Spectrum of MDP Bone Scan in Paediatric Patients - Experience at NINMAS

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ABSTRACT

Objective: **To assess the clinical indications and spectrum of MDP bone scan findings in paediatric patients referred to the National Institute of Nuclear Medicine and Allied Sciences (NINMAS).**

Materials and Methods: **Paediatric patients, age ranged from 2-18 years referred to NINMAS from January 2014 to November 2015 for bone scintigraphy were included in this study. All patients had ^{99m}Tc MDP bone scan for various clinical indications. The spectrum of clinical indications and bone scan findings were recorded and analyzed.**

Results: **Total 2323 bone scans with ^{99m}Tc MDP were done in NINMAS in the above mentioned period. Among them 91 (3.917%) cases were in paediatric age group. Of which 82 (90.11%) patients with known malignancy were referred for radionuclide skeletal survey. The most common clinical indications were osteosarcoma 30 (32.96%) cases and Ewing's sarcoma 25 (27.47%) cases followed by five neuroblastoma (5.49%), four (4.39%) rhabdomyosarcoma, three (3.29%) Langerhans cell histocytosis and rest others. Bone scan was positive in 58 (63.7%) cases and normal in 33 (36.3%) cases. Out of 58 cases 38 had features of primary bony lesion, 10 cases had multiple metastases, four cases had primary bone tumour of Ewing's sarcoma as well as metastases.**

Conclusion: **Bone scan is a popular imaging modality for skeletal survey of paediatric patients in malignancy, both primary and metastatic bone diseases. Bone scanning in paediatric patients contributes a major role in detecting the cause and localizing the pathology of bone. High quality imaging, interpreted by physicians familiar with paediatric diseases, correlation with clinical records and other imaging are mandatory to maximize the benefit.**

Keywords: **MDP Bone scan, Paediatric, Osteosarcoma, Childhood tumour**

INTRODUCTION

The radionuclide bone imaging using ^{99m}Tc MDP (methylene diphosphonate) is a quick, relatively inexpensive, widely available, and exquisitely sensitive and is invaluable in the diagnostic evaluation of numerous pathologic conditions of bone (1, 2). It is the second most frequently performed radionuclide study in paediatric patients. There are a wide variety of indications for ^{99m}Tc MDP bone scan with maximum advantages and minimum disadvantages. It is valuable in the diagnosis of inflammatory conditions, osteomyelitis, septic arthritis, trauma, vascular insult, occult bone pain, hip pain, child abuse and malignant diseases (3, 4, 5). In paediatric patients most of the bone scan is performed with a diagnosis of malignancy, both primary and metastatic bone diseases. Bone scan plays an integral part in tumour staging and management. In recent years Nuclear Medicine methods are also applied in determining the response of tumour to the treatment. The most commonly used radiopharmaceutical is ^{99m}Tc MDP for planar bone scan. Single photon emission computed tomography (SPECT) provides improved spatial resolution of imaging using gamma emitters and, moreover, it can be fused with MRI and CT, thus giving anatomic dimension to nuclear medicine imaging (6). No published data on the incidence of paediatric cancer is available in Bangladesh. paediatric cancer or childhood cancer means cancer in children which are rare and representing between 0.5% and 4.6% of all cancers. Cancer is the second most common cause of death in children, accounting for approximately 10% of all childhood deaths. The overall incidence rates of childhood cancer vary between 50 and 200 per million children across the world (7, 8).

This retrospective study was performed to assess the spectrum of MDP bone scan findings and nature of clinical indications of MDP skeletal survey in paediatric patients referred to a tertiary centre.

