



ORIGINAL RESEARCH ARTICLE

Head-to-head comparison of [^{99m}Tc]Tc-MDP and [^{99m}Tc]Tc-PSMA whole-body SPECT/CT in prostate cancer patients

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ARTICLE INFO

Article History:

Received: 29 April 2026

Revised: 21 June 2026

Accepted: 23 June 2026

Published Online: 28 June 2026

Keyword:

Bone scan

[^{99m}Tc]Tc-MDP

[^{99m}Tc]Tc-PSMA

SPECT/CT

Prostate cancer

Bone metastasis

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ABSTRACT

Introduction: Due to high expenses and lack of wide availability of [⁶⁸Ga]Ga-PSMA PET/CT scan, we aimed to evaluate [^{99m}Tc]Tc-MDP and [^{99m}Tc]Tc-PSMA scan findings in a cluster of prostate cancer patients.

Methods: This prospective cross-sectional study was conducted from March 2021 to March 2022 at Shahid Hashemi Nejad hospital in Tehran, Iran. In this study, prostate cancer patients with intermediate to high-risk or patients with PSA rise during follow-up were selected for undergoing both [^{99m}Tc]Tc-MDP bone scintigraphy and [^{99m}Tc]Tc-PSMA scan. The scans were performed with a maximum 2-week interval. The images were evaluated for presence, number and locations of abnormal lesions. CT findings were used as an anatomical comparator; however, CT was not considered a true reference standard.

Results: 20 patients were evaluated. 63 bone lesions on CT scan, 69 lesions on [^{99m}Tc]Tc-MDP bone scan, 23 lesions on [^{99m}Tc]Tc-PSMA SPECT/CT and 16 lesions on [^{99m}Tc]Tc-PSMA planar images, were visualized. 56.3%, 31.1% and 31.1% of patients had positive conventional bone scan, [^{99m}Tc]Tc-PSMA SPECT/CT and planar [^{99m}Tc]Tc-PSMA images. Mean number of lesions on these modalities were 4.31±6.85, 1.43±3.75 and 1.00±2.30, respectively. Sensitivity rates of these three modalities were 100%, 55.6% and 55.6% while specificity was 100% for all of these modalities. Mean number of bone lesions on [^{99m}Tc]Tc-MDP bone scintigraphy and [^{99m}Tc]Tc-PSMA SPECT/CT showed significant difference (p=0.027).

Conclusion: In this cohort, [^{99m}Tc]Tc-MDP whole-body SPECT/CT scintigraphy identified a greater number of skeletal lesions than [^{99m}Tc]Tc-PSMA SPECT/CT. however, because a composite reference standard was unavailable, these findings should be interpreted as differences in lesion detection rather than definitive evidence of superior diagnostic performance. Larger prospective multicenter studies are warranted.

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How to cite this article: Yazdi E, Hedayati R, Hekmat S, Ghorbani M, Yaghoobi N, Arefpour AM, Kalantari F, kaffashnayeri R, Moasses-Ghafari B. Head-to-head comparison of [^{99m}Tc]Tc-MDP and [^{99m}Tc]Tc-PSMA whole-body SPECT/CT in prostate cancer patients. Iran J Nucl Med. 2026;34(2):161-167.

 <https://doi.org/10.22034/irjnm.2026.130019.1767>

INTRODUCTION

Prostate cancer (PCa) is one of the most common malignancies in males around the world. Osseous metastases in this cancer play a critical role in determination of disease progression and mortality [1]. Pathologic fractures and spinal cord compression are seen in up to 35% of patients with prostate cancer which is associated with 28% increase in mortality risk [2]. Thus, precise detection and identification of bone metastases is necessary for accurate staging, prognostication and clinical decision-making.

Bone scintigraphy with [^{99m}Tc]Tc-MDP has been a longstanding modality for skeletal imaging in prostate cancer patients. This imaging detects osteoblastic activity which is the main alteration in bone metastases of prostate cancer but there are still limitations in its use [3]. The main concern in conventional bone scintigraphy is low specificity with false positive results in many benign conditions such as fractures and degenerative changes [1]. In addition, for small or early metastatic bone lesions, the sensitivity is decreased [1, 4]. Thus, a more precise imaging modality is required.

