# ROLE OF MAGNETIC RESONANCE IMAGING IN NODAL AND METASTATIC STAGING OF PROSTATE CANCER: A SYSTEMATIC REVIEW AND META-ANALYSIS

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***ABSTRACT***

***Objective:*** *This study aims to evaluate the usage of MRI in prostate cancer staging, especially in nodal involvement (N-staging) and metastasis (M-staging) of prostate cancer.* ***Material & Methods:*** *This is a systematic review and meta-analysis assessing the role of MRI in nodal and metastasis staging of prostate cancer. The search of studies were done through search engine using Pubmed, Cochrane, and EBSCO Host and manual searching. Quality of eligible studies were assessed using a revised version of Quality Assessment of Diagnostic Accuracy Studies (QUADAS-2) and analyzed in pooled analysis according to nodal involvement or metastasis staging, modality of diagnosis used as the index test and gold standard used using STATA version 13.* ***Results:*** *Total 26 studies corresponding with study's eligibility criteria were found. Overall, usage of MRI has a sensitivity of 47% (95% CI 35% - 60%; I2 83.08%) and a specificity of 93% (95% CI 89% - 96%, I2 82.21%) in nodal involvement staging of prostate cancer, while using of MRI in M-staging of prostate cancer shows a sensitivity of 94% (95% CI 86% - 97%) and a specificity of 99% (95% CI 97% - 99%). Using lymphotropic superparamagnetic nanoparticle (LSN) - enhanced MRI gives higher sensitivity than using MRI without LSN for N-staging of prostate cancer.* ***Conclusion:*** *The usage of MRI in prostate cancer staging has a moderate sensitivity and relatively high specificity in detecting lymph node. Moreover, it plays an important role and even can be used as a modality of choice in assisting bone metastatic prostate cancer detection.*

***Keywords:*** *Magnetic resonance imaging, prostate cancer, staging.*

***ABSTRAK***

***Tujuan:*** *Mengevaluasi penggunaan MRI dalam penentuan stadium kanker prostat, terutama pada keterlibatan nodal (stadium N) dan metastasis (stadium M) pada kanker prostat.* ***Bahan & Cara:*** *Studi ini merupakan tinjauan sistematis dan meta-analisis yang menilai peran MRI dalam stadium nodal dan metastasis kanker prostat. Pencarian studi dilakukan melalui mesin pencari menggunakan Pubmed, Cochrane, dan EBSCO Host dan pencarian manual. Kualitas studi yang memenuhi syarat dinilai menggunakan versi revisi dari Quality Assessment of Diagnostic Accuracy Studies (QUADAS-2) dan dianalisis dalam analisis gabungan sesuai dengan keterlibatan nodal atau stadium metastasis, modalitas diagnosis yang digunakan sebagai tes indeks dan standar emas yang digunakan menggunakan versi STATA 13.* ***Hasil:*** *Ditemukan total 26 studi sesuai dengan kriteria kelayakan studi. Secara keseluruhan, penggunaan MRI memiliki sensitivitas 47% (95% CI 35% - 60%; I2 83.08%) dan spesifisitas 93% (95% CI 89% - 96%, I2 82.21%) pada stadium keterlibatan nodal. kanker prostat, sedangkan penggunaan MRI pada stadium M kanker prostat menunjukkan sensitivitas 94% (95% CI 86% - 97%) dan spesifisitas 99% (95% CI 97% - 99%). Menggunakan limfotrofik superparamagnetik nanopartikel (LSN) - MRI yang ditingkatkan memberikan sensitivitas yang lebih tinggi daripada menggunakan MRI tanpa LSN untuk pementasan kanker prostat.* ***Simpulan:*** *Penggunaan MRI dalam penentuan stadium kanker prostat memiliki sensitivitas sedang dan spesifisitas yang relatif tinggi dalam mendeteksi kelenjar getah bening. Selain itu, ia memainkan peran penting dan bahkan dapat digunakan sebagai modalitas pilihan dalam membantu deteksi kanker prostat metastatik tulang.*

***Kata Kunci:*** *Magnetic resonance imaging, kanker prostat, stadium.*

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## INTRODUCTION

Prostate cancer is the second most common cancer in men worldwide, with a lifetime risk to develop prostate cancer is 14.3% in men.[1] In the United States and Europe, it is the second most common cause of malignancy-related mortality. The rate of prostate cancer has been expanding worldwide lately. This pattern has been becoming even in Asian countries, especially in northeast Asian countries.

