DOI: https://doi.org/10.53350/pjmhs211571603

ORIGINAL ARTICLE

Diagnostic Accuracy of Magnetic Resonance Imaging in Predicting Malignancy in Musculoskeletal Tumors Taking Histopathology as Gold Standard

SADIA ALI[1], SABA MAQSOOD[1], SANA AKHTAR[2], NAZISH HAMEED[3], SHAIMA ABDUL GHAFFAR[4], MADEHA HUSSAIN[5]
[1] *Assistant Professor of Radiology, Avicenna Hospital and Medical College*
[2]*Assistant Consultant Radiologist, Islamabad Diagnostic Center. Evercare Lahore*
[3]*Assistant Professor Radiology, Sargodha Medical College. University of Sargodha.*
[4]*Radiologist/SMO Chughtai Medical Center*
[5]*Islam Medical and Dental College, Sialkot*
Correspondence to Dr Sadia Ali, Email:sadiaimran1682@gmail.com, Cell: 0331-4342238

ABSTRACT

Background: Tumors of the musculoskeletal system may arise in bone or soft tissues including muscle and cartilage. Because of experimental chemotherapeutic medications and regimens, as well as improvements in imaging and surgical methods, the prognosis of patients with musculoskeletal tumors has increased dramatically.
Aim: To determine the diagnostic accuracy of magnetic resonance imaging in detection of musculoskeletal tumor taking histopathology as gold standard
Study Design: It was cross sectional study
Setting: Department of Radiology, Mayo Hospital, Lahore
Duration: six months i.e. July 2020 to Dec 2020.
Methods: After meeting the inclusion criteria 135 cases were enrolled. Informed consent and demographic information was taken from all the patients. All malignancies were confirmed by surgical histology. MRI was performed routinely on 1.5 Tesla and 3 Tesla. Patients were considered as the confirmed cases of tumors on MRI and histopathology as per operational definition. All the collected data was analyzed on SPSS vr 21.
Results: In this study the mean age of the patients was 42.59±10.16 years, male to female ratio of the patients was 0.68:1. The mean value of duration of disease of the patients was 2.95±1.42 months. The sensitivity, specificity, and diagnostic accuracy of MRI for detecting musculoskeletal tumors was 89.23%, 88.57%, & 88.89% respectively taking histopathology as gold standard.
Conclusion: This finding concluded that the magnetic resonance imaging is very useful and reliable technique in detection of musculoskeletal tumor with high diagnostic accuracy
Keywords: Magnetic Resonance Imaging, Musculoskeletal Tumor, Histopathology

INTRODUCTION

Tumors of the musculoskeletal system may develop in the bone or soft tissues including muscle and cartilage. Sarcomas are cancerous tumors that grow in the bone. The occurrence of pathologic fractures is a significant concern for bone tumors, despite the fact that musculoskeletal system tumors are rare[1].When a tumor is found in an extremity, complete tumor resection is always needed, which can be accomplished by limb salvage procedures or amputation[2].

Osteosarcoma is the most prevalent malignant bone tumor, with a 4.4 per 1,000,000 occurrence rate. The median age of onset is in the second decade of adulthood, with an older adult's peak becoming lower. Ewing sarcoma is the second most frequent malignant bone tumor, with a 2.9 per 1,000,000 occurrence rate, and it may also affect soft tissues. Pressure and swelling of a bone or joint are typical symptoms of bone tumors. In engaged teens, symptoms are often due to athletic accidents. Night pain, fever, and weight loss that persist after several weeks of cautious treatment should alert the clinician of a more severe underlying cause and warrant further investigation[3,4]. Because of its outstanding soft tissue contrast, susceptibility to bone marrow and soft tissue edema, and multiple imaging planes, MRI has become the gold standard for musculoskeletal tumor assessment. Although some cancers have no distinct signal characteristics, MRI may include a diagnostic or a brief differential diagnosis in a significant subset of cases. MRI of musculoskeletal cancers may be difficult since the MRI presentation of such lesions can be deceiving, and understanding whether MRI overestimates and underestimates the malignancy of lesions is indispensable[5].

As newer pulse sequences appear, the role of MRI in the evaluation of musculoskeletal tumors continues to grow. One of the very important role of MRI is to determine the quantity or size of the musculoskeletal tumor before undergoing any intervention or surgery, to make sure that the recovery would be effective and prognosis would be better. Conventional MRI sequencing is mostly appropriate to determine the maximum degree of the musculoskeletal tumor, its association with the nearby neuro-vascular bundles, and the adjacent joints for this purpose[6].On the other hand, MRI can be applied to detect, describe, and estimate the extent of tumor after the surgery. Chemical shift MRI, diffusion-weighted MRI, perfusion imaging, and magnetic resonance spectroscopy are advanced modalities and have significant the role in the detection of malignant tumors and estimating the lesion during excision[7].