A revolutionary change has occurred in the recent years with introduction of PSMA-targeted imaging. PSMA as a transmembrane glycoprotein is overexpressed in majority of prostate cancer cells which is used for highly specific detection of skeletal and extra skeletal metastases [1, 5]. [^{99m}Tc]Tc-PSMA SPECT/CT takes advantage of functional specificity of PSMA and combines it with precise anatomical localization which leads to higher diagnostic accuracy and less equivocal findings [1]. Head-to-head comparison of [^{99m}Tc]Tc-PSMA and [^{99m}Tc]Tc-MDP in a few studies has revealed higher diagnostic accuracy for [^{99m}Tc]Tc-PSMA studies, especially for small lesions and low PSA levels. In addition, [^{99m}Tc]Tc-PSMA SPECT/CT can provide information on extraskelatal metastases which consequently alters the treatment strategies and therapeutic choices [1, 5].

The current comparative studies mainly have focused on PET-based PSMA radiopharmaceuticals ([⁶⁸Ga]Ga-PSMA-11, etc) and more studies are still required to understand the performance of [^{99m}Tc]Tc-PSMA SPECT/CT compared to conventional [^{99m}Tc]Tc-MDP bone scintigraphy [4, 5]. Given that PET/CT scanners are far less accessible compared to SPECT/CT scanners in developing countries and higher cost of PET/CT studies, [^{99m}Tc]Tc-PSMA PET/CT can be considered an appropriate alternative for [⁶⁸Ga]Ga-PSMA

PET/CT. With growing application of radioligand therapy in high-grade prostate cancer patients with [¹⁷⁷Lu]Lu-PSMA and [²²⁵Ac]Ac-PSMA, identification of PSMA-avid lesions before initiation of the treatment is mandatory. Thus, we have designed this study to compare the [^{99m}Tc]Tc-MDP and [^{99m}Tc]Tc-PSMA SPECT/CT findings in a cluster of prostate cancer patients to compare lesion detection characteristics between the two imaging modalities.

METHODS

Study design

This prospective cross-sectional study was performed at Shahid Hashemi Nejad Hospital in Tehran from March 2021 to March 2022. The study sample consisted of prostate cancer patients with intermediate to high risk based on D'Amico classification criteria or prostate cancer patients who experienced PSA rise during follow-up. The imaging procedures were performed upon the request by their treating physicians. Patients who received new treatments between two scans or were not willing to continue their participation in the study, were excluded. Informed consent was taken from all the eligible participants. The study was approved by the research ethics committee of Iran University of Medical Sciences.

Patient classification

The patients fell into three categories of low, intermediate and high for recurrence risk based on D'Amico classification. The low-risk patients were in clinical stage T1-T2a with a Gleason score of 6 and PSA levels <10 ng/ml. The intermediate-risk patients had PSA levels between 10-20 ng/ml, a Gleason score of 7 or a clinical stage of T2b. The high-risk patients also showed PSA levels >20 ng/ml, a Gleason score of 8 or a clinical stage of T2c.

Reference standard

Histopathological confirmation of skeletal lesions was not feasible in most patients because bone biopsy is invasive and not routinely performed in prostate cancer patients with suspected bone metastases. Therefore, lesion classification was based on available imaging findings and clinical information. CT findings were used as the principal anatomical comparator; however, CT was not considered a true gold standard. The absence of a composite reference standard incorporating pathology, MRI, clinical follow-up and serial imaging studies is acknowledged as a limitation of study.

Imaging protocol

All patients underwent two imaging scans with an interval of two weeks. The first study was [^{99m}Tc]Tc-MDP bone scintigraphy performed 3 hours after injection of 20 mci radiotracer. The second procedure was [^{99m}Tc]Tc-PSMA scan conducted 4 hours after injection of 20 mci radiotracer. For both scans, whole-body planar views and fused SPECT/CT images were acquired. Two fields were used for SPECT/CT imaging: neck and thorax as well as abdomen and pelvis. Primary tumoral and metastatic lesions were identified visually and relevant quantitative parameters were also recorded. Presence, number and location of pathological activities were recorded. Normal uptake sites in [^{99m}Tc]Tc-PSMA scan were kidneys, salivary glands, gallbladder, lacrimal glands, spleen, liver, thyroid, urinary system, and gastrointestinal tract.

