Original Article

Detection Rate of Prostate Cancer by Using Magnetic Resonance Imaging-Transrectal Ultrasound Fusion Image-Guided Prostate Biopsy at Phramongkutklao Hospital

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Objective: To determine the accuracy of prostate cancer detection by using magnetic resonance imaging-transrectal ultrasound (MRI-TRUS) fusion image-guided prostate biopsy.

Materials and Methods: Retrospective data were collected from the patients that underwent targeted prostate biopsy guided by MRI-TRUS fusion imaging of the prostate between January 2017 and October 2018. The data including age, serum prostate-specific antigen (PSA) levels, PSA density, prostate size, lesion size from multiparametric magnetic resonance imaging of the prostate (mpMRI), Prostate Imaging and Reporting Archiving Data System score (PI-RADS), number of targeted core biopsy, and result from the pathological diagnosis were collected. Detection rate of prostate cancer was analyzed.

Results: Ninety-five prostate cancer suspected patients underwent prostate biopsy for 143 lesions. Patients' analyses showed better overall detection rate of prostate cancer from the MRI-TRUS fusion image-guided prostate biopsy compared to the extended 12-core systematic biopsy at 49.5% versus 17.9%. Significant prostate cancer with a Gleason score of more than 6 was detected by MRI-TRUS fusion image-guided prostate biopsy at 33.7%. Prostate cancer detection rates from MRI-TRUS fusion image-guided prostate biopsy categorized by PI-RADS score 3, 4, and 5 were 21%, 48%, and 74%, respectively, which showed statistically significant detection rate with higher PI-RADS score ($p<0.001$).

Conclusion: The present study showed better prostate cancer detection rate using MRI-TRUS fusion image-guide prostate biopsy with correlation to higher PI-RADS score.

Keywords: Gleason score; PI-RADS score; mpMRI; MRI-TRUS fusion image-guided prostate biopsy

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Prostate cancer incidence is highly variable around the world. In Thailand, Prostate cancer is the fourth most common cancer in men. Prostate cancer is clinically suspicious in men having abnormal digital rectal examination (DRE) or have elevated serum prostate-specific antigen (PSA). Definite diagnosis of prostate cancer still requires tissue for pathological verification. Systematic transrectal ultrasound (TRUS)-guided biopsy, which typically obtains 10 to 12 cores of prostate tissue, was accepted by urologists as the standard technique. Prostate cancer detection rate by an initial TRUS-guided biopsy is about 30% to 50%[1]. In an attempt to reduce the false-negative rate, reduce unnecessary biopsy, and improve diagnostic accuracy, multiparametric magnetic resonance imaging (mpMRI) of prostate was developed[2,3].

At present, there are three magnetic resonance imaging (MRI) techniques for guided targeted biopsy, direct "in bore" MRI-guided biopsy, cognitive fusion guided biopsy; and MRI ultrasound fusion-guided biopsy[3].

In recent years, MRI ultrasound fusion-guided biopsy has emerged as a new diagnostic tool to improve prostate cancer detection ability. MRI ultrasound fusion-guided biopsy of prostate has three potential advantages. First, patients with no lesion on mpMRI could avoid a prostate biopsy. Second, patients with clinically insignificant disease would avoid diagnosis and subsequent inappropriate treatment, which carries risk of side effects and no benefit in terms of survival[4]. Third, using mpMRI for targeting may improve the detection of clinically significant cancers and improve risk stratification[5,6]. Moreover, the complications between standard

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systematic biopsy and MRI ultrasound fusion-guided biopsy are not significantly different[7].

In Thailand, the study of MRI ultrasound fusion-guided biopsy is still limited. Therefore, this retrospective study was designed to determine the accuracy of prostate cancer by MRI ultrasound fusion-guided biopsy in one center experience, which may further develop in the future.

