve patients with clinical suspicion of having PCA	17 (89.5)	43 (100)	9 (100)	34 (91.9)	103 (95.4)
A negative result of a prior prostate biopsy of a patient with clinical suspicion of PCA	14 (73.7)	22 (51.2)	7 (77.8)	33 (89.2)	76 (70.4)
Staging of prostate cancer	19 (100)	35 (81.4)	5 (55.6)	37 (100)	96 (88.9)
PCA patients under active surveillance	17 (89.5)	35 (81.4)	7 (77.8)	34 (91.9)	93 (86.1)
Prior to RT planning	11 (57.9)	31 (72.1)	3 (33.3)	33 (89.2)	78 (19.4)
PCA patients with biochemical failure after treatments	19 (100)	36 (83.7)	5 (55.6)	36 (97.3)	96 (72.2)
Others	3 (15.8)	5 (11.6)	2 (22.2)	8 (21.6)	18 (16.7)

Values are presented as n (%).
MRI = magnetic resonance imaging, PCA = prostate cancer, RT = radiation therapy, RP = radical prostatectomy

Table 4. Distribution of the number of prostate MRI examinations/month and duration of each prostate MRI examination in each country

	Korea (n = 19)	Japan (n = 43)	Singapore (n = 7)	Taiwan (n = 37)
Number of examinations	144.0 ± 169.0 (10–600)	28.5 ± 29.8 (4–150)	39.0 ± 38.0 (7–100)	42.4 ± 45.6 (1–50)
Duration of each examination, min	34.4 ± 5.1 (28–45)	24.2 ± 7.1 (15–45)	38.1 ± 16.0 (25–60)	39.3 ± 6.7 (20–60)

Data are mean ± standard deviation (range).
MRI = magnetic resonance imaging

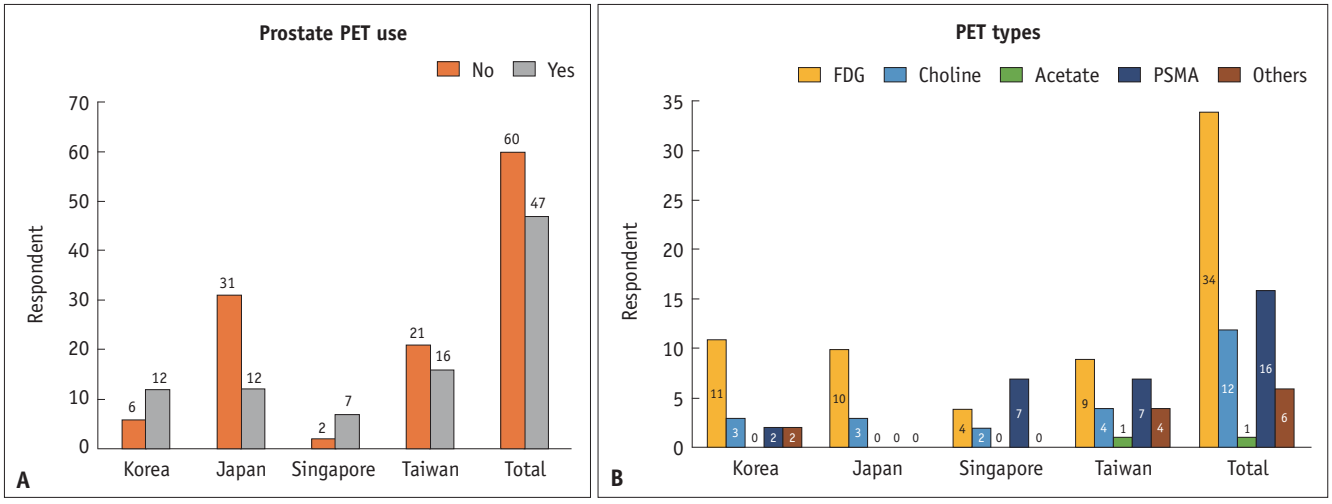

Fig. 4. The use of prostate position emission tomography (PET) and radiotracers in the four Asian countries. **A:** The rates of use of PET in Korea, Japan, Singapore, Taiwan, and all countries were 66.7% (12 of 18), 27.9% (12 of 43), 77.8% (7 of 9), 43.2% (16 of 37), and 43.9% (47 of 107), respectively. **B:** Fluorodeoxyglucose (FDG) is the most commonly used radiotracer in all countries; the rates of use were 72.3% (34 of 47) in all 4 countries, 56.3% (9 of 16) in Taiwan, 57.2% (4 of 7) in Singapore, 83.3% (10 of 12) in Japan, and 91.7% (11 of 12) in Korea. Prostate-specific membrane antigen (PSMA) is the second most common radiotracer, and it is used by 34.0% (16 of 47) in all 4 countries. The rate of use ranges from 0.0% in Japan to 100% in Singapore.