Data Collection

A checklist based on study variables such as age, Gleason score, PSA levels, prior treatments and imaging findings was used for data collection. Lesions were categorized based on their location for easier data analysis.

Data analysis

Statistical analysis was performed with IBM SPSS Statistics for Windows, version 25 (IBM Corp., Armonk, N.Y., USA). Descriptive analysis is presented in the form of frequency and percentage or mean and standard deviation. Independent t-test and chi-square test were used for comparison of continuous and categorical parameters in different time points. P-value ≤ 0.05 was considered as statistical significance threshold.

RESULTS

20 patients were assessed in the current study. Four patients showed no evidence of bone metastases on CT, [^{99m}Tc]Tc-MDP bone scintigraphy or [^{99m}Tc]Tc-PSMA SPECT/CT and were therefore classified as true-negative cases. These patients were included in the diagnostic agreement analysis presented in table 2. Mean age of patients was 68.85 ± 10.30 years (53-86). Mean serum PSA levels at the time of scan was 35.71 ± 65.20 ng/ml (10-280) with a median of 11.95 ng/ml. The most common Gleason score was 8 in 9 patients (45%) followed by scores of 9 (8 patients, 40%), 7 (2 patients, 10%) and 6 (one patient, 5%). Radical prostatectomy was performed in one patient (5%). History of

chemotherapy, radiotherapy and ADT was present in 5 patients (25%), 10 patients (50%) and 7 patients (35%), respectively.

Based on CT scan, [^{99m}Tc]Tc-PSMA SPECT/CT, [^{99m}Tc]Tc-MDP bone scan and [^{99m}Tc]Tc-PSMA planar images, 9 patients (56.3%), 5 patients (31.3%), 9 patients (56.3%) and 5 patients (31.3%) had bone lesions, respectively. Overall, 63 bone lesions were identified on CT scan while 69, 23 and 16 bone lesions were seen on [^{99m}Tc]Tc-MDP, [^{99m}Tc]Tc-PSMA SPECT/CT and [^{99m}Tc]Tc-PSMA planar images, respectively. 22 soft tissue lesions were also reported. Frequency of lesions in these modalities is presented in Table 1.

Mean number of detected bone lesions on CT scan was 3.93 ± 6.19 (0-23) with a median frequency of 2. Mean number of reported lesions on [^{99m}Tc]Tc-MDP bone scintigraphy, [^{99m}Tc]Tc-PSMA SPECT/CT and [^{99m}Tc]Tc-PSMA planar images was 4.31 ± 6.85 (0-23), 1.43 ± 3.75 (0-15) and 1.00 ± 2.30 (0-9), respectively (Figure 1). Apart from bone lesions, 1.15 ± 1.34 (0-3) soft tissue lesions were detected, on average.

Analysis showed no significant difference in bone lesion detection between [^{99m}Tc]Tc-MDP bone scintigraphy and CT scan ($p=0.317$). The same was true for [^{99m}Tc]Tc-PSMA SPECT/CT and CT scan ($p=0.058$). On the other hand, number of detected bone lesions on [^{99m}Tc]Tc-PSMA planar images was significantly different from CT scan ($p=0.018$). This comparison between [^{99m}Tc]Tc-MDP bone scintigraphy and [^{99m}Tc]Tc-PSMA SPECT/CT was also significant ($p=0.027$).

Comparative diagnostic yield of imaging modalities were also assessed. In comparison of [^{99m}Tc]Tc-MDP bone scintigraphy and CT scan, it was revealed that sensitivity and specificity of [^{99m}Tc]Tc-MDP bone scintigraphy was 100% in comparison to CT scan. Sensitivity and specificity of [^{99m}Tc]Tc-PSMA SPECT/CT against CT scan was 55.6% and 100%. Comparison of [^{99m}Tc]Tc-PSMA planar images and CT scan also revealed sensitivity of 55.6% and specificity of 100%. Comparison of [^{99m}Tc]Tc-PSMA SPECT/CT and [^{99m}Tc]Tc-MDP bone scintigraphy also showed sensitivity of 55.6% and specificity of 100%. Agreement with CT findings was assessed. Because CT is not a definitive reference standard for prostate cancer bone metastases, the reported diagnostic performance measures should be interpreted cautiously. The details are shown in Table 2.