To determine further management in prostate cancer, risk group classification based on clinical stage, Gleason score, and prostate-specific antigen (PSA) is used by various guidelines.[2-3] Therefore, modalities which have high accuracy in determining prostate cancer staging is important. Prostate cancer is known as a disease without reliable imaging studies in its management.[4] In current guidelines, CT scan still becomes primary tool in detecting nodal and visceral metastatic disease. Moreover, for detecting bone metastatic, bone scintigraphy still becomes current modality of choice.[3]

However, with the shortage of Technetium-99m (99mTc) worldwide, the medical isotope used for bone scan procedure, the usage of bone scan could be limited in the future.[5] Therefore, other modality to replace the role of bone scan in detecting bone metastasis is a must. Moreover, there is still no single imaging modality which could become all-round modality in diagnosing and staging prostate cancer.

With the advancement of current magnetic resonance imaging (MRI) technology, it has emerged as one of useful tools in management of prostate cancer, such as prostate cancer detection, post-treatment surveillance and of course, prostate cancer staging.[6] In the current iteration, MRI is one of the modality of choice to determine the local staging of the tumor.[2-3] However, its role in determining nodal involvement and metastatic to the bone and visceral in prostate cancer staging is still under questioned.

## OBJECTIVE

This study aims to evaluate the usage of MRI in prostate cancer staging, especially in nodal involvement (N-staging) and metastasis (M-staging) of prostate cancer.

## MATERIAL & METHODS

This study was conducted with reference to Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P).[7]

This study tried to gather all diagnostic studies that used MRI as a modality to determine prostate cancer TNM staging system. Furthermore, this study only focused on nodal (N) and metastasis (M) staging of prostate cancer. The literature included in this study could be studies discussing only the role of MRI or studies comparing MRI and other modalities in assisting prostate cancer staging. Only literature which applied MRI on human and were compared to gold standard, such as histopathology or best valuable comparator (BVC) were considered to be included in this study. Furthermore, if there were multiple literatures which used similar data, only the most recent literature was included in this study. Literature review studies or animal studies were excluded from this study.

Literature search were conducted through search engine using PubMed, EBSCO Host and Cochrane Library and manual searching through references of related studies. Inclusion keywords of ("magnetic resonance imaging" OR "MRI") AND ("lymph node" OR "bone metastasis" OR "metastasis") AND "prostate cancer" were used for search engine keyword.

Literatures which were obtained through all methods mention above were collected and screened for duplication using EndNote X8 software. Duplication-free literatures were screened for its title and abstract. Studies which its title and abstract satisfied eligibility criteria were further screened for its full-text. All screening processes were done by three independent reviewers. Different opinion between three reviewers were settled through discussion. However, if there was no agreement, voting was taken.

From all qualified studies, data which were extracted were divided into two categories: N-staging and M-staging of prostate cancer. For N-staging of prostate cancer, following data were extracted: author's name and year of publication, MRI characteristic (magnetic strength, coverage, sequenced, the usage of endorectal coil and the usage of lymphotrophic superparamagnetic nanoparticle), number of subjects, its gold standard comparison, sensitivity and specificity. This study divided into two categories based on lymph counting, which are patient-based and lymph node-based.

In the other hand, for M-staging of prostate cancer, following data were extracted author's name and year of publication, MRI characteristic (magnetic strength, coverage, and sequenced), number of subjects, its gold standard comparison, type of metastatic, sensitivity and specificity.

To assess for risk of bias or quality of the studies, A Revised Tool for the Quality Assessment of Diagnostic Accuracy Studies (QUADAS-2) was used.[8] Studies which were methodology lacking would be excluded from this study. Determination of studies' quality were decided by discussion among authors.