Materials and Methods

Study design and study population

The authors reviewed the medical records between January 2017 and October 2018. One hundred three men with elevated PSA of more than 4 ng/mL and abnormal DRE received a MRI ultrasound fusion-guided prostate biopsy. All patients were biopsied in the operation room with spinal anesthesia or general anesthesia. The authors used transrectal ultrasound guide technique to biopsy in all patients. Transrectal fusion biopsy was performed using a 3D triplane ultrasound system (BioJet, BK Medical, Analogic Ultrasound Group, Pro Focus, Transducer 8818). All patients who had at least one negative prostate biopsy and persistently had elevated serum PSA values greater than 4 ng/mL were enrolled in the present study. Patients who had MRI ultrasound fusion guided biopsy in either PI-RADs score 1 or 2 lesions were excluded from the study. The present study was approved by The Institutional Ethical Research Committee (IRBRTA958/2562).

Study endpoints

The primary outcome was the overall detection rate of prostate cancer by targeted prostate biopsy guided by computer-assisted fusion of MRI.

Secondary outcomes included detection rate for significant prostate cancer, defined as prostate cancer with Gleason score greater than six and the positive rate among lesion scores detected by mpMRI.

Imaging

Subjects in the present study underwent mpMRI performed with a 3 Tesla without endorectal coil.

The imaging protocol included T1 and T2 weighted imaging, diffusion-weighted imaging (DWI), and dynamic contrast enhanced (DCE) imaging. Detected lesions from mpMRI were scored by radiologists using the Prostate Imaging Reporting and Data System (PI-RADS) version 2 classification from 1 as low to 5 as high, according to the likelihood of prostate cancer being present.

Interventions

Patients who met the present study criteria were hospitalized at least one day before the operation date for preparation. General anesthesia or regional anesthesia by spinal block was chosen for the procedure. Patients were placed in the lithotomy position. The MRI ultrasound fusion-guided biopsy was performed initially. The extended 12-core systematic biopsy was performed afterwards. MRI ultrasound fusion-guided biopsy was performed on lesions with PI-RADS version 2 scores from 3 to 5. Extended 12-core systematic biopsy was performed with at least six cores for each prostatic lobe, thus 12 cores. Urethral catheterization was done and removed on the next day.

Histology

Gleason scoring of the subjects in the present study was performed independently by experienced pathologists and followed the recommendations of the 2005 consensus conference of the International Society of Urological Pathology.

Statistical analysis

A descriptive study was performed. The data were analyzed using the Fisher's extract test, the chi-squared test, and the unpaired t-test to identify the statistical significance of the differences in means ± standard deviation (SD), median (interquartile range, IQR), and proportions, respectively. Analysis was accomplished using Stata, version 12 (StataCorp LP, College Station, TX, USA), with a p-value less than 0.05 considered statistically significant.

Results

Patient baseline characteristics

Ninety-five patients were enrolled in the present study. Mean age (SD) at the time of biopsy was 68.7 (6.5) years. Median serum PSA and PSA density (PSAD) were 9.44 ng/mL (IQR 1.4 to 166) and 0.20 ng/mL^2 (IQR 0.07 to 1.30), respectively. Median prostate volume was 45.3 mL (IQR 15.0 to 136.0). Most men included in the present study had a history of negative biopsy, one to two times and most had one to two suspicious lesions for prostate cancer on mpMRI. Most men did not have a palpable abnormal prostate nodule on digital rectal examination and did not take 5-αARI drug (Table 1).

Primary outcomes (overall prostate cancer detection rate)

Of the 95 patients with suspected prostate cancer

Table 1. Baseline characteristic (n=95)