Table 1. Lesion counts in different imaging modalities

Lesion count	Frequency	Percent	Valid Percent	Cumulative Percent
CT lesions				
0	7	35	43.8	43.8
1	1	5	6.3	50
3	3	15	18.8	68.8
4	1	5	6.3	75
5	1	5	6.3	81.3
9	1	5	6.3	87.5
12	1	5	6.3	93.8
23	1	5	6.3	100
[^{99m}Tc]Tc-MDP bone scan				
0	7	35	43.8	43.8
1	1	5	6.3	50
3	3	15	18.8	68.8
4	1	5	6.3	75
5	1	5	6.3	81.3
9	1	5	6.3	87.5
18	1	5	6.3	93.8
23	1	5	6.3	100
[^{99m}Tc]Tc-PSMA planar				
0	11	55	68.8	68.8
1	2	10	12.5	81.3
2	1	5	6.3	87.5
3	1	5	6.3	93.8
9	1	5	6.3	100
[^{99m}Tc]Tc-PSMA SPECT/CT				
0	11	55	68.8	68.8
1	2	10	12.5	81.3
3	2	10	12.5	93.8
15	1	5	6.3	100
Soft tissue lesions				
0	10	50	52.6	52.6
1	1	5	5.3	57.9
2	3	15	15.8	73.7
3	5	25	26.3	100

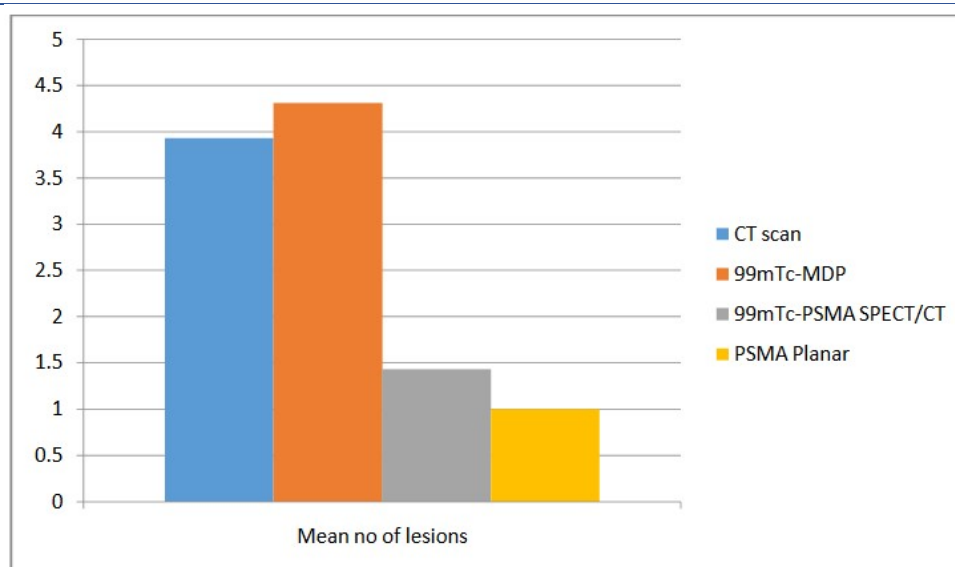


Figure 1. Mean number of detected bone lesions on different imaging modalities

Table 2. Comparative analysis of lesion detection in imaging modalities

		CT scan	
		Negative	Positive
[^{99m}Tc]Tc-MDP bone scintigraphy	Negative	11 (100%)	0 (0%)
	Positive	0 (0%)	9 (100%)
		CT scan	
		Negative	Positive
[^{99m}Tc]Tc-PSMA SPECT/CT	Negative	11 (100%)	4 (44.4%)
	Positive	0 (0%)	5 (55.6%)
		[^{99m}Tc]Tc-MDP bone scintigraphy	
		Negative	Positive
[^{99m}Tc]Tc-PSMA SPECT/CT	Negative	11 (100%)	4 (44.4%)
	Positive	0 (0%)	5 (55.6%)
		CT scan	
		Negative	Positive
[^{99m}Tc]Tc-PSMA planar image	Negative	11 (100%)	4 (44.4%)
	Positive	0 (0%)	5 (55.6%)