Statistical analysis was used to calculate pooled analysis of sensitivity and specificity of studies. Statistical analysis which were planned to perform were as follow: patient-based N-staging analysis, lymph-node based N-staging analysis and M-staging analysis. For N-staging analysis, this study performs pooled analysis for three different group which are group with the usage of endorectal coil, group with the usage of lymphotropic superparamagnetic nanoparticle (LSN) and group without both endorectal coil and LSN. This study also performs pooled analysis to differentiate between histopathology as a gold standard and BVC as a gold standard in both N-staging and M-staging of prostate cancer analysis. However, this study agreed not to do pooled analysis if the number of studies less than 5. STATA version 13 was used to calculate pooled analysis in this study. Heterogeneity between studies was decided using I2.

## RESULTS

This study found 26 studies corresponding with study's eligibility criteria (Figure 1) and consists of 19 studies discussing N-stage prostate cancer, 4 studies discussing M-staging prostate cancer and 3 studies discussing both of N- and M-staging prostate cancer. Study quality assessment could be seen in Supplementary Table 1.

From 20 studies discussing N-staging prostate cancer, 15 studies used MRI without endorectal coil or LSN, three studies used endorectal coil when conducted MRI examination, one study used LSN to detect nodal involvement in prostate cancer and one study compared MRI examination with and without LSN. Regarding gold standard, most of the studies in patient-based N-staging and lymph node-based N-staging were used histopathology as their gold standard (85% and 100%, respectively). Characteristics of all N-staging of prostate cancer studies could be seen in Table 1.

