Orthopaedics & Traumatology: Surgery & Research 102 (2016) S149–S159

Available online at
ScienceDirect
www.sciencedirect.com

Elsevier Masson France
EM|consulte
www.em-consulte.com/en

Review article

Pathological fractures in children: Diagnosis and treatment options

F. Canavese*, A. Samba , M. Rousset

CHU Estaing, université d'Auvergne, service de chirurgie infantile, 1, place Lucie-et-Raymond-Aubrac, 63003 Clermont-Ferrand, France

ARTICLE INFO

Article history:
Received 1st January 2015
Accepted 20 May 2015

Keywords:
Pathological fracture
Children
Congenital disease
Infection
Tumor

ABSTRACT

A fracture is defined as pathological when it arises in a bone tissue that has been modified and reshaped by a local or systemic pathological process. In children, pathological fractures can be secondary to several conditions, ranging from metabolic diseases to tumors, infections or neuromuscular pathologies. History, clinical examination and radiologic assessment are essential to making a diagnosis, to identifying the underlying cause and to planning the right treatment of a pathological fracture. Treatment must be tailored to both the fracture and the underlying cause. The objective of this work is to present the diagnostic approach and the course to follow when a child presents with a pathological fracture. The most common causes of pathological fractures, as well as their characteristics, will be described. Pathological fractures occurring in osteogenesis imperfecta and in abused children as well as stress fractures will not be discussed.

1. Introduction

Children and adolescents often suffer an injury that leads to fracture. The fracture diagnosis is typically easy to make. Nevertheless, there are a certain number of pitfalls – some subtle – that the orthopedic surgeon must be aware of and able to get around to avoid missing a fracture in a pathological bone.

A pathological fracture is one that occurs in bone tissue that is pathological, weak and remodeled, with altered or reduced mechanical and viscoelastic properties. The abnormality in the bone structure can either be focal (local) and responsible for localized bone weakness, or systemic (diffuse) and responsible for generalized bone weakness. As a general rule, a pathological fracture is one caused by minor trauma that typically would not cause the type of fracture observed.

The discovery of a pathological fracture can be a cause for concern because it may be the first sign of an underlying pathology (focal or systemic, benign or malignant) and it is often discovered in an emergency setting. The orthopedic surgeon can put forward a diagnosis of tumor, infection or metabolic syndrome following the discovery of a pathological fracture, but may not have the specialized knowledge required to determine the best treatment indication. This makes it important to have the ability to recognize a pathological fracture and to be able to prioritize whether the fracture itself or the underlying bone pathology should be treated first. Both the fracture and the underlying cause must be taken into account, and both must be treated. The various causes of pathological fractures in children are summarized in Table 1. The fracture's etiology drives the treatment choice; if in doubt, a solution that keeps all options open must be selected. The fracture will be more likely to heal when the mechanical and biological environments are as physiological as possible. Inappropriate treatments that ignore the underlying pathology contributing to the fracture must be avoided. This could place the patient's life in jeopardy, as in cases of pathological fracture in a bone affected by a malignant tumor.

History, clinical examination and etiology identification, confirmation of the pathological nature of the fracture and establishment of a treatment hierarchy between the causal disease and the fracture are key elements of the diagnostic course. The patient's treatment can only be initiated once these various points have been assessed. The treatment must be well thought-out and adapted to each patient, particularly in an emergency setting, so as to preserve the limb's condition when malignant disease is suspected.

2. Frequency of pathological fractures and fracture risk

In children, most pathological fractures are secondary to benign tumors. Tumor-like lesions, metabolic diseases and bone infections can also cause a pathological fracture (Table 2). Pathological fractures secondary to a malignant tumor are much rarer. Nevertheless, this possibility must be kept in mind.

The presence of pain, a lesion wider than 2.5 cm or longer than 3.5 cm, more than 50% reduction in cortical thickness, or destruction of more than 85% of the cortex visible on two perpendicular views are potential risk factors. How these factors contribute to a

* Corresponding author. Tel.: +33 4737 50293; fax: +33 4737 50291.
E-mail address: canavese_federico@yahoo.fr (F. Canavese).

http://dx.doi.org/10.1016/j.otsr.2015.05.010
1877-0568/

Table 1
Causes of pathological fractures in children.