99 of 106) respondents thought localized diseases of the PCA were the most common in their countries and radical prostatectomy was the most used treatment.

DISCUSSION

The response rate of our survey was 97.3%, which is higher than those of other radiology surveys [6,15,16]. A potential reason for this is that the respondents of our survey were representatives of the working hospitals and had professional affiliations to radiological societies, resulting in a higher response rate than those of previous surveys for all members in professional affiliations.

Our survey results showed that prostate MRI examinations

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in all four Asian countries were performed with at least 1.5 T scanners; 3T was most commonly used (44.4%) but rarely with ERC. The preference for 3T without ERC is consistent with the results of a survey by the Society of Abdominal Radiology (SAR) prostate disease-focused panel (DFP) [6]. The rare use of ERC after its application for decades may be explained by patient discomfort, increased cost, possible susceptibility artifacts, and the need for software to correct the high signal intensity ratio bias [17].

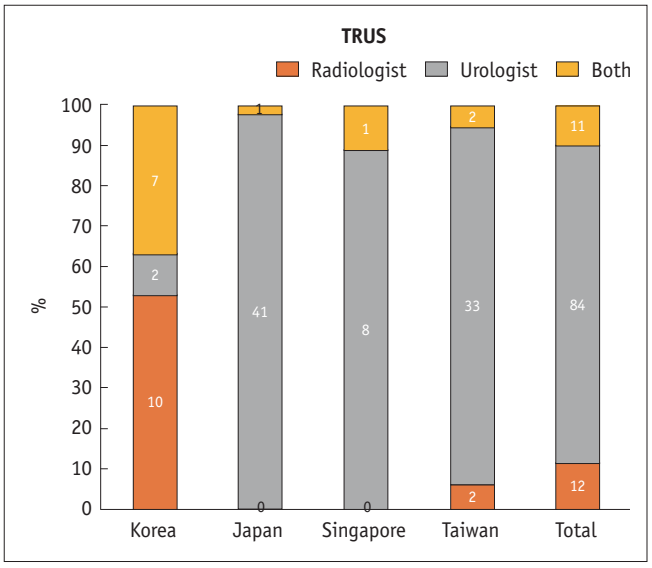

Fig. 5. The radiologists, urologists, and both (radiologists and urologists) as operators of transrectal ultrasonography of the prostate gland (TRUS) account for 11.2% (12 of 107), 78.5% (84 of 107), and 10.3% (11 of 107), respectively, in the 4 Asian countries. Urologists most commonly perform TRUS, except in Korea.

A survey by the SAR prostate DFP reported 54% rectal evacuation before MRI, and evacuating air in the rectum, if present, was considered the most challenging among the preparation factors for prostate MRI [6]. However, laxatives were seldom used in our survey because of the lack of consensus about the need for and optimal methods of rectal preparation and conflicting results of laxative use in the literature [1,7,18].

Regarding the use of antispasmodic agents, our survey results demonstrated only 25.8% in Asian countries, except in Korea (84.2%). Most Korean radiologists believe that antispasmodic agents are useful and necessary for decreasing rectal peristalsis and providing sufficient imaging quality. However, there could be different perceptions of radiologists in the other three countries because of uncertainty about the benefits of antispasmodic agents to all patients in the literature [1]. A survey by the SAR Prostate DFP revealed non-usage of antispasmodic agents by 59% of respondents [6]. Thus, more high-quality studies on patient preparation for prostate MRI are needed to provide robust evidence for the consensus achieved.

In our survey, approximately 10% of the hospitals did not use DCE despite the safety net considered in PI-RADS v2.1 [14]; the advantages include the non-usage of contrast agents, shorter scan duration, lower cost, and similar diagnostic performance of bpMRI. In addition, the DCE parameters used varied: the phase number range was

