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Nora's lesion, a distinct radiological entity?

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Abstract *Objective:* To describe the radiological findings of "Bizarre parosteal osteochondromatous proliferation"(BPOP)—otherwise known as Nora's lesion, to describe the natural evolution of BPOP and to assess radiologically if BPOP is indeed part of a spectrum of reactive lesions including florid reactive periostitis and turret exostosis. *Design:* Four experienced musculoskeletal radiologists studied plain radiographs and other imaging documents of histologically-proven Nora's lesions, looking for soft-tissue changes, periosteal reaction/calcification and calcified/ossified pseudotumours, and compared those findings with findings on pathology reviewed by a peer group of pathologists. *Patients:* Twenty-four Nora's lesions originating from a series of 200 consecutive, histologically-verified bone (pseudo) tumours of the hand, seen by the "Netherlands Committee on Bone Tumours" for review and second opinion. *Results:* Nora's lesions have a recognised presentation on radiographs without specific MR characteristics. Natural evolution could be assessed retrospectively in four cases. Recurrent lesions were seen in seven cases and are difficult to differentiate from primary lesions. *Conclusions:* Nora's lesion, defined as a "well-marginated mass of heterotopic mineralization arising from the periosteal aspect of an intact cortex, without medullary changes" has a distinct radiological presentation and is part of a spectrum of reactive lesions which includes florid reactive periostitis and turret exostosis. As it has a distinct radiological appearance, differential diagnosis of malignant lesions such as osteosarcoma and chondrosarcoma should be clear. It does not require immediate biopsy unless the natural evolution is unspecific.

Keywords Florid reactive periostitis · Bizarre parosteal osteochondromatous proliferation · Nora's lesion · Turret exostosis

Introduction

Bizarre parosteal osteochondromatous proliferation (BPOP) was first described by Nora et al. in 1983 and since then has been referred to as Nora's lesion [1]. Notwithstanding the lesion being more frequent than commonly accepted and well known by pathologists, only a few reports about BPOP are available in radiological literature, which makes this entity virtually unknown amongst the majority of practising radiologists [2, 3]. Pathologically, BPOP is mostly seen as part of a spectrum of reactive lesions, which includes florid reactive periostitis (FRP) and turret exostosis. Our first aim is to describe the radiological hallmarks of BPOP and secondly, to describe the natural evolution and to assess if the radiological evolution of BPOP parallels the findings on pathology.

Materials and methods

The material consists of 24 histologically-proven Nora's lesions originating from a series of 200 consecutive bone (pseudo)tumours of the hand, seen by the "Netherlands Committee on Bone Tumours" for review and second opinion between 1997 and 2003. All cases were reviewed by a peer group of pathologists and by four musculoskeletal radiologists with large experience in bone tumour pathology, and a diagnosis was produced by consensus of both groups. All 24 lesions were analyzed with regard to age, sex, location and size.

Plain radiographs of all 24 cases were available, but only a small number of cases had MRI (n=6), CT (n=2), bone scintigraphy (n=2) and ultrasound (n=1). On plain radiographs lesions were categorized as soft-tissue swelling/mass, parosteal calcification or bony mass. Changes at the endosteal and periosteal aspect of the cortex and at the cortical bone itself, changes at the medullary bone and the presence of a radiolucent line (zone) between the lesion and the adjacent cortex were analysed. MR examinations were reviewed describing the signal intensity of the lesion on T1- and T2-weighted images and after intravenous contrast administration. In four cases, consecutive radiographs were available to assess the evolution of Nora-like lesions and to compare these findings with the spectrum of disease as conceived and described by pathologists. Recurrent tumours were seen in seven patients, and imaging findings were compared with those of the primary tumours.