MATERIALS AND METHODS

This retrospective study was carried out in National Institute of Nuclear Medicine and Allied Sciences, Dhaka, from January 2014 to November 2015. Total 2323 bone scans were performed at NINMAS and out of them 91 paediatric patients were enrolled (48 males and 43 females, age range 2-18 years, mean age 11.37 ± 4.91 years) in this study. All paediatric patients between 0-18 years of age referred for bone scan with various clinical indications were included in this study. The WHO recommended standard age of paediatric patient is 0-18 years (9). Whole body bone scan was performed on anterior and posterior projections in each patient after intravenous injection of ^{99m}Tc MDP. If needed, three phase bone scan and spot views were obtained by using Siemens E.cam dual head gamma camera. The available clinical data, detail history and related investigation results and imaging findings were recorded from the departmental data archiving system. Images of all patients were reviewed and interpreted by at least two senior nuclear medicine specialists. The spectrum of clinical indications of bone scan and nature of scan findings were recorded for analysis.

RESULTS

Total 91 paediatric patients, 48 males and 43 females (Table 1), age range 2-18 years, mean age 11.37 ± 4.91 years were referred for radionuclide skeletal survey with various clinical indications which were predominantly malignant. The most common clinical indications were osteosarcoma 30 (32.96%) cases and Ewing's sarcoma 25 (27.47%) cases followed by five (5.49%) neuroblastoma, four (4.39%) rhabdomyosarcoma, three (3.29%) Langerhans cell histocytosis and rest others (Table 2). Bone scan was positive in 58(63.7%) cases and normal in 33(36.3%) cases (Table 3). Out of 58 cases 38 cases had features of primary bony lesion, 10 cases had multiple metastases, among four cases had primary bone tumour of Ewing's sarcoma with metastases and solitary bone lesion suspicious for metastasis were present in three cases (Table 4). The childhood tumour was present in 69 cases with osteosarcoma predominance and the distribution of childhood tumour in different age group is summarized in Table 5. Metastatic bone involvement was more prevalent in Ewing's sarcoma; in 24% cases comparing to osteosarcoma, which was 13.3%. Distribution of bony lesion according to the skeletal site of involvement shown in Table 6, where appendicular bony involvement was predominant (60.35%).

Table 1: Distribution of number and percentage of sex in study population (n=91)

Sex	Number of patient	Percentage (%)
Male	48	52.75%
Female	43	47.25%

Table 2: Distribution of frequency and percentage of clinical indications of MDP bone scan in study population (n=91)

Types	n=91	Percentage (%)
Osteosarcoma	30	32.967 %
Ewing's Sarcoma	25	27.472%
Neuroblastoma	05	5.494%
Rhabdomyosarcoma	04	4.395%
Langerhans cell histocytosis	03	3.297%
Nasopharyngeal carcinoma	02	2.197 %
Renal cell carcinoma	02	2.197 %
Nephroblastoma	02	2.197%
Brain tumour	02	2.197%
Giant cell tumour	02	2.197 %
Malignant peripheral sheath tumour	01	1.098%
Retinoblastoma	01	1.098%
Carcinoma of rectum	01	1.098 %
Metastatic papillary carcinoma of thyroid	01	1.098%
Carcinoma of breast	01	1.098%
Non malignant conditions	09	9.90%

Table 3: Distribution of bone scan findings among the study population (n=91)

Findings	n=91	Percentage (%)
Positive /abnormal bone scan	58	63.7%
Normal bone scan	33	36.3%
Total	91	100%

Table 4: Distribution of nature of bony lesion among the positive or abnormal bone scan (n=58)

	Findings	n=58	Percentage (%)
Positive /abnormal bone scan	Primary bony lesion	38	65.52%
	Primary bony lesion with metastasis	4	6.91%
	Multiple bone metastases	10	17.24%
	Solitary bony lesion	3	5.17%
	Significant response/flare phenomena	1	1.72%
	Chronic osteomyelitis	1	1.72%
	Benign bony lesion	1	1.72%
Total		58	100%

Table 5: Distribution of childhood tumour in different age group (n=69)