DISCUSSION

Published studies in the literature have shown superiority of PET/CT with [⁶⁸Ga]Ga-PSMA in detection of prostate cancer lesions [4, 5] but PET/CT scanners are not widely accessible in less developed countries and the number of available PET/CT scanners is much less than SPECT/CT machines. Limited production of ⁶⁸Ga from a ⁶⁸Ge-⁶⁸Ga generative and its short half-life leads to the need for multiple production sessions in a day to suffice the requirements of patients which ultimately limits the number of daily evaluations. With introduction of radioligand therapy (RLT) based on PSMA in prostate cancer patients in recent years, this area has gained interest. For candidates of [¹⁷⁷Lu]Lu-PSMA radioligand therapy, a pre-treatment PSMA-targeted imaging is necessary but this imaging does not require a resolution as high as obtained in PET images. ^{99m}Tc obtained from ⁹⁹Mo-^{99m}Tc generators is widely used in SPECT imaging and has appropriate physical properties, low cost and wide availability. Thus, [^{99m}Tc]Tc-PSMA based ligand are cost-effective appropriate alternatives for ⁶⁸Ga products. Thus, the current study was performed to compare the [^{99m}Tc]Tc-MDP bone scintigraphy results with [^{99m}Tc]Tc-PSMA scan in a group of prostate cancer patients.

In the current study, 56.3% of patients had positive [^{99m}Tc]Tc-MDP bone scan while 31.3% had positive [^{99m}Tc]Tc-PSMA SPECT/CT and 31.1% had positive findings on planar [^{99m}Tc]Tc-PSMA. Mean number

of lesions in these modalities were 4.31, 1.43 and 1.00, respectively with a significant difference between number of detected lesions in [^{99m}Tc]Tc-MDP bone scintigraphy and [^{99m}Tc]Tc-PSMA SPECT/CT ($p=0.027$). Given these findings, it seems that the detected lesions with [^{99m}Tc]Tc-PSMA has been significantly less than [^{99m}Tc]Tc-MDP bone scintigraphy which is in contrast to the previously published articles. For instance, Albalooshi et al. [6] reported no significant difference for bone metastases between [^{99m}Tc]Tc-MDP and [^{99m}Tc]Tc-PSMA on SPECT/CT. Regarding all lesions, no significant difference was found in serum PSA levels of over 2.1 ng/ml. Kabunda et al. [7] also reported that out of 55 bone lesions on [^{99m}Tc]Tc-MDP bone scintigraphy, 52 lesions were detected on [^{99m}Tc]Tc-PSMA SPECT/CT which shows no significant difference for detection rate of bone metastases. Orunmuyi et al. [8] used planar [^{99m}Tc]Tc-PSMA images in limited-resource conditions and found out that in low-risk prostate cancer, [^{99m}Tc]Tc-PSMA has no advantage over conventional bone scintigraphy but in intermediate-risk patients, it could identify complete response to treatment in oligometastatic disease and partial response in widespread metastatic disease. In a patient with high-risk prostate cancer, planar [^{99m}Tc]Tc-PSMA images could detect more bone lesions which were not detected on conventional bone scintigraphy. Rathke et al. [9] also reported that in 4 patients, extensive bone marrow lesions were found on [^{99m}Tc]Tc-PSMA scan which were not detected on