	n (%)
Age	
Mean±SD	68.74±6.49
Median (min to max)	69.00 (51.00 to 87.00)
Previous biopsy	
Naïve	40 (42.11)
Previous negative biopsy	40 (42.11)
Previous negative biopsy >1	15 (15.79)
Nodule from DRE	
Non palpable	76 (80.00)
Palpable	19 (20.00)
PSA	
Mean±SD	11.89±16.91
Median (min to max)	9.44 (1.40 to 166.00)
On 5 alpha reductase inhibitor drugs	
No	77 (81.05)
Yes	18 (18.95)
Free PSA	
Mean±SD	1.40±0.68
Median (min to max)	1.37 (0.26 to 3.90)
%PSA	
Mean±SD	16.54±6.69
Median (min to max)	15.13 (5.00 to 33.00)
Prostate volume	
Mean±SD	50.00±25.48
Median (min to max)	45.30 (15.00 to 136.00)
PSA density	
Mean±SD	0.24±0.18
Median (min to max)	0.20 (0.07 to 1.30)
Lesions in mpMRI	
1	51 (35.66)
2	43 (30.07)
3	2 (1.40)

DRE=digital rectal examination; PSA=prostate specific antigen; mpMRI=multiparametric magnetic resonance imaging; SD=standard deviation

Table 2. Detection rate per patient (n=95)

Per patient analysis (n=95)	Overall	Targeted biopsy	Systematic biopsy
Detection rate	51.5% (49/95)	49.5% (47/95)	17.9% (17/95)

Table 3. Detection rate per lesion (n=143)

Lesion (n=143)	n (%)
Positive target biopsy	62/143 (43.36)

Table 4. Significant prostate cancer detection rate

	Person (n=95); n (%)
Positive target biopsy (n=95)	47/95 (49.47)
Target pathological	
• Gleason 6	15 (15.79)
• Gleason >6	32 (33.68)
Positive systemic biopsy (n=95)	17/95 (17.89)
Systematic pathological	
• Gleason 6	6 (6.31)
• Gleason >6	11 (11.58)

	Target biopsy+ (n=95); n (%)	Systemic biopsy+ (n=95); n (%)	p-value
Gleason >6	32/95 (33.68)	11/95 (11.58)	<0.001

Chi-square test, significant if p<0.05

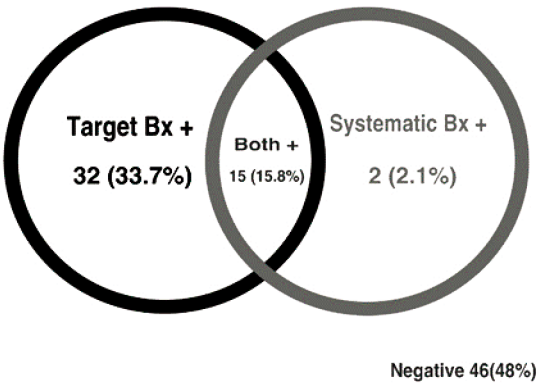

Figure 1. Pile chart.

that underwent prostate biopsy for 143 lesions, per-patient analysis showed better overall detection rate of prostate cancer by MRI ultrasound fusion-guided biopsy rather than extended 12-core systematic biopsy at 49.5% versus 17.9% (Table 2).

Per-lesion analysis showed that the detection rate of prostate cancer from targeted prostate biopsy was 43% (Table 3).

The MRI ultrasound fusion-guided biopsy showed a higher detection rate of prostate cancer. However, without the 12-core systematic biopsy, there would be an increase in missed diagnosed prostate cancer patient by 2.1% (Figure 1).

Secondary outcomes

Significant prostate cancer detection rate: Significant prostate cancer with a Gleason greater than six was detected by MRI ultrasound fusion guided biopsy at

Table 5. Positivity rate among lesions

	Lesion (n=143)	Overall; n (%)	MRI U/S fusion biopsy; n (%)	p-value	Systemic biopsy; n (%)	p-value
PI-RADS				<0.001		0.084
3	52	15 (28.85)	11 (21.15)		5 (9.80)	
4	64	32 (50.00)	31 (48.44)		11 (17.19)	
5	27	20 (74.07)	20 (74.07)		8 (29.63)	

PI-RADS=Prostate Imaging and Reporting Archiving Data System; MRI=magnetic resonance imaging; U/S=ultrasound

Chi-square test, † Fisher's exact test, significant if p<0.05

33.7% and the extended 12-core systematic biopsy at 11.6%. The results showed statistically significant association (p<0.001) (Table 4).