Received on 08-02-2021
Accepted on 28-06-2021

With an annual prevalence of 4.5 cases per million population, rhabdomyosarcomas account for more than half of all soft tissue sarcomas in children. Rhabdomyosarcomas may appear anywhere, but the way they look depends on where they started. Orbital Rhabdomyosarcomas, for example, may cause proptosis, bladder, or prostate cancer[8]. The rationale of the study is to determine the accuracy of MRI. Pakistan is a developing country, and resources for diagnosis of musculoskeletal tumors are scarce.So there is a need to perform less expensive diagnostic tests to reduce the cost for diagnosis and treatment.

So, this study was conducted to check the findings of MRI for the diagnosis of malignancy in patients with musculoskeletal tumors.

MATERIAL AND METHOD

After approval from Ethical Committee this cross sectional study was conducted in the Department of Radiology, Mayo Hospital, Lahore from July 2020 to Dec 2020. Sample size of 132 cases was estimated by keeping confidence level at 95%, percentage of musculoskeletal lesions as 79.3%[2] with 7% margin of error. Sampling technique used was non - probability consecutive sampling.

Inclusion Criteria: Patients of age 20-60 years, both genders with suspicion of musculoskeletal tumor (prolonged fever, body pain, and edema)

Exclusion Criteria: Patients taking chemotherapy for any type of lesions, liver cirrhosis, undergone orthopedic surgery, unconscious patients

Data Collection Procedure: Total 132 cases were enrolled after taking the informed written consent. All the patients referred to radiology department from other Hospitals, underwent contrast induced magnetic resonance imaging. MRI was done by using 1.5 and 3 Tesla. It was taken as malignant if there is intermediate signal intensity on T1 weighted images compared to skeletal muscle and high signal intensity on T2 weighted images with early rapidly progressive and peripheral enhancement. Then all patients, later on, were underwent surgery for confirmation of malignancy. Tumor cells show enlarged nuclear size (with large nuclear / cytoplasmic ratio), dissimilarity in the cell or nuclear size (pleo-morphism), lack of differentiation, high nuclear DNA contents with subsequent dark stain obtained on the H & E slides. Patients were confirmed as the cases of tumors on MRI & histopathology. Data was collected in the proforma.

Data Analysis: Data was entered & analyzed in SPSS v.21. 2x2 table was developed to calculate the "sensitivity, specificity, positive & negative predictive values and overall diagnostic accuracy" of the MRI.

RESULTS

The mean age of the patients, involved in this study was 42.59±10.16 years. In this study 55(40.74%) patients were males while 80(59.26%) patients were females. The male - to - female ratio was noted as 1 : 1.5. The mean value of duration of disease of the patients was 2.95±1.42 months. Out of 135 patients, there were 65(48.1%) patients were diagnosed positive with musculoskeletal tumor by MRI. Out of 135 patients, there were 66(48.89%) patients were diagnosed positive with musculoskeletal tumor by histopathology (Table 1).

According to this study the sensitivity, specificity, PPV, NPV and diagnostic accuracy of MRI for detecting musculoskeletal tumors was 89.23%, 88.57%, 87.88%, 89.86% & 88.89% respectively taking histopathology as gold standard (Table 2).

Table 1: Baseline characteristics of patients

N	132
Age (years)	42.59 ± 10.16
Gender	
Male	55 (40.74%)
Female	80 (59.26%)
Duration (Months)	2.95 ± 1.42
Musculoskeletal carcinoma on MRI	
Positive	65 (48.1%)
Negative	70 (51.9%)
Musculoskeletal carcinoma on histopathology	
Positive	66 (48.9%)

Table 2: Accuracy of MRI for detection of musculoskeletal tumors taking histopathology as gold standard

Histopathology	MRI		Total
	Positive	Negative	
Positive	58	8	66
Negative	7	62	69
Total	65	70	135

Sensitivity 89.23%, Specificity 88.57%, PPV87.88%, NPV 89.86% and diagnostic Accuracy 88.89%

DISCUSSION

Malignant musculoskeletal tumors are estimated to account for 5.1 to 15.5% of all sarcomas[9]. As newer pulse sequences appear, the role of MRI in the evaluation of musculoskeletal tumors continues to grow. It is important to access the size of tumor before undergoing surgery and MRI play important role in determining the size of the lesion before undergoing the surgery to ensure effective recovery preparation. MRI may also be used to diagnose, characterize, and evaluate a tumor after it has been treated (both; after neoadjuvant therapy before surgery to assess the therapeutic response and after the surgery to assess the post-surgical residual or recurrence of the disease)[10].