Type of childhood tumour	Age Up to 5 years	Percentage (%)	Age >5 years	Percentage (%)	Total
Osteosarcoma	00	00	30	53.57	30
Ewing's sarcoma	1	7.70	24	42.86	25
Neuroblastoma	5	38.46	00	00	5
Brain tumour	2	15.38	00	00	2
Rhabdomyosarcoma	2	15.38	2	3.57	4
Nephroblastoma/Wilms' tumour	2	15.38	00	00	2
Retinoblastoma	1	7.70	00	00	1
Total	13	100	56	100	69

Table 6: Distribution of bony lesion according to the skeletal site of involvement (n=58)

Site	n=58	Percentage (%)
Skull	6	10.34 %
Appendicular bone	35 Lower limb:27 ; (46.55%) Upper limb: 8 ; (13.8%)	60.35%
Axial Bone	17	29.31 %

DISCUSSION

Radionuclide imaging provides both functional as well as anatomical information (3). Numerous studies have confirmed that it is considerably more sensitive than conventional radiography for detecting skeletal abnormalities. It is valuable in the diagnosis of inflammatory conditions, trauma, vascular insult, occult bone pain and malignant diseases (9). The application of radionuclide skeletal survey in the management of malignant diseases in children consists of detecting and estimating the degree of tumour spread (10).

After introduction of Technetium-99m labeled (^{99m}Tc) polyphosphonate compounds like methylene diphosphonate (MDP), bone scan has become a practical investigation in children. The biodistribution of MDP in children is different to adults with higher activity in the growth plates. ^{99m}Tc MDP has rapid clearance from blood and soft tissue and high affinity for bone with fast uptake. Accumulation of ^{99m}Tc MDP in bone relate to the amount of blood flow to the region, but uptake is primarily controlled by the amount of osteogenic activity, being much higher in areas of active bone formation or repair compared to mature bone. Decreased activity is seen in areas of reduced blood flow or infarction. Diminished uptake or cold areas are also seen in regions of very aggressive metastases, which are associated with severe destruction. The positive scan indicates presence of pathology but does not indicate the etiology of the lesion. Clinical presentation plays a major role in drawing inference of bone scan findings by narrowing the spectrum of differential diagnosis. Bone scan has the advantage of whole body imaging with single injection and scans become positive many days before radiographic changes. The early localization helps to focus on lesion for further investigations with CT or MRI (11).

This study shows that 91 bone scans were performed in the paediatric patients having known malignancy and specially bone tumour. The most common clinical indications of paediatric bone scan were osteosarcoma in 30 (32.96%) cases and Ewing's sarcoma in 25 (27.47%) cases. Bone tumour comprises 7.3% of all malignancies

among paediatric patients with almost 90% cases with osteosarcoma was reported by Jabeen S et al. This study also accords with Mirabello study, where osteosarcoma was reported predominantly in adolescent and young adults and accounts for 5% of childhood tumours (12, 13). In the workup of childhood malignancies like osteosarcoma, Ewing's sarcoma, neuroblastoma and rhabdomyosarcoma, bone scan is recommended to evaluate the primary lesion, to indentify metastatic involvement and to find out multifocal diseases. Bone scan is also recommended for pre-therapy survey and sometimes to evaluate the response of therapy (14, 15, 16). In this study, primary bone lesion was evident in 41 cases; four cases had primary tumour associated with metastases. One case with Ewing's sarcoma showed response of therapy in the follow up bone scan comparing to the previous bone scan after chemotherapy.

Bone scan is the investigation next to radiography for the osteomyelitis, septic arthritis and trauma. It is recommended when the radiological evaluations are negative. The sensitivity of three phase bone scan is 95% for the osteomyelitis with reported accuracy of 75 % or better and useful in differentiating osteomyelitis from cellulitis (17).

CONCLUSION

Bone scan in paediatric patients contributes a major role in detecting the cause and localizing the pathology of bone. It is a popular imaging modality for skeletal survey of paediatric patients in malignancy, both primary and metastatic bone diseases. High quality imaging, interpreted by physicians familiar with paediatric diseases, correlation with clinical records and other imaging modalities are mandatory to maximize the benefit.

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