Results

Of the 24 Nora's lesions, 15 were found in males (62.5%) and 9 in females (37.5%). The age varied between 12 and 81 years, with a mean of 38.8 and a median of 37.5. All lesions measured less than or were equal to 4 cm. Twenty-two of the lesions (92%) were situated in the phalanges, with six in the proximal, 11 in the middle and five in the distal phalanx. The remaining two lesions were located in the metacarpals (8%). The lesion was predominantly located in the diaphysis and metaphysis (75%). Sixteen (67%) lesions were located in the right hand and eight lesions (33%) in the left hand. All lesions originated from the periosteal aspect of an intact cortex of the affected bone. There were no cases with medullary bone involvement. In only two cases (8%), a lucent line between the lesion and the cortex was visible. In one case, initial presentation consisted of a soft-tissue mass (4%), and in seven cases (29%) of a soft-tissue mass containing various amounts of calcifications, from round and tiny to flame-like and extensive, whilst 16 of the lesions (67%) presented as a purely bony mass.

In four cases, consecutive radiographs were available showing the natural evolution of the lesions (Figs. 1, 2 and 3). In a first stage only, a periosteal soft-tissue swelling or mass, sometimes with tiny calcification, was evident. Later on, calcification became more prominent in two cases, and the end stage showing a completely ossified lesion, was reached in two other cases. Natural evolution is a swift process, taking a maximum of 6 months. In seven cases (29%), recurrences occurred after previous resection. In four cases, one recurrence was reported. In three cases, there were two consecutive recurrences. All recurrences were reported within a period of 6 months after (incomplete) resection. Recurrences presented as partially calcified or completely ossified lesions with less homogeneous, more irregular calcifications in comparison with the original lesion.

MRI was performed in six cases (25%). On T1-weighted images, the lesion showed an overall intermedi-

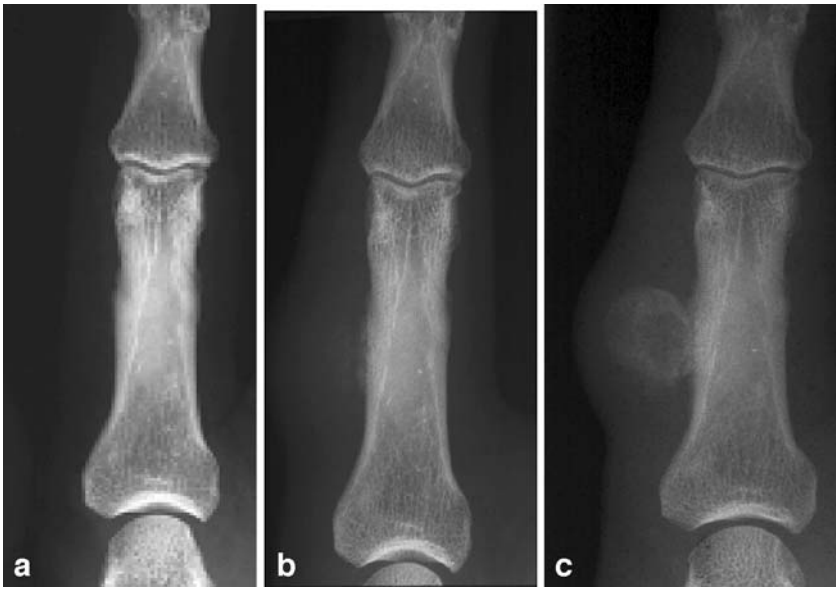

Fig. 1a–c Natural evolution of a NORA-like lesion over six weeks, from a parosteal soft tissue swelling **a** over a parosteal, flamelike calcification **b** to a matured (osteophytic) bony lesion **c**

ate signal. On T2-weighted images, a variable signal was noted, varying from intermediate (2) to high (4). In four patients, MRI after intravenous contrast administration showed marked enhancement of all lesions. A zonal phenomenon was noted in one case.

The ultrasound image (only performed in one patient) showed a calcified mass, without involvement of the underlying cortex. The CT images, performed in two patients, illustrated the unaffected underlying cortex. Bone scintigraphy in two cases revealed a focal increase in tracer uptake (Fig. 4).