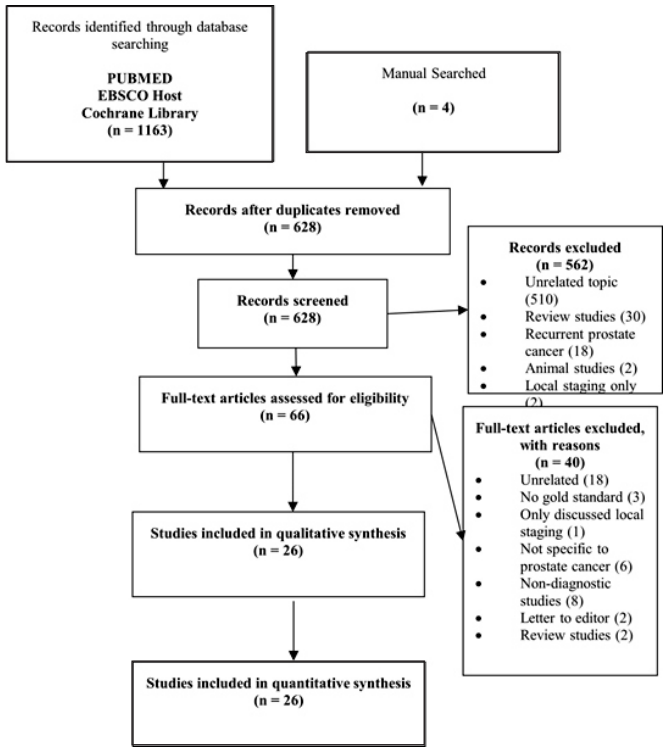


**Figure 1**. Study flow diagram.

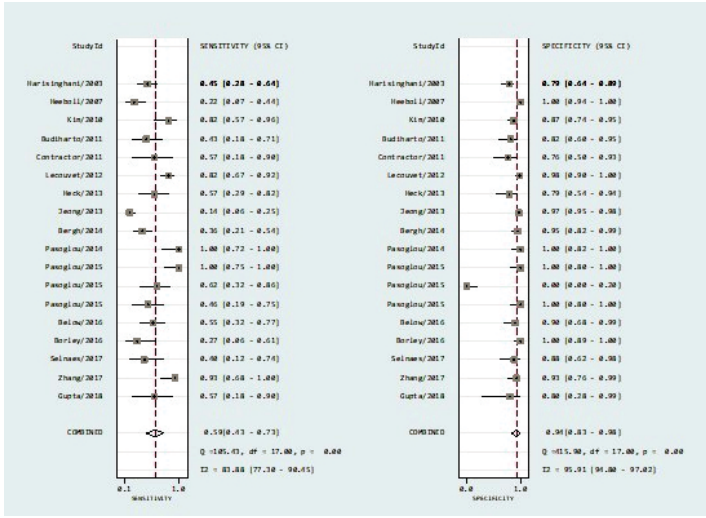

**Figure 2.** Pooled analysis of patient-based N-staging of prostate cancer.

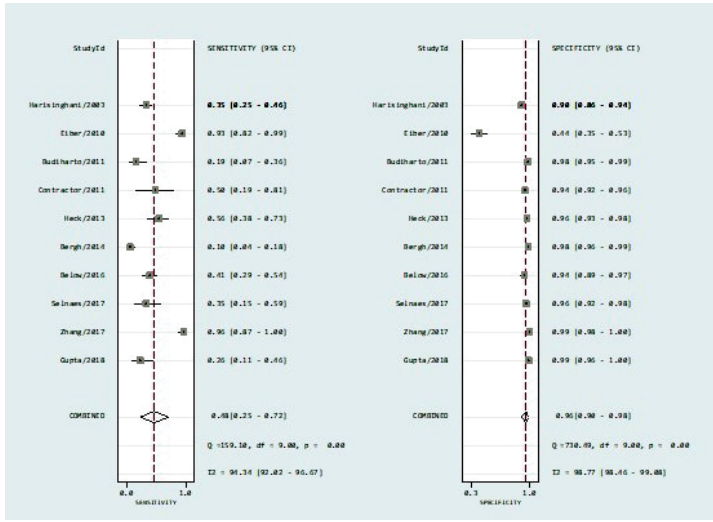

**Figure 3.** Pooled analysis of lymph node-based N-staging of prostate cancer.

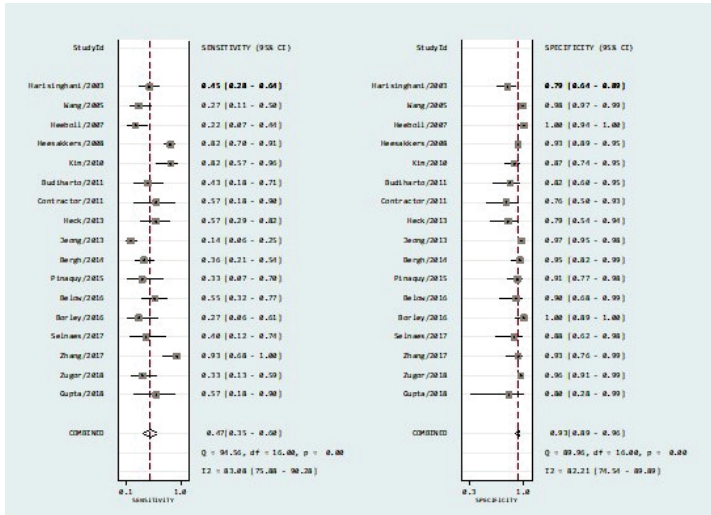

**Figure 4.** Supplementary Figure 1. Pooled analysis of N-staging of prostate cancer with histopathology as gold standard.

**Table 1.** Study characteristics of MRI role in N-staging of prostate cancer.

| Authors and Year of Study | MRI Characteristic | | | | | Number of Subjects | Comparison | Sensitivity | Specificity | Lymph Node or Patient Based |
|---|---|---|---|---|---|---|---|---|---|---|
| | Magnetic Strength | Coverage | Sequence Used | Endorectal Coil | LSN | | | | | |
| Gupta 2018[9] | 1.5-T | Pelvis | T1-weighted, T2-weighted, DWI | No | No | 12 | Histopathology | 57.14% | 80% | Patient-based |
| | | | | | | 243 | Histopathology | 25.93% | 98.61% | Lymph node-based |
| Zugor 2018[10] | 1.0-T | Pelvis | T1-weighted | Yes | No | 168 | Histopathology | 33% | 96% | Patient-based |
| Selnaes 2017[11] | 3.0-T | Pelvis | 3D T2 -weighted, DWI, DCE | No | No | 26 | Histopathology | 40% | 87.5% | Patient-based |
| | | | | | | 205 | Histopathology | 35% | 95.7% | Lymph node-based |
| Zhang 2017[12] | 3.0-T | Pelvis | T1-weighted, T2-weighted, DCE, DWI with ADC maps | No | No | 42 | Histopathology | 93.3% | 96.3% | Patient-based |
| | | | | | | 621 | Histopathology | 96.08% | 99.47% | Lymph node-based |
| Below 2016[13] | 3.0-T | Pelvis | T1-weighted, T2-weighted, DWI, ADC | No | No | 40 | Histopathology | 55% | 90% | Patient-based |
| | | | | | | 240 | Histopathology | 41% | 94% | Lymph node-based |
| Borley 2016[14] | 1.0-T | Pelvis | T2-weighted | No | No | 55 | Histopathology | 27.3% | 100% | Patient-based |
| Pasoglou 2015[15] | 3.0-T | Whole body | 2D T1-weighted | No | No | 30 | BVC | 46% | 100% | Patient-based |
| | | | 2D T1 -weighted + PDFS | | | | | 62% | 100% | |
| | | | 3D T1-weighted | | | | | 100% | 100% | |