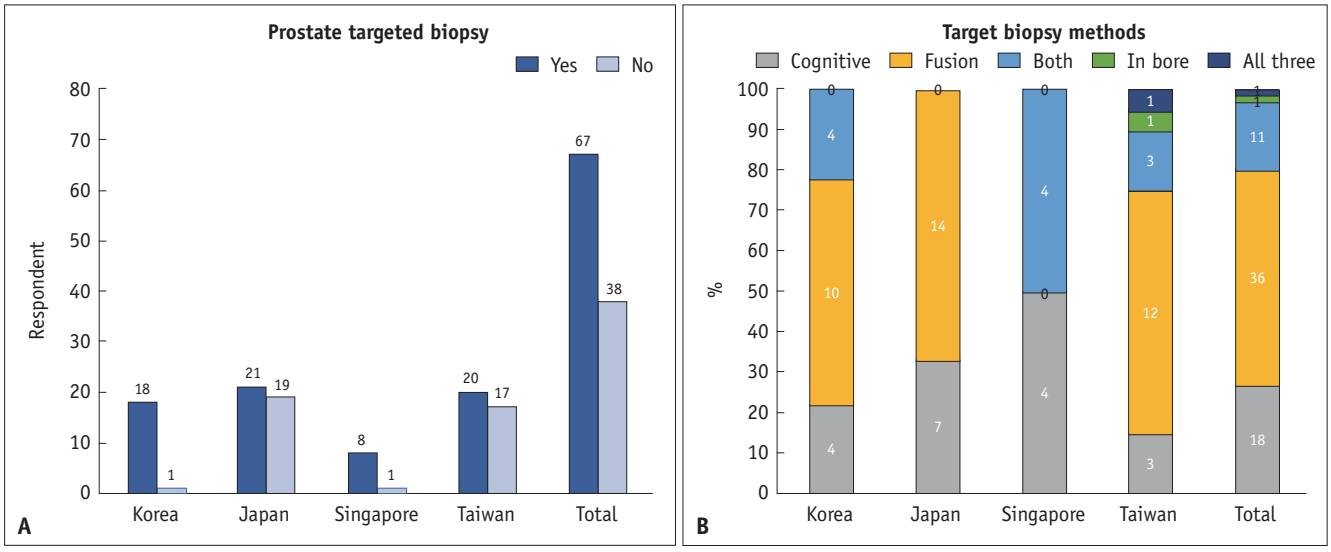

Fig. 6. The use and approached methods of prostate target biopsy. **A:** Prostate target biopsy had been performed by 63.8% (67 of 105) across all 4 countries, accounting for 52.5% (21 of 40) in Japan, 54.1% (20 of 37) in Taiwan, 88.9% (8 of 9) in Singapore, and 94.7% (18 of 19) in Korea, respectively. **B:** The magnetic resonance imaging-ultrasound (MRI-US) method is the most commonly used for prostate target biopsy in the 4 countries (53.7%; 36 of 67), followed by the cognitive method (26.9%; 18 of 67).

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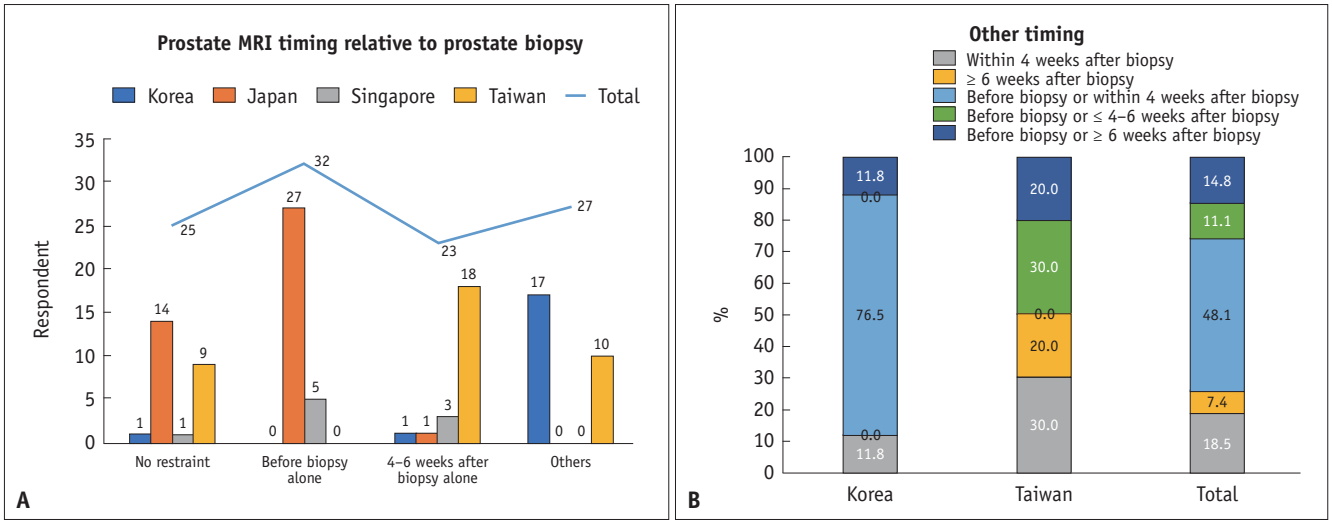