Discussion

Although originally described as a lesion located in both hands and feet, BPOP also occurs in long bones in 25% of the cases [4–6]. Because our material originates from a series of 200 bone tumours of the hand, only hand lesions were included. Although described as a very uncommon lesion by Dahlin et al. [7], true prevalence of BPOP is difficult to assess because most lesions are reported as case studies and because larger, mostly histological studies suffer from retrospectivity [1, 4, 8]. The unusually high number of BPOP cases in our series does not reflect the true prevalence, as it is hampered by a twofold selection bias. Firstly, the basis of referring cases to the "Netherlands Committee on Bone Tumours" by clinicians, radiologists and pathologists is voluntary, and their referring strategy is influenced by their experience in bone tumour pathology, and secondly, there is a level of ignorance about BPOP amongst practising radiologists, who frequently include a malignant bone tumour in their differential diagnosis.

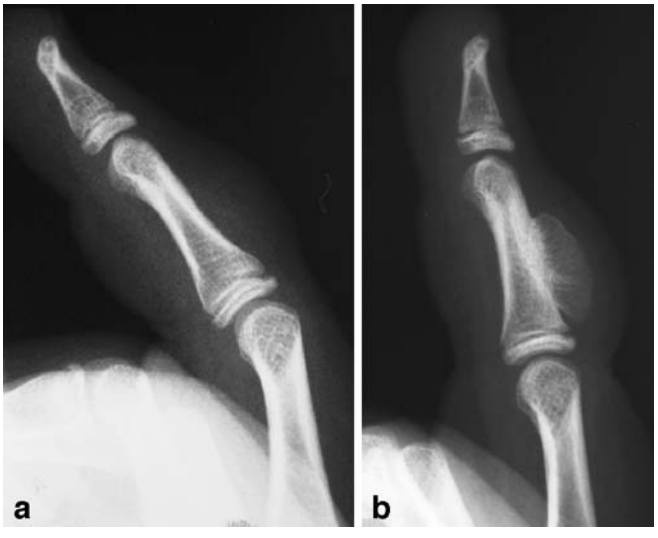

Fig. 2a,b Natural evolution of a NORA-like lesion over six months, from a non-characteristic soft tissue swelling **a** to a matured (osteophytic) bony mass **b**

The tendency of the lesions to occur in the phalanges was already reported by Nora in his original article on BPOP [1], proximal phalanges being more affected than distal ones [1, 2]. These findings are confirmed in our series, 22 lesions being located at the phalanges; nevertheless, five lesions occurred at the distal phalanges. In our series, males were more frequently affected than females (15/24). The range and peak in our series was in accordance with earlier reported series [4]. Sixty-seven percent of the lesions were located in the right hand. Because most people are right-handed (84.4% of men, 90.1% of women) and more traumatic events happen to the right hand, this favours a possible traumatic etiology of BPOP. Unfortunately, the data on medical history were not sufficient enough to confirm this hypothesis.

Taking into account the data in the literature [1, 4, 8] and our own findings, a Nora's lesion can be defined as a "well-marginated mass of heterotopic mineralization arising from the periosteal aspect of an intact cortex, without medullary changes". Nora's lesions have a non-specific presentation on MRI, which is in accordance with findings of Torreggiani et al. [2]. Cases with associated intramedullary inflammatory extension, as reported by Oui et al., were not found in our series [9]. There are no reports on ultrasound and CT scan in Nora's lesion, and the low number of these examinations in our series doesn't allow any conclusion to be drawn.

Dorfman described a spectrum of reactive lesions [10] (Fig. 5) of which the first stage is known as florid reactive periostitis and pathologically consists of spindle cells with minimal osteocartilaginous proliferation (Fig. 5). Later, new bone and metaplastic cartilage become more prominent (= BPOP) (Fig. 5). Finally, the focus of ossification matures and a bony base is formed with a cartilage cap (= acquired osteochondroma or turret exostosis) (Fig. 5). When located subungually, it's called a subungual exostosis.