DWI – diffusion-weighted imaging; DCE – dynamic contrast enhanced; ADC – apparent diffusion coefficient; LSN – lymphotrophic superparamagnetic nanoparticle; BVC – best valuable comparator

Table 1 (Cont). Study characteristics of MRI role in N-staging of prostate cancer.

| Authors and Year of Study | MRI Characteristic | | | | | Number of Subjects | Comparison | Sensitivity | Specificity | Lymph Node or Patient Based |
|---|---|---|---|---|---|---|---|---|---|---|
| | Magnetic Strength | Coverage | Sequence Used | Endorectal Coil | LSN | | | | | |
| Pinaquy 2015[16] | 1.5-T | Pelvis | T2-weighted, DWI with ADC maps, DCE | Yes | No | 44 | Histopathology | 33% | 91% | Patient-based |
| | | | | | | 482 | Histopathology | 17% | 99% | Lymph node-based |
| Van den Bergh 2014[17] | 1.5-T | Pelvis | T2-weighted, DWI with ADC maps | No | No | 74 | Histopathology | 36.1% | 94.7% | Patient-based |
| | | | | | | 671 | Histopathology | 8.2% | 98.8% | Lymph node-based |
| Pasoglou 2014[18] | 3.0-T | Pelvis | T1-weighted T2 -weighted, DCE, DWI with ADC maps | No | No | 30 | BVC | 100% | 100% | Patient-based |
| Heck 2013[19] | 1.5-T | Pelvis | DWI | No | No | 33 | Histopathology | 57% | 79% | Patient-based |
| | | | | | | 261 | Histopathology | 55.9% | 96.5% | Lymph node-based |
| Jeong 2013[20] | 1.5-T to 3.0-T | N/A | T1-weighted, T2-weighted, DWI | No | No | 922 | Histopathology | 14% | 96.9% | Patient-based |
| Lecouvet 2012[21] | 1.5-T | Whole body | T1-weighted, DWI | No | No | 100 | BVC | 82% | 98% | Patient-based |
| Budiharto 2011[22] | 1.5-T | Pelvis | T2-weighted, DWI with ADC maps | No | No | 36 | Histopathology | 42.9% | 81.8% | Patient-based |
| | | | | | | 227 | Histopathology | 18.8% | 97.6% | Lymph node-based |
| Contractor 2011[23] | 1.5-T | Pelvis | T1-weighted, T2-weighted | No | No | 26 | Histopathology | 50% | 72.2% | Patient-based |
| | | | | | | 406 | Histopathology | 18.5% | 98.7% | Lymph node-based |

DWI – diffusion-weighted imaging; DCE – dynamic contrast enhanced; ADC – apparent diffusion coefficient; LSN – lymphotrophic superparamagnetic nanoparticle; BVC – best valuable comparator