[^{99m}Tc]Tc-MDP scan. In three patients, results of conventional bone scintigraphy and [^{99m}Tc]Tc-PSMA SPECT/CT were matched but in 16 patients, more suspicious lesions were found on PSMA scan compared to conventional bone scan. In addition, Zhang et al. [1] reported 20 bone metastases found on [^{99m}Tc]Tc-PSMA SPECT/CT while in [^{99m}Tc]Tc-MDP bone scintigraphy images, 18 bone metastases were visualized. They pointed out that in bone metastases of 6 mm and less, a significant difference was present between two scans and [^{99m}Tc]Tc-PSMA SPECT/CT could change management in 14.9% of patients. They concluded that [^{99m}Tc]Tc-PSMA SPECT/CT is superior to [^{99m}Tc]Tc-MDP bone scintigraphy in detection of bone metastases of prostate cancer, particularly for small lesions and patients with low serum PSA levels. Overall, the mentioned studies indicate that performance of [^{99m}Tc]Tc-PSMA SPECT/CT for identification of osseous lesions has been better or equal to [^{99m}Tc]Tc-MDP bone scintigraphy. Our finding regarding higher lesion detection by [^{99m}Tc]Tc-MDP bone scan in the present cohort in prostate cancer patients should be evaluated and confirmed in a larger sample population. Several factors may explain the lower lesion detection rate observed with [^{99m}Tc]Tc-PSMA SPECT/CT in our cohort. First, a substantial proportion of patients had previously received androgen deprivation therapy, radiotherapy, or chemotherapy. Treated or healed skeletal metastases may continue to demonstrate osteoblastic activity and remain positive on [^{99m}Tc]Tc-MDP bone scintigraphy despite reduced viable tumor burden and lower PSMA expression. Second, differences in disease burden and lesion characteristics may influence tracer uptake. Third, the relatively small sample size increases susceptibility to sampling variation. Finally, the absence of a composite reference standard limits definitive characterization of discordant findings.

Sensitivity and specificity of [^{99m}Tc]Tc-MDP bone scan for bone metastases has been 100% and 100% in our study. These values for both [^{99m}Tc]Tc-PSMA planar images and SPECT/CT were 55.6% and 100%. Zhang et al [1] have reported sensitivity rates of 72% and 80% for [^{99m}Tc]Tc-MDP and [^{99m}Tc]Tc-PSMA scans in detection of bone lesions of prostate cancer patients. Specificity rates have also been 81.3% and 100%, respectively. Farkas et al [10] also reached sensitivity and specificity values of 88% and 100% with [^{99m}Tc]Tc-PSMA scan for prostate cancer patients referred for staging. These values were 91% and 92% on restaging. In the study by Duncan et al [11], sensitivity and specificity of [^{99m}Tc]Tc-PSMA scan has been 99.7% and 83.3%.

Similarly, Seigiera et al [12] indicated sensitivity and specificity rates of 84.3% and 100%. A meta-analysis by Wang et al [5] concluded that the sensitivity and specificity for [^{99m}Tc]Tc-PSMA SPECT/CT has been 89% and 92%. Overall, it seems that the specificity rate found in our study is similar to the previous studies in the literature but the sensitivity value in our study has been lower than the similar studies with [^{99m}Tc]Tc-PSMA scan. This finding also needs confirmation in future studies with larger sample sizes and broader spectrum of patients suffering from prostate cancer.

Study limitations

The present study has several important limitations. First, the sample size was relatively small and the study was performed at a single institution, limiting statistical power and generalizability. Second, a composite reference standard incorporating pathology, MRI, clinical follow-up, and serial imaging studies was unavailable. Consequently, CT was used only as an anatomical comparator rather than a true gold standard. Third, the patient population was heterogeneous regarding disease stage, PSA level, Gleason score, and prior treatment history. Fourth, inter-reader and intra-reader agreement analyses were not performed. Fifth, subgroup analyses according to PSA level, Gleason score, treatment status, and disease burden were limited by the small sample size. Finally, lesion-based validation was not feasible.

CONCLUSION

This study demonstrated that [^{99m}Tc]Tc-MDP bone scintigraphy identified more skeletal lesions than [^{99m}Tc]Tc-PSMA SPECT/CT in the studied cohort. However, because a composite reference standard was unavailable and the sample size was limited, these findings should be interpreted cautiously. The observed differences may reflect treatment-related changes, patient heterogeneity, and methodological limitations rather than true differences in diagnostic performance. Larger prospective multicenter studies incorporating standardized lesion validation and longitudinal follow-up are needed.