Fig. 7. The timing of prostate magnetic resonance imaging (MRI) relative to prostate biopsy. **A:** The most common timing for prostate MRI was before biopsy (29.9%, 32 of 107) in all 4 countries, followed by other timings (25.2%, 27 of 107), no restraint (23.4%, 25 of 107), and 4–6 weeks after biopsy (21.5%, 23 of 107), respectively. **B:** Other timings have been used in Korea and Taiwan. Among 5 other timings for prostate MRI, Korean radiologists usually perform it before biopsy or within 4 weeks after biopsy (76.5%, 13 of 17). In contrast, two other timings are equally common in Taiwan: within 4 weeks after biopsy and both before biopsy or 4–6 weeks after biopsy (both 30.0%, 3 of 10 for each).

2–90 and the phase duration range was 3–60 seconds. The highest b-values of 800–2000 sec/mm^2 were not consistent with the highest b-values of ≥ 1400 sec/mm^2 [1,19]. There are several possible explanations for these findings. First, the technical limitations of MRI systems did not allow temporal resolutions of less than 15 seconds on DCE or higher b-value of ≥ 1400 sec/mm^2. Second, radiologists and MRI technologists were blinded to the recommendations. Third, DCE is not the dominant sequence for MRI interpretation and can only be used to upgrade lesions in the peripheral zone. Both MR spectroscopy and IVIM are rarely used because they are not recommended by the PI-RADS [1,2,10], although some studies have explored their values [8,12,20].

It was surprising that additional scanning regions up to the abdomen cavity were reported for 40.5% and 31.6% of the respondents in Taiwan and Korea, respectively. Nonetheless, an effort to communicate the importance of spending time focusing on the most important prostate and seminal vesicle regions with clinicians due to the trade-off of MRI is necessary to maintain image quality. The field of view (FOV) for scanning the prostate and seminal vesicles was 9–30 cm, which is not consistent with the recommended FOV (12–20 cm) for the PI-RADS [1,2]. This may result in a longer scanning duration or insufficient spatial resolution.

In our survey, approximately 73% of the respondents had used PI-RADS reporting, but some radiologists still did not use PI-RADS reporting for prostate MRI [1,2], which was lower than the 92% reported by a recent survey [6]. These results indicate that an educational course for Asian radiologists and those leading prostate MRI programs is needed to improve the evidence, awareness of the updated definitions of PI-RADS scores 2 and 3 in the transition zone [1], and familiarity with the technical requirements of PI-RADS to standardize the imaging technique and for consistent MRI reporting.

PCA screening during health examinations was the least (13.0%) chosen indication. Hao et al. [21] showed that PCA screening using PI-RADS 3–5 foci on MRI for combined systemic and targeted biopsies in Sweden is probably more cost-effective than PSA screening with a standard biopsy alone. Another population-based study showed PI-RADS 4–5 on MRI, compared with PSA of ≥ 3 ng/mL, was associated with clinically significant prostate cancers (csPCAs) without an increase in overdiagnosis [22]. Nonetheless, the prevalence of PCA, csPCA proportions, reimbursement policies, diagnostic strategies, and ethnic and geographic factors may all affect the estimates and outcomes of screenings [13]. Thus, there is a great demand for further studies to address the value of prostate MRI in health examinations and population-based cohorts. Given that prostate MRI is central to the "MRI diagnostic pathway," it has great demand for clinical decision-making

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not only in the United States and Europe [10] but also in Asia. There were 1–600 prostate MRI examinations per month, with each examination lasting 15–60 minutes in the four countries. The diagnostic performance and positive predictive value of prostate MRI vary, which is partly related to the experience of the radiologist. Much experience is required to develop competency in evaluating and reporting prostate MRI scans [23,24]. Experienced radiologists from busy centers could serve as teachers for hands-on training of inexperienced radiologists. However, the increase in demand and workflow could be a critical issue in a busy center, which may be alleviated by optimizing the imaging parameters with a reduction in scanning time, resulting in more examinations being performed [25].

PSMA is the most sensitive and specific radiotracer for the diagnosis of PCA [11,26,27], and it has not been widely used except in Singapore. However, the common use of FDG may be explained by its availability for several cancers, despite its nonspecific uptake by PCA overlapping with benign prostate tissues [9]. Prostate PET and MRI can be complementary [11,28] but they are rarely used concurrently because of high cost.

This survey also showed that radiologists usually performed TRUS-guided prostate biopsies in Korea, contrasting with urologists in the other three countries. Thus, the infrastructure, knowledge, and experience of Korean radiologists [29] may be used by Asian radiologists to promote TRUS-guided prostate biopsy use.