**Table 1 (Cont).** Study characteristics of MRI role in N-staging of prostate cancer.

| Authors and Year of Study | MRI Characteristic | | | | | Number of Subjects | Comparison | Sensitivity | Specificity | Lymph Node or Patient-Based |
|---|---|---|---|---|---|---|---|---|---|---|
| | Magnet Strength | Coverage | Sequence Used | Endorectal Coil | LSN | | | | | |
| Eiber 2010[24] | 1.5-T | Pelvis | T2-weighted, DWI, ADC maps | No | No | 118 | Histopathology and follow-up imaging | 86.0% | 85.3% | Lymph node-based |
| Kim 20102[5] | 1.5-T | N/A | T1-weighted, T2-weighted | No | No | 64 | Histopathology | 71.4% | 94.7% | Patient-based |
| Heesakkers 2008[26] | 1.5-T | Pelvis | T1-weighted, T2-weighted | No | Yes | 375 | Histopathology | 82% | 93% | Patient-based |
| Heeboll 2007[27] | 1.5-T | N/A | T1-weighted | No | No | 227 | Histopathology | 22% | 100% | Patient-based |
| Wang 2005[28] | 1.5-T | Pelvis | T1-weighted, T2-weighted | Yes | No | 411 | Histopathology | 27.2% | 98.46% | Patient-based |
| Harishinghani 2003[29] | 1.5-T | Pelvis | T2-weighted | No | No | 80 | Histopathology | 45.4% (without LSN) | 78.7% (without LSN) | Patient-based |
| | | | | No | Yes | | | 100% (with LSN) | 95.7% (with LSN) | |
| | | | | No | No | 334 | Histopathology | 35.4% (without LSN) | 90.4% (without LSN) | Lymph node-based |
| | | | | No | Yes | | | 90.5% (with LSN) | 97.8% (with LSN) | |
| Harishinghani 2002[30] | 1.5-T | N/A | T1-weighted, T2-weighted, T2 -weighted | No | Yes | 168 | Histopathology | 92% | 93% | Lymph node-based |

**Supplementary Table 1.** Studies' Quality Assessment.

| Author and Year of Study | Patient Selection | Index Test | Reference Standard | Flow and Timing |
|---|---|---|---|---|
| Gupta 2018 | ? | + | + | + |
| Zugor 2018 | + | + | + | + |
| Selnaes 2017 | + | + | + | + |
| Zhang 2017 | + | + | + | + |
| Borley 2016 | + | ? | + | + |
| Woo 2016 | + | + | + | + |
| Vargas 2016 | + | + | + | + |
| Below 2015 | + | - | + | + |
| Pasoglou 2015 | + | + | + | + |
| Pinaquy 2015 | ? | + | ? | + |
| Vallini 2015 | + | + | + | + |
| Bergh 2014 | + | + | + | + |
| Pasoglou 2014 | + | + | + | + |
| Heck 2013 | + | + | + | + |
| Jeong 2013 | + | - | + | + |
| Lecouvet 2012 | + | + | + | + |
| Budiharto 2011 | + | + | ? | + |
| Contractor 2011 | + | ? | + | + |
| Eiber 2010 | + | + | ? | + |
| Kim 2010 | ? | + | + | + |
| Venkitaraman 2009 | + | + | ? | + |
| Venkitaraman 2009 | + | + | ? | + |
| Heesakkers 2008 | + | + | + | + |
| Heebool 2007 | + | ? | ? | ? |
| Wang 2004 | + | ? | + | + |
| Harisinghani 2003 | + | + | + | + |
| Harishingani 2002 | + | ? | + | + |

+ : low risk of bias; - : high risk of bias; ? : unclear risk of bias.

Patient-based N-staging in studies without the usage of LSN and endorectal coil showed pooled sensitivity of 59% (95% CI 43% - 73%; I2 83.88%) and pooled specificity of 94% (95% CI 83% - 98%; I2 95.91%). Moreover, relatively similar results were showed in lymph-node based N-staging studies without the usage of LSN and endorectal coil. The pooled analysis of those studies showed sensitivity of 48% (95 CI 25% - 72%; I2 94.34%) and specificity of 96% (95% CI 90% - 98%; I2 98.77%). Due to limited number of studies, pooled analysis of patient-based N-staging and lymph-node based N-staging in studies with the usage of endorectal coil and LSN were not done.

The usage of endorectal coil in studies conducted by Zugor et al.[10], Pinaquy et al.[16] and Wang et al.[28] showed similar sensitivity (33%, 33% and 27.2%, respectively) and specificity (96%, 91% and 98.46%, respectively). However, the usage of LSN showed relatively higher sensitivity compared to without the usage of LSN. One study conducted by Harishinghani et al.[12] compared directly the usage of LSN to detect lymph node and showed superiority of LSN usage in detecting lymph node involvement in both patient-based and lymph node-based N-staging.