Natural evolution of Nora's lesions through the spectrum described above is difficult to ascertain, because lesions are frequently biopsied or resected at the BPOP stage, interrupting the evolutionary process. Histology by biopsy also reflects only a moment during evolution, and lesions are rarely imaged in the first stage when they consist of a para-periosteal soft-tissue swelling. If radiographs are performed, these subtle lesions are difficult to ascertain and frequently overlooked. The four cases in this study with follow-up radiographs enabled us to assess retrospectively the imaging features at the first stage, i.e. at that of a possible FRP, and we were able to illustrate the hypothetical spectrum of evolution as proposed by the pathologists [3, 4, 11], from periosteal thickening over a calcified periosteal mass lesion to a more sessile bone formation (exostosis), nicely paralleling the scheme as proposed by Dorfman [10]. In this regard we saw four lesions in the first stage, seven lesions in the second and 23 in the third stage of disease, the total number exceeding the

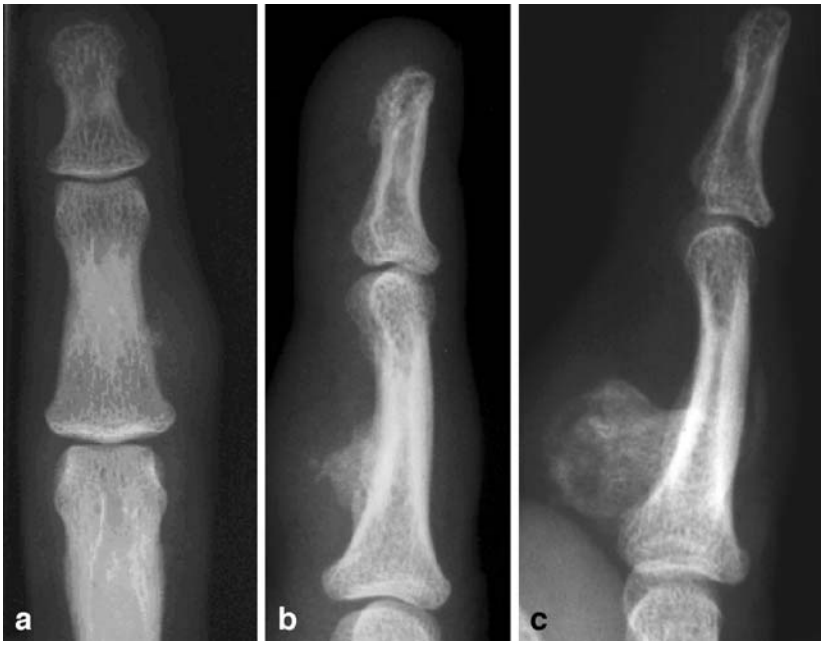

Fig. 3a–c Natural evolution of a NORA-like lesion over seven months, from a subtle parosteal calcified focus within an area of soft tissue swelling **a** to a flamelike parosteal calcification **b**. After surgical resection, there was a quick recurrence, consisting of a mushroomlike, ossified mass adjacent to the intact cortex **c**

number of patients because different stage images were available in some patients (Fig. 6).

Reported recurrency rates are between 35 and 54% at a 2-year interval [12]. In our series, recurrency after resection was noted in 29% of the cases. Differential diagnosis includes both benign and malignant conditions involving the periosteum, including juxtacortical chondroma, periosteal/parosteal chondrosarcoma and osteosarcoma [4, 8].

Conclusion

Our study confirms the radiological appearances of Nora's lesion, and demonstrates that these lesions have a spectrum of reactive changes which includes florid reactive periostitis and turret exostosis, as postulated by pathologists. Since Nora's lesion has a distinct appearance on radiography, the differential diagnosis of malignant lesions such as osteosarcoma and chondrosarcoma should be clear. Finally, Nora's lesion does not require immediate biopsy but a control examination after 6 months, except when the natural evolution is unclear, when biopsy may be considered as a next step.

