Bone superscan in initial staging of gastric adenocarcinoma

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ABSTRACT:
A 37-year-old woman presented with dyspepsia, bone pain, and significant weight loss. Endoscopy revealed an infiltrative gastric body mass, and histology confirmed signet ring cell gastric adenocarcinoma. A contrast-enhanced CT scan showed peritoneal carcinomatosis and multiple lytic-sclerotic skeletal metastases. A whole-body Technetium-99m methylene diphosphonate ([^{99m}Tc]Tc-MDP) scan revealed a "superscan" pattern, characteristic of widespread bone metastases. While bone scintigraphy is sensitive for detecting osteoblastic metastases, the superscan pattern can be mistaken for a normal scan, particularly in gastric cancer patients where it's an uncommon finding. Our brief review of the literature illustrates this infrequently observed phenomenon may occasionally occur in gastric cancer, especially in symptomatic patients.

Keywords: Gastric cancer; Superscan; [^{99m}Tc]Tc-MDP; Signet ring cell; Bone metastasis

INTRODUCTION
Technetium-99m methylene diphosphonate ([^{99m}Tc]Tc-MDP) is a highly sensitive imaging modality in the evaluation of skeletal metastasis, especially for osteoblastic lesions. Superscan, is a rare phenomenon which can occasionally occur and is defined as diffuse and prominent bone uptake which has a broad differential diagnosis [1]. Here we report a case of gastric cancer in which this pattern was observed at the initial staging of the disease suggesting diffuse skeletal metastases.

CASE PRESENTATION
A 37-year-old woman presented with dyspepsia, bone pain and significant weight loss. An endoscopic evaluation revealed an infiltrative mass in the proximal portion of the gastric body (Figure 1A). Biopsy results indicated the presence of signet ring cell type gastric adenocarcinoma. A contrast-enhanced CT evaluation demonstrated wall thickening in the gastric body (Figure 1B), along with fat stranding and ascites, suggesting peritoneal

carcinomatosis. Additionally, diffuse lytic-sclerotic skeletal metastases were identified (Figure 1C). A whole-body [^{99m}Tc]Tc-MDP scan (Figure 1D) was subsequently conducted given her bone pain and CT scan findings, which revealed a pattern consistent with "superscan". Both whole-body (Figure 1D) and static images (Figure 1E) demonstrated relatively homogeneous and diffuse increased uptake of [^{99m}Tc]Tc-MDP throughout the skeleton, accompanied by non-visualization of the kidneys and high target-to-background ratios.

DISCUSSION

Bone scintigraphy is highly sensitive for detecting osteoblastic metastases, but the superscan pattern can be misinterpreted as normal by inexperienced readers. Superscans can result from metastatic, metabolic, or hematologic conditions. Metabolic etiologies often exhibit characteristic features, including symmetrical uptake, distal appendicular uptake, periarticular uptake on bone scans, as well as osteolytic lesions on CT, ribs pain, and hypercalcemia [1, 2]. In a previous study, it was reported that a bone superscan occurs in 2.6% of gastric cancer patients, and its manifestation during initial staging is extremely uncommon [3-6]. Furthermore, a study indicates that gastric cancer accounts for 6.25% of bone superscan cases [7]. The metastatic pattern of gastric cancer varies according to the pathological subtype and anatomical location. Cardia cancers are more likely to metastasize to the lungs, brain, and bones, while non-cardia cancers tend to metastasize more frequently to the peritoneum. On the other hand, Signet ring adenocarcinomas more frequently metastasize to the peritoneum, bone, and ovaries, while they metastasize less often to the lungs and liver compared to generic adenocarcinomas. Given these differences, it's better to consider bone scan imaging particularly in patients with cardia cancers and those diagnosed with signet ring adenocarcinomas, as these subtypes have a higher propensity for bone metastases [8]. A chest, abdomen, and pelvic contrast-enhanced CT scan is the preferred modality for initial staging [9]. Given the rarity of bone involvement in gastric cancer, with a reported incidence ranging from 3.5% to 10%, bone scans are generally performed only in symptomatic cases and are not routinely utilized. However, early detection of bone involvement through bone scans can guide appropriate management and avoid futile interventions including surgery or radiotherapy [10]. We conducted a systematic search of the PubMed database using the following search terms: (Stomach Neoplasm*[tiab] OR Gastric Neoplasm*[tiab] OR Stomach Cancer*[tiab] OR Gastric Cancer*[tiab]) AND (Bone*[tiab] OR Condyle*[tiab]) AND (metastas*[tiab]). This strategy was designed to identify case reports and studies related to bone superscan occurrences in gastric cancer. Our findings (summarized in Supplementary Table 1**)** indicate that these cases are more frequently reported in Asia, likely due to the region's highest incidence of gastric cancer [11, 12]. However, new emerging functional imaging modalities, including FAP (fibroblast activation protein)-targeted imaging, are being developed for use in gastric cancer and may help overcome the limitations of previously employed functional imaging techniques, such as [^{18}F]F-FDG PET/CT and [^{99m}Tc]Tc-MDP scans [13-16].