For 53.7% of respondents in our survey, MRI-US fusion targeted biopsy was preferred over cognitive fusion or in-bore methods and was mainly performed by urologists (78.5%). This was consistent with the reports of previous studies [6,30,31]. The common use (63.8%) of targeted biopsies reflects an ongoing paradigm shift for PCA diagnosis in all four Asian countries; however, targeted biopsies for PI-RADS 3 foci remain unsolved since their diagnostic yields of 10%–18% are only based on PI-RADS v2 definitions [31].

The timing of prostate MRI relative to biopsy depends on the purpose of prostate MRI. Biopsy may not interfere with PCA detection on MRI because the hemorrhage exclusion sign can be an indicator of the PCA location [1,32]. Nonetheless, PCA staging on MRI can sometimes lead to post-biopsy hemorrhage and inflammation; thus, MRI is recommended at least 6 weeks after biopsy [1]. The prostate MRI timing in this survey covered nearly all possible scenarios to reflect real-world practice. It did not only depend on the knowledge and preferences of urologists but also MRI timing availability, patient preferences, and expected waiting times in these countries.

Most respondents thought that there was PSA screening for PCA in their countries based on the clinical knowledge that PSA is a first-line clinical test for patients suspected of or concerned with PCA in all countries. However, routine PSA screening tests for populations are not currently recommended because there has not yet been any benefit against PCA mortality, and PCA characteristics are heterogeneous [33].

Our survey had some limitations. First, the respondents representing their working hospitals in each country were members or councilors of the society or radiologists/urologists of training or tertiary hospitals across the four countries. This variation may have introduced some bias of the answers chosen. However, this variation is expected to affect the answers in the PCA background domain, and the results of this domain should be interpreted with caution. Second, to keep this survey as simple as possible to enhance the response rates, we did not ask questions regarding the technical recommendations of PI-RADS. For example, questions were not asked about the spatial resolutions used for pulse sequences of mpMRI, which may make it difficult to exactly determine whether the MRI examinations used are truly PI-RADS compliant, although it is easy to determine noncompliance via assessment of other imaging parameters. Third, we did not ask the respondents to send their structured reports for prostate MRI, and we assumed that the structured reports used were based on the PI-RADS recommendations. This is because there could be intellectual contributions from radiologists at each hospital, which may be considered confidential by the respondents. Fourth, these survey results are based on the perceptions of respondents, and we could not validate the consistency of the answers provided by the respondents and the true situations of each hospital being represented. Finally, the survey duration and period varied across the four countries by an approximate 1-year interval, which may have introduced interval changes. This survey failed to explore the impact of health insurance on the use of prostate imaging methods and biopsies in the four countries, although TRUS biopsy rather than MRI-US fusion biopsy is paid for by national health insurance.

In summary, this survey showed various protocols, imaging parameters, reporting practices, and indications of prostate MRI and other prostate imaging and prostate-

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targeted biopsies in the four Asian countries. The findings indicate the need to enhance the knowledge of imaging parameters compliant with PI-RADS. In the era of MRI-directed biopsy pathways for PCA diagnosis, there will be a surge in the number of patients needing MRI for the detection, risk stratification, and planning of targeted biopsies of PCA in Asia. Well-designed educational programs and certification systems for different levels of readers for Asian radiologists may fill the knowledge gap and ensure prostate MRI quality as well as the competency to meet the clinical needs associated with the impending surge.

Availability of Data and Material

The datasets generated or analyzed during the study are available from the corresponding author on reasonable request.

Conflicts of Interest

Chan Kyo Kim, the editor board member of the *Korean Journal of Radiology*, was not involved in the editorial evaluation or decision to publish this article. All remaining authors have declared no conflicts of interest.

Author Contributions

Conceptualization: all authors. Data curation: Li-Jen Wang, Masahiro Jinzaki, Cher Heng Tan, Chan Kyo Kim. Formal analysis: Li-Jen Wang, Masahiro Jinzaki, Cher Heng Tan, Chan Kyo Kim. Investigation: all authors. Project administration: Li-Jen Wang, Masahiro Jinzaki, Cher Heng Tan, Chan Kyo Kim. Supervision: Li-Jen Wang, Chan Kyo Kim. Visualization: Li-Jen Wang, Chan Kyo Kim. Writing—original draft: Li-Jen Wang, Masahiro Jinzaki, Cher Heng Tan, Young Taik Oh, Hiroshi Shinmoto, Chau Hung Lee. Writing—review & editing: Nayana U. Patel, Silvia D. Chang, Antonio C. Westphalen, Chan Kyo Kim.

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