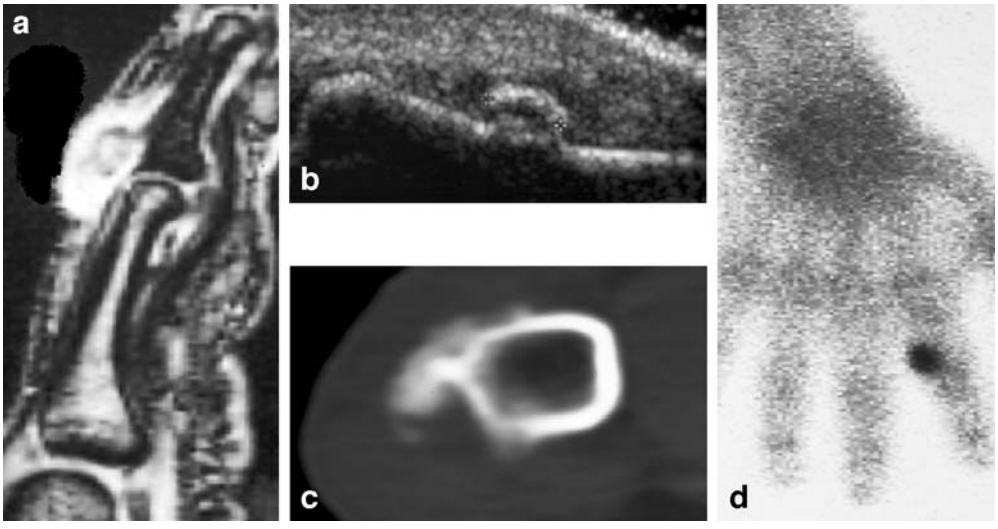

Fig. 4a–d NORA-like lesions on MRI, T2-weightes image **a**, Ultrasonography **b**, CT scan **c** and Scintigraphy **d**