CONCLUSION

A review of previously documented cases reveals a higher prevalence of bone superscan in gastric cancer patients notably in Asia. We presented a case of bone superscan detected during initial staging of gastric cancer, a phenomenon more commonly associated with prostate or breast cancer. This highlights the need for clinicians and nuclear medicine physicians to be vigilant for bone superscan patterns in symptomatic gastric cancer patients, particularly those with signet ring cell histology or cardia tumors. Early recognition of this finding can facilitate timely bone scintigraphy, appropriate management decisions and avoiding unnecessary interventions.

REFERENCES

1. Askari E, Shakeri S, Roustaei H, Fotouhi M, Sadeghi R, Harsini S, Vali R. Superscan pattern on bone scintigraphy: a comprehensive review. Diagnostics (Basel). 2024 Oct 6;14(19):2229.
2. Shakeri S, Khosravi S, Divband G, Sadeghi R, Shafiei S. Whole-body blood pool metastatic superscan (bone hunger pattern). Clin Nucl Med. 2019 Jun;44(6):475-6.
3. Kovacsne A, Kozon I, Bentestuen M, Zacho HD. Frequency of superscan on bone scintigraphy: A systematic review. Clin Physiol Funct Imaging. 2023 Sep;43(5):297-304.
4. Sudo H, Takagi Y, Katayanagi S, Hoshino S, Suda T, Hibi Y, Ito K, Tsutida A, Aoki T. Bone metastasis of gastric cancer. Gan To Kagaku Ryoho. 2006 Aug;33(8):1058-60.
5. Koyama M, Koizumi M. Two cases of diffuse osteoblastic metastases from early type gastric cancer. Clin Nucl Med. 2007 Jul;32(7):545-7.
6. Choi CW, Lee DS, Chung JK, Lee MC, Kim NK, Choi KW, Koh CS. Evaluation of bone metastases by Tc-99m MDP imaging in patients with stomach cancer. Clin Nucl Med. 1995 Apr;20(4):310-4.
7. Manohar PR, Rather TA, Khan SH, Malik D. Skeletal metastases presenting as superscan on Technetium 99m methylene diphosphonate whole body bone scintigraphy in different type of cancers: a 5-year retro-prospective study. World J Nucl Med. 2017 Jan-Mar;16(1):39-44.
8. Riihimäki M, Hemminki A, Sundquist K, Sundquist J, Hemminki K. Metastatic spread in patients with gastric cancer. Oncotarget. 2016 Aug 9;7(32):52307-16.
9. Ajani JA, D'Amico TA, Almhanna K, Bentrem DJ, Chao J, Das P, Denlinger CS, Fanta P, Farjah F, Fuchs CS, Gerdes H, Gibson M, Glasgow RE, Hayman JA, Hochwald S, Hofstetter WL, Ilson DH, Jaroszewski D, Johung KL, Keswani RN, Kleinberg LR, Korn WM, Leong S, Linn C, Lockhart AC, Ly QP, Mulcahy MF, Orringer MB, Perry KA, Poultsides GA, Scott WJ, Strong VE, Washington MK, Weksler B, Willett CG, Wright CD, Zelman D, McMillian N, Sundar H. Gastric cancer, Version 3.2016, NCCN clinical practice guidelines in oncology. J Natl Compr Canc Netw. 2016 Oct;14(10):1286-312.
10. Petrillo A, Giunta EF, Pappalardo A, Bosso D, Attademo L, Cardalesi C, Diana A, Fabbrocini A, Fabozzi T, Giordano P, Ottaviano M, Rosanova M, Silvestri A, Federico P, Daniele B. Bone metastases from gastric cancer: what we know and how to deal with them. J Clin Med. 2021 Apr 19;10(8):1777.
11. Lin JL, Lin JX, Lin GT, Huang CM, Zheng CH, Xie JW, Wang JB, Lu J, Chen QY, Li P. Global incidence and mortality trends of gastric cancer and predicted mortality of gastric cancer by 2035. BMC Public Health. 2024 Jul 2;24(1):1763.
12. Pang Y, Huang H, Fu L, Zhao L, Chen H. 68Ga-FAPI PET/CT detects gastric signet-ring cell carcinoma in a patient previously treated for prostate cancer. Clin Nucl Med. 2020 Aug;45(8):632-5.
13. Beyhan E, Çermik TF, Erol Fenercioğlu Ö, Şahin R, Alçin G, Aksoy T, Arslan E, Ergül N. The contribution of 68 Ga-FAPI-04 PET/CT to staging and prognosis in gastric cancer. Clin Nucl Med. 2024 Oct 1;49(10):e485-91.
14. Chen X, Wei M, Wang S, Yang Z, Wang X. Characterizing concomitant follicular lymphoma and gastric carcinoma using 68Ga-FAPI-04 and 18F-FDG PET/CT. Clin Nucl Med. 2022 Jan 1;47(1):81-2.
15. Zhang Z, Jiang H, Zhang L, Cheng C, Zuo C. 68Ga-FAPI-04 PET/CT versus 18F-FDG PET/CT in the detection of malignant gastrointestinal stromal tumor. Clin Nucl Med. 2023 Jan 1;48(1):61-3.
16. Raeisi N, Tanha AS, Aryana K, Soltani E, Barashki S. Utilizing 99m Tc-FAPI-46 SPECT/CT in detection of peritoneal carcinomatosis in gastric poorly differentiated adenocarcinoma : a case report. Clin Nucl Med. 2025 Feb 1;50(2):e122-3.
17. Hori K, Sudo A, Wakabayashi H, Matsumine A, Kusuzaki K, Uchida A. Asymptomatic disseminated carcinomatosis of bone marrow presenting as hyperphosphatasia: report of a case. Acta Gastroenterol Belg. 2008;71:271–4.
18. Fujita K, Okubo A, Nakamura T, Takeuchi N. Disseminated carcinomatosis of the bone marrow caused by granulocyte colony-stimulating factor: A case report and review of literature. World Journal of Gastrointestinal Oncology. 2022 Oct 15;14(10):2077.
19. Das J, Ray S, Ghosh J, Zameer L. A rare case of metastatic super scan from signet ring cell adenocarcinoma of stomach. Int J Med Clin Imaging. 2020;5(1):114-7.
20. Kobayashi F, Ikeda T, Tozuka S, Noguchi O, Fukuma T, Sakamoto S, Marumo F, Komoda T, Sakagishi Y, Sato C. A variant alkaline phosphatase found in a case of gastric carcinoma with super bone scan. Gut. 1995 Feb;36(2):299-302.
21. Tokushima K, Ikeda T, Kobayashi F, Kurosaki M, Tozuka S, Sakamoto S, Marumo F, Koyama I, Komoda T, Sakagishi Y, Hirota N, Sato C. A variant alkaline phosphatase-producing gastric carcinoma with super bone scan. Dig Dis Sci. 1997 Jan;42(1):66-73.
22. Sato T, Sato Y, Akashi K, Shiina M, Matsushima J, Fujii A, Ban S. An autopsy case of disseminated carcinomatosis of the bone marrow caused by early gastric cancer. Dokkyo Med J. 2023 Dec 25;2(4):310–4.