In our study the sensitivity, specificity, positive & negative predictive values and overall diagnostic accuracy of MRI for detecting musculoskeletal tumors was 89.23%, 88.57%, 87.88%, 89.86% & 88.89% respectively taking histopathology as gold standard. A study by Daniel, et al.,[11] resulted in their study that the sensitivity of an MRI in predicting musculoskeletal system malignancy was 95%, and the precision was 84%. In their study, they stated that the MRI is helpful in forming a properly organized differential diagnosis on the basis of occurrence of the tumor, age of the patient, and anatomical position of tumor. The systematic approach significantly raises the diagnostic results.

Primary musculoskeletal tumors appear as a heterogeneous group of entities with varying signal intensity characteristics on T1-weighted and fluid-sensitive images[11].The T1 and T2 stimulating properties of tumors are not consistently unaffected because they are representative of changes in the tumor microenvironment due to several

interacting factors present in a developing tumor, such as changes in water content due to necrosis and hemorrhage or myxoid transfer, or changes in tumor oxygenation. As a result, therapy should predict improvements in T1 and T2 relaxation times in the tumor compared to pretreatment stages[12]. Furthermore, differences in critical tumor histologic characteristics influence the appearance of musculoskeletal tumors on T1- and T2-weighted images.

According to a report, the sensitivity and specificity for malignancy were 90% and 91%, respectively, based on a cut-off value for mean ADC of 1.03 x 10^3 mm^2/sec[13].

MRI is said to be the best imaging tool for assessing a soft-tissue mass or the degree of soft-tissue or bone-marrow involvement by a bone tumor. MRI allows doctors to see the depth, scale, and local extent of tumors. The use of MRI to characterize the pathologic presence of musculoskeletal masses and differentiate between benign and malignant lesions has been debatable in the literature. A wide range of MRI sensitivity values for distinguishing benign from malignant musculoskeletal lesions has been reported in the literature[14].

According to a report, the sensitivity and specificity for malignancy were 90% and 91%, respectively, based on a cut-off value for mean ADC of 1.03 x 10^3 mm^2/sec[13].MRI of the primary had a sensitivity of 84% (95% CI; 72–92) and a specificity of 82% (95% CI; 71–89) in another analysis[15]. Prospective studies done by Ma et al., during1995,[16] Berquist et al., during1990[17] and Moulton et al., during 1995,[18] respectively, showed that the sensitivity rate was 100%, 94% and 78%, respectively, while the specificity rate was 17%, 90% and 89%, respectively for prediction of the musculoskeletal malignancy. The highest rate of100% sensitivity was observed by Ma et al. But same study showed very low specificity i.e.17%. This value was affected by the rough threshold of parameters, which differentiated the malignant and benign lesions, escaping all the false negative cases. In such cases, the supplementary importance of the MRI was debatable to distinguish the malignant from benign musculoskeletal lesions.

In patients, presenting with the soft tissues lesions, Gielen et al. done a prospective cohort study to assess the anti - MR parameter. It showed the sensitivity of 93%, specificity as 82%, negative predictive value as 98%, while positive predictive value as 60%, while the overall accuracy rate was 85% to distinguish the benign and malignant musculoskeletal lesions[19].

Baweja et al., found that MRI is the recommended imaging modality for musculoskeletal tumors and that it should be collected after radiographic examination. With high contrast resolution, its multiplanar imaging capability aids in the delineation of tumors and their extent in bone and soft tissues. It's a great way to figure out whether there's a neurovascular packet involved, whether there's a joint involved, what the local magnitude is, and how to stage it.[14]
Another research by Bhuyan and Bhuyan found that the specificity for an MRI diagnosis of a bone and soft tissue tumor was 100%, and the accuracy was 98%. The detection of benignity and malignancy has a 94.7% specificity. It is beneficial to create a differential diagnosis that is appropriately organized based on tumor occurrence and age[20].

In our study by applying stratification by gender we find these findings. In male patients the sensitivity, specificity and diagnostic accuracy of MRI for musculoskeletal tumors was 96.15%, 89.66% & 92.73% respectively taking histopathology as gold standard. Similarly in female patients the sensitivity, specificity and diagnostic accuracy of MRI for musculoskeletal tumors was 84.62%, 87.8% & 86.25% respectively taking histopathology as gold standard.