REFERENCES

1. Zhang Y, Lin Z, Li T, Wei Y, Yu M, Ye L, Cai Y, Yang S, Zhang Y, Shi Y, Chen W. Head-to-head comparison of ^{99m}Tc-PSMA and ^{99m}Tc-MDP SPECT/CT in diagnosing prostate cancer bone metastasis: a prospective, comparative imaging trial. *Sci Rep.* 2022 Sep 26;12(1):15993.
2. Moreira DM, Howard LE, Sourbeer KN, Amarasekara HS, Chow LC, Cockrell DC, Pratson CL, Hanyok BT, Aronson WJ, Kane CJ, Terris MK, Amling CL, Cooperberg MR, Freedland

- SJ. Predicting time from metastasis to overall survival in castration-resistant prostate cancer: results from SEARCH. *Clin Genitourin Cancer*. 2017 Feb;15(1):60-6.e2.
3. Even-Sapir E, Metser U, Mishani E, Lievshitz G, Lerman H, Leibovitch I. The detection of bone metastases in patients with high-risk prostate cancer: [99mTc]Tc-MDP Planar bone scintigraphy, single- and multi-field-of-view SPECT, 18F-fluoride PET, and 18F-fluoride PET/CT. *J Nucl Med*. 2006 Feb;47(2):287-97.
 4. Zhao G, Ji B. Head-to-head comparison of ⁶⁸Ga-PSMA-11 PET/CT and ^{99m}Tc-MDP bone scintigraphy for the detection of bone metastases in patients with prostate cancer: a meta-analysis. *Am J Roentgenol*. 2022 Sep;219(3):386-95.
 5. Wang Y, Qiu Y, Yan X. Prostate-specific membrane antigen PET versus [^{99m}Tc]Tc-MDP bone scan for diagnosing bone metastasis in prostate cancer: a head-to-head comparative meta-analysis. *Front Med (Lausanne)*. 2024 Sep 25;11:1451565.
 6. Albalooshi B, Al Sharhan M, Bagheri F, Miyanath S, Ray B, Muhasin M, Zakavi SR. Direct comparison of 99mTc-PSMA SPECT/CT and 68Ga-PSMA PET/CT in patients with prostate cancer. *Asia Ocean J Nucl Med Biol*. 2020 Winter;8(1):1-7.
 7. Kabunda J, Gabela L, Kalinda C, Aldous C, Pillay V, Nyakale N. Comparing 99mTc-PSMA to 99mTc-MDP in prostate cancer staging of the skeletal system. *Clin Nucl Med*. 2021 Jul 1;46(7):562-8.
 8. Orunmuyi AT, Oladeji AA, Azodoh EU, Omisanjo OA, Olapade-Olaopa EO. Planar ^{99m}Tc-PSMA imaging of prostate cancer in a low-resource setting: a series report. *World J Nucl Med*. 2022 Jun 28;21(2):142-7.
 9. Rathke H, Afshar-Oromieh A, Giesel FL, Kremer C, Flechsig P, Haufe S, Mier W, Holland-Letz T, De Bucourt M, Armor T, Babich JW, Haberkorn U, Kratochwil C. Intraindividual comparison of ^{99m}Tc-methylene diphosphonate and prostate-specific membrane antigen ligand ^{99m}Tc-MIP-1427 in patients with osseous metastasized prostate cancer. *J Nucl Med*. 2018 Sep;59(9):1373-9.
 10. Farkas I, Sipka G, Bakos A, Maráz A, Bajory Z, Mikó Z, Czékus T, Urbán S, Varga L, Pávics L, Besenyi Z. Diagnostic value of [^{99m}Tc]Tc-PSMA-I&S-SPECT/CT for the primary staging and restaging of prostate cancer. *Ther Adv Med Oncol*. 2024 Jan 18;16:17588359231221342.
 11. Duncan I, Ingold N, Martinez-Marroquin E, Paterson C. An Australian experience using Tc-PSMA SPECT/CT in the primary diagnosis of prostate cancer and for staging at biochemical recurrence after local therapy. *Prostate*. 2023 Jul;83(10):970-9.
 12. Sergieva S, Mangalgiev R, Dimcheva M, Nedev K, Zahariev Z, Robev B. SPECT-CT Imaging with [^{99m}Tc]PSMA-T4 in patients with Recurrent Prostate Cancer. *Nucl Med Rev Cent East Eur*. 2021;24(2):70-81.