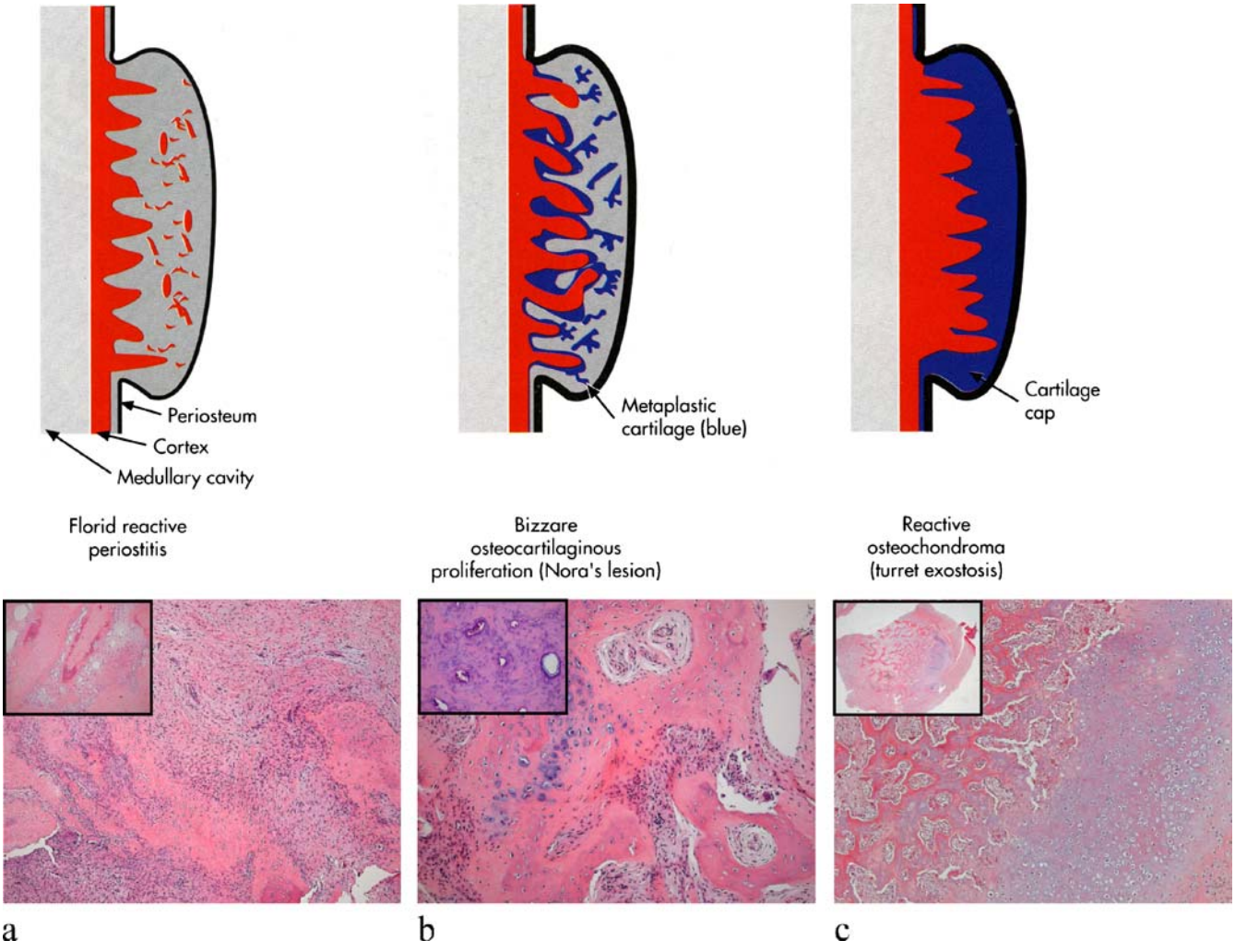

Fig. 5 Light micrographs (H&D) displaying the spectrum of reactive lesions. (Reprinted from:Dorfman HD, Czerniak B. Bone tumors.St. Louis,Mosby, 1998.) **a**. Florid reactive periostitis mostly consisting of fibrous tissue with spindle cell proliferation and trabeculae of woven bone developing within the fibrous tissue. **b**. NORA's lesion, composed of bizarre cartilage with hypercellularity and binucleated cells, blending together with woven bone on a fibrous background. **c**. Subungual (turret) exostosis, with the onset of the nail clearly visible. The center of the lesion is bony, the periphery consists of a cartilage cap

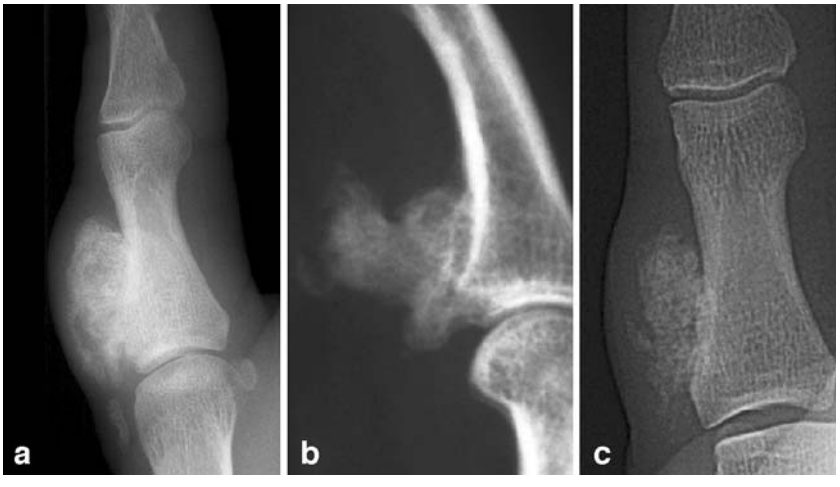

Fig. 6 Three cases with end stage (turret exostosis) of NORA's lesion

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