Original Research Paper

Volume - 12 | Issue - 02 | February - 2022 | PRINT ISSN No. 2249 - 555X | DOI : 10.36106/ijar

Radiology

TYPES OF PERIOSTEAL REACTIONS ON RADIOGRAPHY IN CHARACTERIZATION OF OSSEOUS NEOPLASMS

Dr. Nagaraj Biradar Consultant Radiologist Department of Radiodiagnosis Jindal Sanjeevani Multispeciality Hospital, Toranagallu, Ballari.

Dr. Vivek Jirankali* Consultant Radiologist Department of Radiodiagnosis Jindal Sanjeevani Multispeciality Hospital, Toranagallu, Ballari. Karnataka, India. *Corresponding Author

Dr. Brahmdeep Singh Wadhawan Consultant Radiologist, Department of Radiodiagnosis, Tera Hi Tera Mission Hospital, Chandigarh.

ABSTRACT

OBJECTIVE: To assess the utility of types of periosteal reactions on radiography in distinguishing between nonaggressive (usually benign) and aggressive (usually malignant) osseous neoplasms.

MATERIALS AND METHODS: Current study is a retrospective study. Review of X-rays of 52 bone lesions were done. Type of periosteal reaction was assessed in radiograph of each bone lesion and was categorised as either non-aggressive or aggressive with further subcategorization into further types. Type of periosteal reaction (Aggressive v/s Nonaggressive) was correlated with histopathological diagnosis.

RESULTS: Of 52 osseous lesions, there were 22 benign bone lesions and 30 malignant bone lesions. 17 of 22 (77%) benign osseous lesions showed Nonaggressive periosteal reaction and 1 of 22 (5%) showed aggressive periosteal reaction. 4 of 22 (18%) benign osseous lesions did not show any periosteal reaction. 28 of 30 (93%) malignant lesions showed aggressive periosteal reaction and 2 of 30 (7%) malignant osseous lesions showed nonaggressive periosteal reaction.

CONCLUSIONS: Types of periosteal reactions (Aggressive and Nonaggressive) correlate with risk of malignancy. Lesions with nonaggressive type of periosteal reaction are usually benign and lesions with aggressive type of periosteal reaction are usually malignant.

KEYWORDS : Periosteal reaction, Aggressive, Nonaggressive.

INTRODUCTION

Periosteum is a fibrous membrane covering the bone except for few of the surfaces. It is composed of two layers – outer fibrous layer and inner cambium layer. It is an essential component of the growth of the bones. Periosteal reaction is the result of reaction of cortical bone to any of the insults. Periosteal reaction can result from infection, trauma, neoplasms, drugs and some rheumatological conditions. There are various kinds and patterns of periosteal reactions. One of the commonly used classification system of periosteal reactions is published by American Journal of Roentgenology.[1] This classification system mainly classifies the periosteal reaction into aggressive and non-aggressive types under which there are few subtypes (Table 1).

Periosteal reactions can be evaluated by radiography, CT scan and MRI and sometimes by Ultrasonography, although radiography is most commonly used and CT scan is the best modality for evaluation of periosteal reaction.[2]

MRI capability of assessing periosteal reactions is underestimated. Even though periosteal reaction is not specific for a particular disease process, it aids in the characterisation of the bone lesions and helps in arriving at a differential diagnosis/diagnosis.[3] Generally, fast processes cause aggressive periosteal reaction and slow/indolent processes cause nonaggressive periosteal reaction. Current study evaluates the utility of type of periosteal reactions in characterisation of osseous neoplasm and in differentiating nonaggressive (usually benign) and aggressive (usually malignant) osseous neoplasms.

MATERIALS AND METHODS

The study was a retrospective observational study. Retrospective review of radiographs of 52 patients with proven osseous neoplasms was done. The study was conducted in the department of Radiology, Jindal Sanjeevani Multi-speciality Hospital, Toranagallu, Karnataka from August 2019 to September 2021. Institutional ethics committee approval was taken. Informed consent was not required, keeping in requirements with retrospective study. Radiographic diagnosis was correlated with final histopathological diagnosis. Statistical analysis was done using "IBM SPSS statistics" (Version 16.0) and analysis was done using chi-square tests.