Based on gold standard used, pooled analysis of N-staging of prostate cancer studies which used histopathology as gold standard showed sensitivity of 47% (95% CI 35% - 60%; I2 83.08%) and specificity of 93% (95% CI 89% - 96%, I2 82.21%). This study did not conduct pooled analysis for BVC as gold standard due to limited number of studies. However, studies using BVC as gold standard show relatively higher sensitivity and specificity.[15,18,21]

From studies which met the eligibility criteria and discussed about detecting metastatic prostate cancer lesions, only bone metastatic prostate cancer which was discussed by all studies.

Of seven studies which discussed role of MRI in detecting bone metastatic prostate cancer, only two studies which used histopathology as their gold standard. However, both of studies did not use histopathology as their gold standard in their entire research. Therefore, this study decided not to divide pooled analysis based on gold standard used. MRI characteristics (magnet strength, coverage, and sequence used) of all M-staging of prostate cancer studies could be seen in Table 2. Pooled analysis of MRI role in M-staging of prostate cancer showed sensitivity of 94% (95% CI 86% - 97%) and specificity 99% (95% CI 97% - 99%). However, forest plot and heterogeneity cannot be obtained due to missing matrix.

**Table 2.** Study characteristics of MRI role in M-staging of prostate cancer.

| Authors and Year of Study | MRI Characteristic | | | Number of Subjects | Type of Metastatic | Comparison | Sensitivity | Specificity |
|---|---|---|---|---|---|---|---|---|
| | Magnet Strength | Coverage | Sequence Used | | | | | |
| Woo 2016[31] | 3.0-T | Pelvis | T1-weighted, T2-weighted, DWI, DCE | 308 | Pelvic bone | Histopathology or BVC | 95.2% | 100% |
| Vargas 2016[32] | 1.5-T or 3.0-T | Whole body | T1-weighted, T2-weighted | 228 | Bone | Histopathology or radiological follow up | 89% | 98% |
| Pasaglou 2015[15] | 3.0-T | Whole body | 2D T1-weighted | 30 | Bone | BVC | 90% | 100% |
| | | | 2D T1-weighted + PDFS | | | | 90% | 100% |
| | | | 3D T1-weighted | | | | 100% | 100% |
| Pasoglou 2014[19] | 3.0-T | Whole body | T1-weighted, DWI | 30 | Bone | BVC | 100% | 100% |
| Lecouvet 2012[21] | 1.5-T | Whole body | DWI | 100 | Bone | BVC | 100% | 100% |
| Venkitaraman 2009[33] | 1.5-T | Whole body | T1-weighted | 39 | Bone | Clinical and radiological follow-up | 70% | 100% |
| Venkitaraman 2009[34] | 1.5-T | Whole body or spine MRI | T1-weighted | 99 | Bone (spine only) | Clinical and radiological follow-up | 85.7% | 97.65% |

DWI – diffusion-weighted imaging; DCE – dynamic contrast enhanced; ADC – apparent diffusion coefficient; LSN – lymphotrophic superparamagnetic nanoparticle; BVC – best valuable comparator.

## DISCUSSION

Presently, bone scintigraphy still becomes the modality of choice for detecting bone metastatic prostate cancer. This procedure uses medical isotope Technetium-99m (99mTc). This radioisotope has been used in nuclear medicine approximately 80% to 90%.[5] However, since 2007, there has been shortage of this medical isotope and this condition will certainly affect patient care. One way to overcome its impact on patient care is optimizing the functionality of other possible diagnostic modalities. One of the modalities is the use of MRI, where in this study discussed its role in nodal and metastatic staging of prostate cancer.

This study found that MRI has a moderate sensitivity and relatively high specificity in detecting nodal involvement in prostate cancer. This study also showed the usage of LSN in MRI examination might help to increase the sensitivity and specificity in detecting nodal metastasis in prostate cancer. However, additional of endorectal coil in MRI examination did not increase the sensitivity and specificity to detect nodal involvement in prostate cancer. Based on pooled analysis conducted in both patient-based and lymph node-based N-staging of prostate cancer showed high heterogeneity between studies.