Positivity rate among lesions with PI-RADS score of 3 to 5 on mpMRI: There were 143 lesions classified as PI-RADS V2 score 3 to 5 detected on mpMRI. The overall detection rate of prostate cancer among lesions with PI-RADS V2 score were PI-RADS3 at 29%, PI-RADS4 at 50%, and those with PI-RADS5 at 74%. MRI ultrasound fusion-guided biopsy found PI-RADS3 at 21%, PI-RADS4 at 48%, and PI-RADS5 at 74%. The detection rates showed statistically significant association (p<0.001) (Table 5).

Discussion

The ideal test for prostate cancer should be minimally invasive, having few side effects, identify a high proportion of men who would benefit from the treatment, and minimize the identification of men with clinically insignificant cancer to prevent overtreatment.

The present study results have shown the benefit of MRI ultrasound fusion-guided biopsy over a 12-core systematic biopsy. The overall prostate cancer detection rate by MRI ultrasound fusion-guided biopsy and 12-core systematic biopsy were 49.5% and 17.9%, respectively[8].

However, the present study found that MRI ultrasound fusion-guided biopsy alone could miss diagnosis of prostate cancer: Performing subsequent 12-core systematic biopsy after MRI ultrasound fusion-guided biopsy can eliminate the possibility of missed diagnosis of prostate cancer[9].

When comparing the prostate cancer detection rate using a combination of both the MRI ultrasound fusion-guided biopsy and the 12-core systematic biopsy with either MRI ultrasound fusion-guided biopsy or 12-core systematic biopsy alone, a combination of both techniques is significantly superior to either MRI ultrasound fusion-guided biopsy or 12-core systematic biopsy alone[10].

Prostate cancer detection rate is correlate with high PI-RADS. The present study showed the highest positivity rate was among PI-RADS with a score of 5 at 74%, followed by those with a score of 4 at 50%, and those with a score of 3 at 29%[11].

Many recent studies have shown that MRI ultrasound fusion-guided biopsy has a higher prostate cancer detection rate for significant prostate cancer compared with the standard random prostate biopsy[12], but a lower detection rate for insignificant prostate cancer[13]. In contrast, the present study results show that MRI ultrasound fusion guided biopsy has a higher detection rate of both significant and insignificant prostate cancer.

The present study has some limitations. First, performing MRI ultrasound fusion-guided biopsy prior to 12-core systematic biopsy undoubtedly had an influence on the diagnostic performance of 12-core systematic biopsy. The bleeding areas from MRI ultrasound fusion-guided biopsy might have guided the operator to target 12-core systematic biopsy, especially at these areas. Second, the operators who performed MRI ultrasound fusion-guided biopsy and subsequent 12-core systematic biopsy were the same person. Third, PI-RADS scoring of the subjects in the present study was performed independently by radiologists. Fourth, the authors did not record the complications of MRI ultrasound fusion-guided biopsy in the present study. And lastly, the present study was retrospective in nature.

Further prospective studies should be conducted to eliminate the risk of bias.

Conclusion

The prostate cancer detection rate by MRI ultrasound fusion-guided biopsy was higher than with the 12-core systematic biopsy. However, without the 12-core systematic biopsy, there is an increase chance of misdiagnosed prostate cancer. A combination of both techniques was significantly superior to either MRI ultrasound fusion-guided biopsy or 12-core

systematic biopsy alone.

What is already known on this topic?

The MRI ultrasound fusion-guided biopsy has been used in Thailand in the last two to three years and had demonstrated promising result in diagnosis of prostate cancer. However, only few studies in Thailand had reported the result of this new technique.

What this study adds?

A better detection rate of prostate cancer by MRI ultrasound fusion-guided biopsy may develop as a new standard diagnostic technique. This will reduce unnecessary biopsy and improve diagnostic accuracy in the future.

Conflicts of interest

The authors declare no conflict of interest.

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