Table 1: Types of Periosteal reactions

Nonaggressive	Aggressive
Thin	Laminated
Solid	Spiculated: a) Perpendicular/Hair-on-end b) Sunburst
Thick irregular	Disorganised
Septated	Codman triangle

Source: AJR 2009; 193:259–72

Table 2: Benign lesions included in the study.

Benign Tumours	No of tumours
Giant cell tumour	6
Chondroblastoma	3
Benign Spindle tumour	1
Fibrous cortical defect	1
Fibrous dysplasia	2
Non-ossifying fibroma	2
Aneurysmal Bone cyst	2
Enchondroma	2
Osteofibrous dysplasia	1
Simple bone cyst	1
Osteochondroma	1
Total	22

Table 3: Malignant lesions included in the study.

Malignant Tumours	No of tumours
Osteosarcoma	16
Ewing Sarcoma	8
Epithelioid hemangioendothelioma of bone	1
Sarcoma NOS	1
Adamantinoma	1
Chondrosarcoma	2
Metastases	2
Total	30

Table 4: Lesions showing nonaggressive periosteal reactions.

	Non-aggressive			
Diagnosis	Thin	Solid	Thick Irregular	Septated
Benign	5 (83)	2 (100)	9 (90)	1(100)
Malignant	1 (17)	0 (0)	1 (10)	0 (0)

Table 5: Lesions showing aggressive periosteal reactions and no periosteal reaction.

	Aggressive					
Diagnosis	Laminated	Hair-on-end	Sunburst	Disorganised	Codman triangle	None
Benign	0(0)	0 (0)	0 (0)	1 (11)	0(0)	4(100)
Malignant	5(100)	2 (100)	12 (100)	8 (89)	1 (100)	0(0)

IMAGES

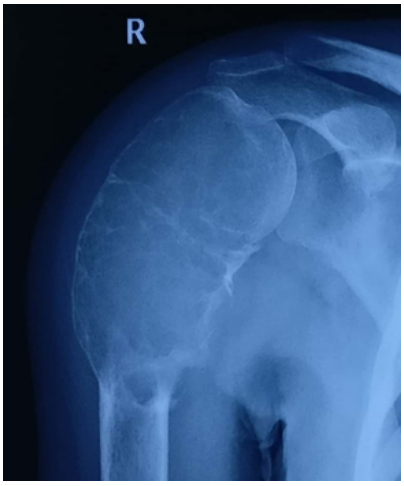

Figure 1. Thin type of Nonaggressive periosteal reaction involving proximal humerus in a 27-year-old woman. Final diagnosis was Giant cell tumor.

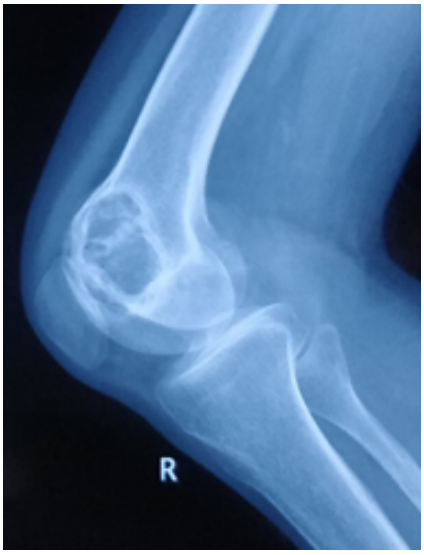

Figure 2. Solid type of Nonaggressive periosteal reaction involving distal tibia in a 19-year-old male adolescent. Final diagnosis was Chondroblastoma.

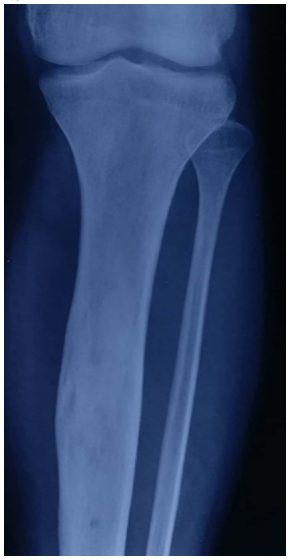

Figure 3. Laminated type of aggressive periosteal reaction involving diaphysis (mid-part) of tibia in a 17-year-old adolescent male. Final diagnosis was Ewing's sarcoma.

