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Educational Corner

Approach to Hetrotopic Ossification (HO): Educational Corner

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Background

Heterotopic ossification (HO) is a prevalent complication after trauma, injury, or surgery defined by the existence of extraskeletal lamellar type of bone in muscle and soft tissue (1). HO is a disturbance of normal tissue repair. HO also has a genetic form which is rare in comparison to the non-genetic form. HO has a broad spectrum of clinical symptoms, from small lesions to lesions with high morbidity (2). This complication is induced by infiltration of inflammatory cells and osteoinductive growth factors, which are released following an injury and activate an osteochondrogenic program. HO formation takes 6-12 weeks following the operation and ceases after that without any progression. The pathway of bone formation in HO may be either intramembranous or endochondral. HO is classified into four grades based on Brooker's classification. Most cases of HO are categorized as grade one and grade two, which are asymptomatic and accidentally discovered in radiographic follow-ups. In grades three and four, the patient confronts more pain and reduced range of motion (ROM) (3). HO is a condition that requires early diagnosis to prevent the complications such as peripheral nerve entrapment, pressure ulcers, and functional impairment if ankyloses develop. Non-specific signs and symptoms hinder the early diagnosis and consist of fever, erythema, localized pain, tenderness, swelling, and decreased joint motion. HO occurs mainly in areas susceptible to injuries, including thighs, elbows, pelvis, and shoulders, but can also occur anywhere (4). The most effective treatment of HO is prophylaxis. In case of painful and symptomatic HO, which limits the patient's quality of life (QOL), surgery in addition to oral prophylaxis [nonsteroidal anti-inflammatory drugs (NSAIDs)], COX-2 blockers, and/or low dose irradiation are indicated (1, 5, 6).

The Brooker classification splits the level of HO formation following total hip arthroplasty (THA) into four classes (Figure 1).

Class 1 is defined as islands of bone in the soft tissues of the hip.

Class 2 includes bone spurs originating from the pelvis or proximal end of the femur, leaving at least 1 cm between the opposing bone surfaces.

Class 3 consists of bone spurs originating from the pelvis or proximal end of the femur, reducing the space between the opposing bone surfaces to less than one cm.

Class 4 shows apparent bone ankylosis of the hip. Brooker did not define Class 0 in his original manuscript and studies, but the following studies utilizing the Brooker classification have defined Class 0 as the lack of radiographic findings of HO (7-9).

Clinical Features

Epidemiology: Most cases of HO occur in a young male with a history of surgery or trauma, although we have a wide age distribution from infancy to aged older people. Radiological findings of HO can be found in a varied group of people, such as combat-injured patients, especially patients who have undergone amputations. The percentage of patients with symptomatic HO in civilian amputation is lower than combat-injured patients. Additionally, HO is common in traumatic accidents of brain and so spinal cord injury, which is called neurogenic heterotopic ossification (NHO) (10). Hip arthroplasty, distal humerus fractures, and severe burns are other predisposing factors. In some cases, autoimmune diseases like dermatomyositis and systemic sclerosis contribute to the expansion of HO in the skin (2).

Risk Factors: The factors which can lead to HO following hip arthroplasty are ankylosing spondylitis, hypertrophic osteoarthritis, and Paget's disease (2), as well as some surgical factors like increased time of ischemia, surgical approach, and utilization of cemented implants (11).

In fracture-induced HO, the risk factors comprise of surgical approach, concurrent neurologic injury, delayed internal fixation, and usage or replacement of bone graft (2).

In NHO, the following conditions can lead to the HO formation: patients who have lesions in low cervical or high thoracic regions, extreme spasticity, tracheostomy, pneumonia, impaired cognition, and urinary tract infections (2).

Regarding the HO following a thermal injury, the risk factors are the size of the affected zone of the body, male gender, and full-thickness injury (2).

The common imaging modalities include conventional radiography, CT scan, positron emission tomography (PET) scan, and single photon emission computed tomography (SPECT). Usually, the mature intramuscular HO appears as a well-expanded and well-demarcated radiodense mass, accompanied by a zonal ossification process in conventional radiography.