Age	Type	Benign	Malignant
0–5 years	Focal	Osteomyelitis	Radiation therapy
		Eosinophilic granuloma	Isolated metastatsis
		Congenital pseudarthrosis of tibia (idiopathic)	Ewing sarcoma
		Prolonged immobilization	
	Diffuse	Hand-Schuller-Christian disease	Leukemia
		Congenital pseudarthrosis of tibia (associated with NF-1)	Litterer-Siwe disease
			Metastatic tumors
		Osteogenesis imperfecta	Wilms tumor
		Osteopetrosis	Neuroblastoma
		Pycnodysostosis	
5–10 years	Focal	Non-ossifying fibroma	Radiation therapy
		Unicameral bone cyst	Isolated metastasis Osteosarcoma
		Aneurysmal bone cyst	Ewing sarcoma
		Monostotic fibrous dysplasia	
		Enchondroma	
		Congenital pseudarthrosis of tibia (idiopathic)	
		Osteomyelitis	
		Prolonged immobilization	
		Limb lengthening	
	Diffuse	Monostotic fibrous dysplasia (McCune-Albright syndrome)	Leukemia
		Enchondtromatosis (Ollier disease, Maffucci disease)	
		Congenital pseudarthrosis of tibia (associated with NF-1)	
		Osteogenesis imperfecta	
		Osteopetrosis	
		Pycnodysostosis	
10–15 years	Focal	Non-ossifying fibroma	Radiation therapy
		Unicameral bone cyst	Isolated metastasis Osteosarcoma
		Aneurysmal bone cyst	Ewing sarcoma
		Monostotic fibrous dysplasia	
		Chondroblastoma	
		Giant cell tumor	
		Osteoid osteoma	
		Osteomyelitis	
		Prolonged immobilization	
		Limb lengthening	
	Diffuse	Osteogenesis imperfecta	Leukemia
		Osteopetrosis	Lymphoma
		Pycnodysostosis	
0–15 years	Neuromuscular disease	Long-term corticosteroid treatment	

fracture occurring at a focal anomaly is still controversial [1–6]. In the context of metabolic diseases responsible for a diffuse anomaly in the bone structure, the fracture risk is higher but difficult to estimate.

In non-walking children with cerebral palsy, the risk of developing a pathological fracture following minor trauma is estimated at 0.065% per year. The frequency of pathological fractures is a function of the severity of the neurological disorder [7,8].

Pathological fractures due to a primary malignant bone tumor are rare and can be secondary to surgical biopsy that increases the weakness of an already pathological bone. The incidence of osteosarcomas diagnosed following a pathological fracture is 5% to 13% [9,10].

Fractures occurring secondary to osteomyelitis are now very rare, not because this condition has disappeared, but because the diagnosis is being made earlier and antibiotic treatment started more quickly. However, in developing countries, fractures secondary to chronic osteomyelitis are still relatively common and make up about three-quarters of pathological fractures [11].

3. History, clinical examination and search for etiology

3.1. History

When a child presents with a suspect fracture, the search for its etiology starts by taking detailed history. In addition to questions related to the trauma itself (no injury, minor injury or recurrent injury), questions about the history of mechanical and/or inflammatory pain, swelling before occurrence of the fracture, fever, weight loss and recent overall health should be asked. Questions about growth, psychomotor development and the child's eating habits are needed. It is also necessary to look for the presence of any kidney diseases (e.g., vitamin D resistant rickets or renal osteodystrophy) or hormonal diseases (e.g., primary hyperparathyroidism), without forgetting about family history of bone dysplasia, metabolic disorders, neuromuscular diseases or osteoporosis. It is also important to ask the parents if the child has a history of malignant neoplasm, as they do not always provide this information spontaneously. However, if the underlying pathology is already known, the line of questioning should directly focus on how it is being treated.

3.2. Clinical exam

A clinical examination follows the history taking. The goals of this examination are to assess the skin condition, palpate for any tissue masses, and determine if local inflammatory signs such as erythema, heat or edema are present. It is very important to differentiate between a post-fracture hematoma from a tumor mass, as both increase the volume of the body part being palpated.