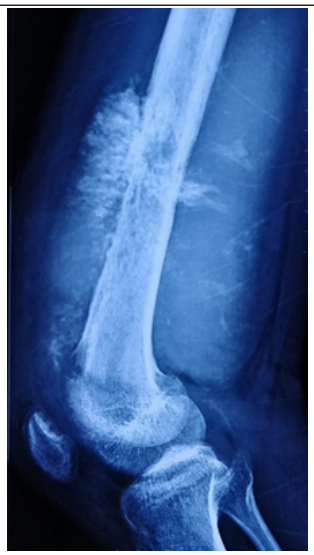

Figure 4. Sunburst type of aggressive periosteal reaction involving mid-distal femur in a 16-year-old adolescent male. Final diagnosis was Osteosarcoma.

RESULTS

Mean age of the participants in the study was 23 years. There were 15 (29%) females and 37 (71%) males in the current study. On final diagnosis by histopathological examination, 22 (42%) were benign osseous neoplasms and 30 (58%) were malignant osseous neoplasms (Tables 2, 3). Giant cell tumour was the most common benign osseous neoplasm and Osteosarcoma was the most common malignant osseous neoplasm found in our study.

17 of 22 (77%) benign osseous lesions (Table 2) showed Nonaggressive periosteal reaction and 1 of 22 (5%) showed aggressive periosteal reaction. 4 of 22 (18%) benign osseous lesions did not show any periosteal reaction. In the category of Nonaggressive periosteal reactions in benign lesions, 5 lesions showed thin periosteal reaction, 2 lesions showed solid periosteal reaction, 9 lesions showed thick irregular periosteal reaction and 1 lesion showed septated periosteal reaction. 2 benign lesions showed disorganised type of aggressive periosteal reaction.

28 of 30 (93%) malignant osseous lesions showed aggressive periosteal reaction and 2 of 30 (7%) malignant lesions showed nonaggressive periosteal reaction. In the category of Aggressive periosteal reactions in malignant lesions, 12 lesions had sunburst periosteal reaction, 7 lesions had disorganised periosteal reaction, 5 lesions had laminated periosteal reaction, 2 lesions had Hair-on-end periosteal reaction and 1 lesion had Codman triangle. One malignant lesion showed thin type of nonaggressive periosteal reaction and one malignant lesion showed thick irregular type of nonaggressive periosteal reaction. Most benign osseous lesions showed nonaggressive periosteal reaction (Table 4) and most malignant osseous lesions showed aggressive periosteal reaction (Table 5) and the association was statistically significant (p value < 0.05).

DISCUSSION

Periosteum is a thin membrane covering almost all the bones. Periosteal reaction is a nonspecific finding seen on x-rays. Periosteal reaction is the one in which periosteum forms new bone in response to any insult. It can result from infection, trauma, neoplasms, drugs and some rheumatological conditions.[4,5] Periosteal reactions are commonly evaluated on radiography, though can be evaluated on CT and MRI scans and sometimes by Ultrasonography.

There are several types/patterns of periosteal reactions. Broad categories/types of periosteal reactions include aggressive and nonaggressive types.[6] Various subtypes of periosteal reactions are included under aggressive and nonaggressive periosteal reactions. The classification system employed in the current study was published in the residents section of American Journal of Roentgenology. Nonaggressive type includes following subtypes of periosteal reactions – Thin, Solid, Thick irregular, Septated. Aggressive type includes following subtypes of periosteal reactions - Laminated (onionskin), Spiculated, Perpendicular/hair-on-end, Sunburst, Disorganized and Codman triangle.

Nonaggressive periosteal reactions are slow with adequate time for the response and hence the response is organized. Aggressive periosteal reactions are the result of rapid bone formation/deposition – usually seen in malignant osseous lesions and severe infections.[7] All osseous neoplasms lead to periosteal reaction except for four neoplasms – Fibrous dysplasia, Enchondroma, Nonossifying fibroma and Simple bone cyst which do not show periosteal reaction unless there is an underlying fracture.[8]

Thin type of periosteal reaction (Figure 1) is 1-2 mm thick and is usually seen in healing fracture and Langerhans cell histiocytosis. Solid periosteal reaction (Figure 2) is a sign of being process and has unform density all through it, usually seen in osteomyelitis and Chondroblastoma. Thick irregular periosteal reaction is usually seen in chronic osteomyelitis and Hypertrophic pulmonary osteoarthropathy.