This high heterogeneity might due different methodology between studies, different magnetic strength used or sequence used and also gold standard used. Roughly, studies with BVC as its gold standard comparison had higher sensitivity and specificity. Higher sensitivity and specificity in BVC might due to agreement-based between experts which is less objective compared to histopathological result. However, based on study quality assessment, all studies were well conducted studies. The cause of heterogeneity was also showed in study conducted by Woo et al which showed magnetic field strength as one of the cause of heterogeneity in their studies.[35]

For M-staging of prostate cancer, this study found that MRI had relatively good sensitivity and specificity. Although lymph node and bone are typical locations for prostate cancer metastasis, it may also metastasize to lung, liver and brain. In a post-mortem examination of 1589 patients found to have prostate cancer, metastatic lesions were seen in 90% to bone, 46% to lung, 25% to liver, 21% to pleura, and 13% to adrenal.[36] However, all studies used bone metastatic as their outcome of interest and no visceral metastasis. Study conducted by Jacobs et al showed similar results which whole-body MRI had excellent sensitivity and specificity for detecting metastatic bone disease. Moreover, this study also showed that whole-body MRI also reliable in detecting visceral metastasis from solid tumors.[37]

In oncological patient care, MRI has been appeared to be especially sensitive for the identification of cerebral, abdominal and vertebral metastases.[38] Due to its high specificity resulting from optimal lesion-to-liver contrast and no radiation exposure, MRI is quickly rising as the imaging modality of choice for detection and characterization of liver lesions.[39] Biederer et al also found the patients with pulmonary nodules with size of 5 mm and more would identificated with a sensitivity of 100% which made it superior to plain chest radiography, yet at the same time mediocre compared to CT (specifically different row detector scanners) for the identification of small lung nodules.[38]

Currently, the usage of MRI 1.5T or 3T is the preferred approach for prostate cancer imaging. But, lately it has been demonstrated that prostate MRI at 3T is feasible with adequate picture quality. However, there is no study proposing a distinction in diagnostic performance between 1.5T and 3 T MRI for the identification and characterization of bone metastases.[32]

The principle used in LSN-enhanced MRI is the decrease of lymph node tissue in involvement of cancer. In normal condition, LSN particle will be incorporated in macrophage in lymph node, making its intensity caught by MRI decreased. Transformation of lymph node tissue into cancerous tissue increase intensity of LSN caught by MRI, indicating involvement of cancer in a lymph node.[41] Some study evaluating LSN-enhanced MRI found relatively high sensitivity and specificity of LSN-enhanced MRI in deciding various cancer stage. Study existed found LSN-enhanced MRI has sensitivity and specificity ranged about 80-100%.[40-41] Relatively limited study existed make the potential of LSN-enhanced MRI in cancer staging still open to be evaluated and to be used in the future.

The question that needs to be answered is "does MRI could be reliable radiological tools for guiding management of prostate cancer?". This study showed that MRI still could not become reliable diagnostic tools for prostate cancer. Even though it had good sensitivity and specificity in terms of detecting bone metastatic prostate cancer, it

has moderate sensitivity in terms of detecting lymph node involvement. This statement also supported by de Rooij et al which stated that MRI also had poor sensitivity in term of local staging.[42]

Notwithstanding its versatile capabilities, MRI has several drawbacks. This modality is not as generally accessible or as simple to apply to prostate imaging, as ultrasound. Moreover, MRI has limitations in its implementation protocol. The procedure normally takes duration of 40-50 minutes to be operated, and patients might experience of being placed in an encased space and hearing the loud noises that MRI machines produce. These conditions can make some patients uncomfortable and feel claustrophobic while they are undergoing the MRI scan. Still, a man who is very large may not fit into the opening of specific sorts of MRI machines.

## CONCLUSION

This review concluded that the use of MRI in prostate cancer diagnosis and staging has a moderate reliability in detecting lymph node involvement. Its sensitivity and specificity may be enhanced by LSN, but since limited study evaluating it, there must be a thorough research in the future to confirm its reliability. In addition, MRI can be used as a modality of choice in detecting bone metastatic prostate cancer.

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