CONCLUSION

This study finding concluded that the magnetic resonance imaging is very useful and reliable technique in detection of musculoskeletal tumor with high diagnostic accuracy.
Conflict of interest: Nil

REFRENCES

1. Campanacci M. Bone and soft tissue tumors: Springer; 2013.
2. Bergovec M, Kubat O, Smerdelj M, Seiwerth S, Bonevski A, Orlic D. Epidemiology of musculoskeletal tumors in a national referral orthopedic department. A study of 3482 cases. Cancer epidemiology 2015;39(3):298-302.
3. Mirabello L, Troisi RJ, Savage SA. Osteosarcoma incidence and survival rates from 1973 to 2004: data from the Surveillance, Epidemiology, and End Results Program. Cancer: Interdisciplinary International Journal of the American Cancer Society 2009;115(7):1531-43.
4. Esiashvili N, Goodman M, Marcus RB. Changes in incidence and survival of Ewing sarcoma patients over the past 3 decades: Surveillance Epidemiology and End Results data. Journal of pediatric hematology/oncology 2008;30(6):425-30.
5. Ma LD. Magnetic resonance imaging of musculoskeletal tumors: skeletal and soft tissue masses. Current problems in diagnostic radiology 1999;28(2):33-62.
6. Beddy P, Moyle P, Kataoka M, Yamamoto AK, Joubert I, Lomas D, et al. Evaluation of depth of myometrial invasion and overall staging in endometrial cancer: comparison of diffusion-weighted and dynamic contrast-enhanced MR imaging. Radiology 2012;262(2):530-7.
7. Rauscher I, Eiber M, Fürst S, Souvatzoglou M, Nekolla SG, Ziegler SI, et al. PET/MR imaging in the detection and characterization of pulmonary lesions: technical and diagnostic evaluation in comparison to PET/CT. Journal of Nuclear Medicine 2014;55(5):724-9.
8. Arndt CA, Crist WM. Common musculoskeletal tumors of childhood and adolescence. New England Journal of Medicine 1999;341(5):342-52.
9. Toro JR, Travis LB, Wu HJ, Zhu K, Fletcher CD, Devesa SS. Incidence patterns of soft tissue sarcomas, regardless of primary site, in the surveillance, epidemiology and end results program, 1978–2001: an analysis of 26,758 cases. International Journal of Cancer 2006;119(12):2922-30.
10. Fayad LM, Jacobs MA, Wang X, Carrino JA, Bluemke DA. Musculoskeletal tumors: how to use anatomic, functional, and metabolic MR techniques. Radiology 2012;265(2):340-56.
11. Daniel A, Ullah E, Wahab S, Kumar V. Relevance of MRI in prediction of malignancy of musculoskeletal system-A prospective evaluation. BMC musculoskeletal disorders 2009;10(1):125.
12. Ellingson BM. Radiogenomics and imaging phenotypes in glioblastoma: novel observations and correlation with molecular characteristics. Current neurology and neuroscience reports 2015;15(1):506.
13. Neubauer H, Evangelista L, Hassold N, Winkler B, Schlegel PG, Köstler H, et al. Diffusion-weighted MRI for detection and differentiation of musculoskeletal tumorous and tumor-like lesions in pediatric patients. World Journal of Pediatrics 2012;8(4):342-9.
14. Baweja S, Arora R, Singh S, Sharma A, Narang P, Ghuman S, et al. Evaluation of bone tumors with magnetic resonance

imaging and correlation with surgical and gross pathological findings. Indian Journal of Radiology and Imaging 2006;16(4):611.
15. van der Hoorn A, van Laar PJ, Holtman GA, Westerlaan HE. Diagnostic accuracy of magnetic resonance imaging techniques for treatment response evaluation in patients with head and neck tumors, a systematic review and meta-analysis. PloS one 2017;12(5):e0177986.
16. Ma LD, Frassica FJ, Scott Jr WW, Fishman EK, Zerbouni E. Differentiation of benign and malignant musculoskeletal tumors: potential pitfalls with MR imaging. Radiographics 1995;15(2):349-66.
17. Berquist TH, Ehman RL, King BF, Hodgman C, Ilstrup D. Value of MR imaging in differentiating benign from malignant soft-tissue masses: study of 95 lesions. AJR American journal of roentgenology 1990;155(6):1251-5.
18. Moulton J, Blebea J, Dunco D, Braley S, Bisset 3rd G, Emery K. MR imaging of soft-tissue masses: diagnostic efficacy and value of distinguishing between benign and malignant lesions. AJR American journal of roentgenology 1995;164(5):1191-9.
19. Gielen JL, De Schepper AM, Vanhoenacker F, Parizel PM, Wang XL, Sciot R, et al. Accuracy of MRI in characterization of soft tissue tumors and tumor-like lesions. A prospective study in 548 patients. European radiology 2004;14(12):2320-30.
20. Mary Hazarika Bhuyan, Bhuyan R K. How accurate is MRI in prediction of musculoskeletal tumors -A prospective evaluation. International Journal of Biomedical Research 2015;6(12):942-6.