Laminated type of periosteal reaction (Figure 3) has multiple layers of new bone formed circumferentially around the cortex. It is seen in Ewing's sarcoma and osteomyelitis.[9]

In spiculated periosteal reaction, spicules of the new bone emanating from the cortex represent an aggressive process. Orientation of the spicules lead to two subtypes – Perpendicular (Hair-on-end) and Sunburst (divergent). Perpendicular subtype has parallel bone spicules which emanate perpendicular to the cortex and is commonly seen in Ewing's sarcoma and some cases of osteosarcoma. Sunburst subtype (Figure 4) has spicules in a divergent manner from the cortex and is typically seen in Osteosarcoma. In disorganized type of periosteal reaction, spicules are randomly arranged and is commonly seen in Osteosarcoma and some malignant lesions. In Codman triangle type of periosteal reaction, a part of periosteum is elevated by hemorrhage, tumour or pus and is seen in Osteomyelitis and Osteosarcoma.[10]

In the current study, most malignant osseous lesions demonstrated aggressive periosteal reaction and most benign lesions demonstrated nonaggressive periosteal reaction and correlates with final histopathological diagnosis. Therefore, identifying the type of periosteal reaction gives a clue regarding the aggressiveness of the lesion and therefore helps partly in differentiating benign and malignant osseous lesions. Lodwick method/Modified Lodwick-Madewell grading system is commonly used to assess tumour margins and correlate with biological activity of the osseous neoplasms. Along with the above-mentioned classification system, determining the type of periosteal reaction helps to further characterize the osseous neoplasm and narrow the differential diagnosis.

CONCLUSIONS

Types of periosteal reactions (Aggressive and Nonaggressive) correlate with risk of malignancy. Lesions with nonaggressive type of periosteal reaction are usually benign and lesions with aggressive type of periosteal reaction are usually malignant, although there is a significant overlap in the disease processes that cause aggressive and nonaggressive types.

Declaration of Conflicting Interests

The authors declare that there are no potential conflicts of interests.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article

REFERENCES

1. Rana RS, Wu JS, Eisenberg RL. Periosteal reaction. American Journal of Roentgenology. 2009 Oct;193(4):W259-72.
2. Alencar CH, Silveira CR, Cavalcante MM, Vieira CG, Teixeira MJ, Neto FA, de Abreu A, Chhabra A. Periosteum: An imaging review. European Journal of Radiology Open. 2020 Jan 1;7:100249.
3. Nogueira-Barbosa MH, Sá JL, Trad CS, Oliveira RC, Elias Júnior J, Engel EE, Simão MN, Muglia VF. Magnetic resonance imaging in the evaluation of periosteal reactions. Radiologia Brasileira. 2010;43:266-71.
4. Ragsdale BD, Madewell JE, Sweet DE. Radiologic and pathologic analysis of solitary bone lesions. Part II: periosteal reactions. Radiologic Clinics of North America 1981;19:749–83.
5. Wenaden AE, Szyszko TA, Saifuddin A. Imaging of periosteal reactions associated with focal lesions of bone. Clinical Radiology 2005; 60:439–456.
6. Chen EM, Masih S, Chow K, Matcuk G, Patel D. Periosteal reaction: review of various patterns associated with specific pathology. Contemporary Diagnostic Radiology. 2012 Aug 15;35(17):1-5.
7. Resnick DM, Kransdorf MM. Bone and joint imaging, 3rd ed. Richmond, VA: Elsevier Saunders, 2005:1536.
8. Wenaden AE, Szyszko TA, Saifuddin A. Imaging of periosteal reactions associated with focal lesions of bone. Clinical radiology. 2005 Apr 1;60(4):439-56.
9. Mar W, Taljanovic S, Bagatell R, et al. Update on imaging and treatment of Ewing sarcoma family tumors: what the radiologist needs to know. Journal of Computer assisted Tomography 2008;30:108-118.
10. Gross M, Stevens K. Sunburst periosteal reaction in osteogenic sarcoma. Pediatric Radiology 2005; 35:647–648.