23. Jenkins MA, Steer CB, Cheng LW, Ratnaike S. An unusual alkaline phosphatase isoenzyme associated with gastric carcinoma. Ann Clin Biochem. 1999 Nov;36 (Pt 6):743-8.
24. Iizumi S, Shimoi T, Nishikawa T, Kitano A, Sasada S, Shimomura A, Noguchi E, Yunokawa M, Yonemori K, Shimizu C, Fujiwara Y, Tamura K. Prolonged hypocalcemia following a single dose of denosumab for diffuse bone metastasis of gastric cancer after total gastrectomy. Intern Med. 2017 Nov 1;56(21):2879-82.
25. Kanazawa K, Isozaki E. "Super bone scan" in a case of diffuse bone marrow metastasis of gastric adenocarcinoma. Intern Med. 2009;48(18):1719-20.
26. Ermiş F, Erkan ME, Besir FH, Oktay M, Kutlucan A, Aydın Y. Osteoblastic metastasis from signet ring cell gastric cancer in a young male. Turk J Gastroenterol. 2014 Dec;25 Suppl 1:284-6.
27. Tago M, Tokushima Y, Oie S, Yamashita SI. Slight brightness and osteosclerotic changes of bones on plain X-ray could be clues to the diagnosis of disseminated carcinomatosis of bone marrow. Clin Case Rep. 2019 Jun 11;7(7):1458-9.
28. Omi R, Hatori M, Sano H, Watanabe K, Watanabe M, Kokubun S. Super bone scan due to bone marrow metastases appearing 19 years after surgery for early gastric cancer--a case report. Ups J Med Sci. 2004;109(1):49-56.
29. Narváez JA, Narváez J, Clavaguera MT, Juanola X, Valls C, Fiter J. Bone and skeletal muscle metastases from gastric adenocarcinoma: unusual radiographic, CT and scintigraphic features. Eur Radiol. 1998;8(8):1366-9.
30. Lin CY, Chen YW, Chang CC, Yang WC, Huang CJ, Hou MF. Bone metastasis versus bone marrow metastasis? Integration of diagnosis by (18)F-fluorodeoxyglucose positron emission/computed tomography in advanced malignancy with super bone scan: two case reports and literature review. Kaohsiung J Med Sci. 2013 Apr;29(4):229-33.
31. Kim HM, Park JH, Kim HS, Choi JH, Kim CJ, Lee EA. A case of signet ring cell gastric carcinoma initially presenting with disseminated bone marrow metastases. Korean J Med. 2008;75(3):787-91.
32. Rather T, Khan S, Manohar R. Krukenberg Tumor with Diffuse Skeletal Metastasis. A Case Report With Review of Literature. J Med Sci. 2014 Dec 4;17(2):64-8
33. Okazaki J, Muguruma N, Kitamura S, Kimura T, Okamoto K, Miyamoto H, Kishi K, Bando Y, Kondo T, Endo I, Abe M, Takayama T. Paraneoplastic hypocalcemia developed in gastric cancer accompanied by osteoblastic metastasis. Intern Med. 2017;56(11):1345-9.