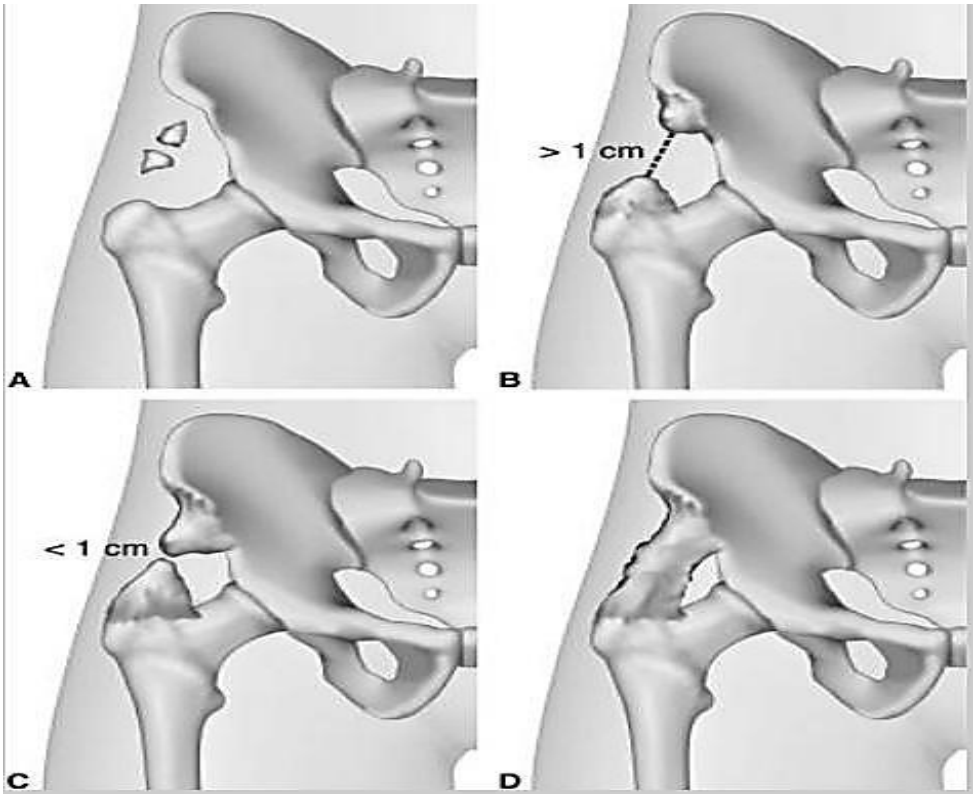

Figure 1. The Brooker classification divides the extent of heterotopic ossification (HO) formation following total hip arthroplasty (THA) into four classes: (A) Class 1 is described as islands of bone within the soft tissues around the hip; (B) Class 2 includes bone spurs originating from the pelvis or proximal end of the femur, leaving at least 1 cm between the opposing bone surfaces; (C) Class 3 consists of bone spurs originating from the pelvis or proximal end of the femur, reducing the space between the opposing bone surfaces to less than 1 cm; and (D) Class 4 shows apparent bone ankylosis of the hip. Reproduced with permission from Kate Sweeney.

Early lesions are usually hypercellular and have little bone formation, whereas later lesions have a characteristic zonal architecture with a prominent peripheral ossification (2).

Early or Late Excision: Choosing between early or late excision of a heterotopic bone is controversial. There are two recommendations about the best time of resection; the traditional way is to delay the surgical HO resection until the maturation of the HO to reduce the risk of recurrence. HO takes 18-24 months to mature. Nowadays, some reports suggest the early resection of HO to limit the disability time. Waiting for a long time for the maturation of HO can lead to substantial problems such as muscle deconditioning, pressure ulcers, perineal breakdown, contracture, and osteopenia (12, 13). Some new studies claim the optimal time for surgical intervention is when HO causes the loss of joint motion and neural or vascular compression, and the interval between trauma and surgery does not increase the chance of recurrence. If the interval between trauma and surgery gets too long, cartilage loss may happen (14).

Garland suggested choosing the surgery time based upon the etiology and underlying conditions (15). There are some methods for determining the degree of HO maturation, such as radiographic appearance, alkaline phosphatase level, and bone scan, which are controversial and inconclusive. Radiographic findings are less reliable than bone scan and alkaline phosphatase (ALP) level tests. In the past, it was believed that performing HO resection was not allowed until reaching normal ALP levels or stable bone scan (16). There are some other factors that affect the recurrence rate like neurologic recovery. Garland and Orwin found that outpatients with poor neurologic recovery and persistent spasticity were associated with higher HO recurrence rate and no improvement in limb function (17).

Wu et al. reported that in their case series did not experience any increase in the rate of HO recurrence with early HO resection vs late resection (16). Early resection allows for a better distinction between the heterotopic and cortex of the normal bone. They figured out that less waiting time for surgery means less deconditioning, less scarring and fibrosis, fewer surgery complications like iatrogenic femoral neck fracture, sciatic nerve injury, and avascular necrosis (AV) of the femoral neck, which leads to easier rehabilitation. Non-steroidal anti-inflammatory drugs and radiation are the main methods for preventing HO recurrence (16).

Early excisions should be accompanied by adjunctive treatments, otherwise early excision is not effective and therefore not recommended (18, 19). Early excision without considering the maturation time also avoids unnecessary blood test and serial bone scan. Wick et al. (20) and Cole et al. (12) found out that many patients, despite having radiographic evidence of HO recurrence, did not have significant functional problems and loss of function in other patients was accompanied by other comorbidities such as AVN; therefore the situation was difficult for researchers to solely contribute the poor outcome to early timing of HO excision.

Conflict of Interest

The authors declare no conflict of interest in this study.

Acknowledgments

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