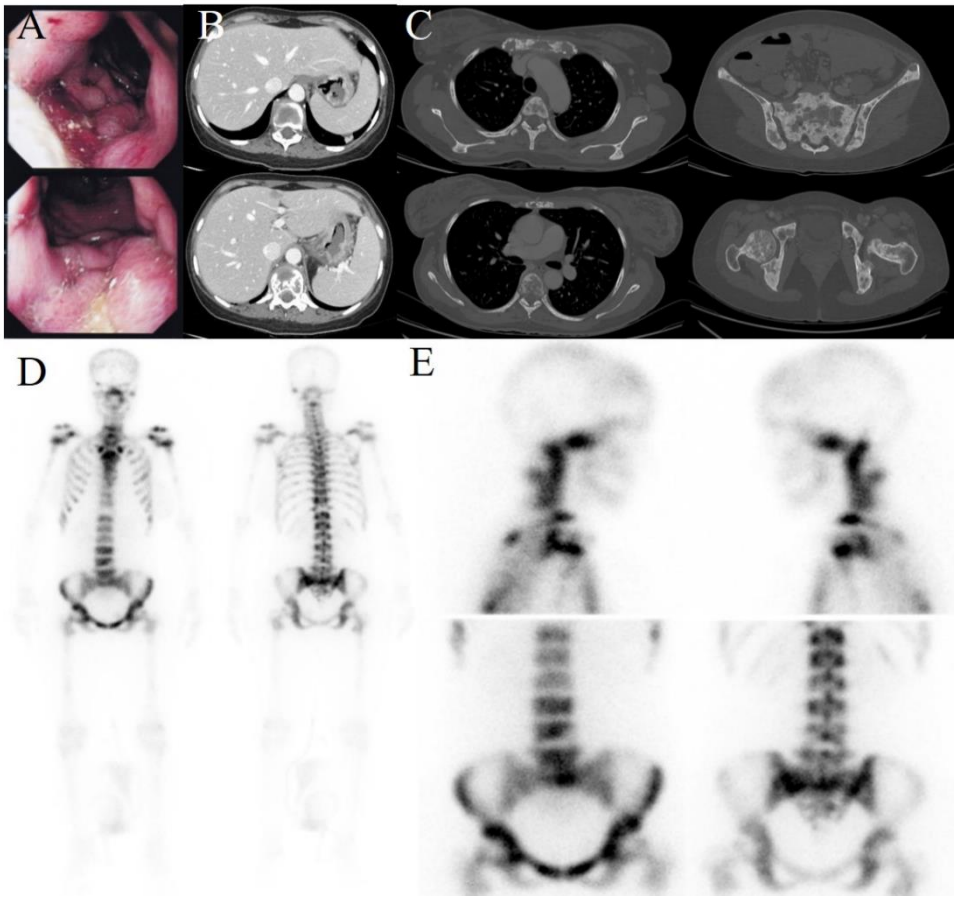

Figure 1. (A) Endoscopic assessment shows an infiltrative mass in the proximal portion of the gastric body. (B) Wall thickening of the gastric body on the contrast-enhanced CT images. (C) Bone window of the CT images demonstrates diffuse lytic-sclerotic skeletal metastases. (D) The whole-body scan shows diffusely increased MDP uptake in the axial and proximity of the appendicular skeleton as well as negligible renal and soft tissue uptake. (E) The static images of the skull and pelvic region clearly shows the increased MDP uptake in the axial skeleton