

Heterotopic Ossification Following Acquired Brain Injury in Children

What is heterotopic ossification?

Heterotopic ossification (HO) is a benign condition of abnormal formation of bone in tissues which typically do not exhibit any ossification properties.^{1,2} It is characterized by the rapid development of calcified bone in soft tissues.² Other terms used to describe HO include myositis ossificans, ectopic ossification, and ectopic bone formation.

How does HO affect individuals?

HO is frequently asymptomatic;¹ however, as it becomes more severe, symptoms of HO include decreased range of motion (ROM),^{1,3} joint stiffness,³ local pain,⁴ warmth,^{3,4} swelling^{3,4} and erythema.^{3,4} In adults with acquired brain injury, having HO is associated with poorer functional outcome, although it is not clear whether HO causes the decrease in function, or if it simply is an indicator of patients that will not advance or progress as quickly during rehabilitation.⁵

Why does HO occur?

The aetiology of HO is still unknown.³ A suggested theory is that HO is caused by osteoprogenitor cells that are pathologically induced by an imbalance in local or systemic factors.¹ It is thought that the development of HO depends on three factors: an osteogenic precursor cell; an inducing agent; and a permissive environment.⁶

Who is at risk of developing HO?

HO occurs in conjunction with many diseases and various traumas. These include burns, muscle and joint injuries or operations (traumatic or iatrogenic HO) or damage to the nervous system such as a brain or spinal cord injury (neurogenic HO).^{1,3,7} It is also thought that some individuals may be genetically predisposed to developing HO (genetic HO).¹

In children with brain injuries, an increased tendency for HO has been found in children with multiple fractures.⁸ Other risk factors that appear to increase the risk for HO include age greater than 11 years, longer coma duration, and poor predicted functional outcome.⁸ An association with spasticity has also been reported^{9,10} although one study did find that spasticity was not predictive of HO.⁸ Unlike in adults, gender differences in the incidence of HO in children have not been found.⁸

Interestingly, HO has also been reported in children with spina bifida and cerebral palsy.¹¹

When does HO typically occur?

HO is typically diagnosed approximately 4 months after neurological injury.⁷

How often does HO occur in children?

The incidence of HO in children with traumatic brain injuries has been reported to be between 14% and 23%.^{8,9,12} Much lower incidence of HO was found in a more recent study that included children with traumatic brain

injury (7.9%), near drowning or strangulation (3.8%), cerebral hemorrhage (2.6%), hydrocephalus (2.0%), or spinal cord injury (2.8%).⁷

Where in the body does HO typically occur?

In children with traumatic brain injury, the soft tissues surrounding the hip, elbow, knee and shoulder are most commonly involved, and more than one site can be involved at a time.^{8,9,12}

How is HO treated once it occurs?

In adults, medical management and surgical excision is often completed to relieve severe functional impairment or intractable pain¹ although frequently occurring complications such as deep vein thrombosis, infection, and pressure ulcers need to be considered.³ Surgery is generally followed by prophylactic measures including radiation therapy and/or nonsteroidal anti-inflammatory drugs.^{1,3}

The physical management of adult HO is controversial. It has been postulated that vigorous passive manipulation of a joint to preserve ROM may initiate the pathological process leading to HO in adult patients with neurological conditions.³ Animal studies have demonstrated that immobilization and forcible manipulation induced HO,^{13,14} whereas gentle passive ROM below the pain threshold could actually maintain and possibly even improve joint mobility without affecting bone formation.^{3,15} In contrast, authors of one study of HO in the adult traumatic brain injury population indicate that manipulation under anaesthetic, followed by a program of ROM, continuous passive motion and

positioning, led to an increase in joint motion at the time of manipulation and when retested at 15 months without acceleration or exacerbation of the process of ossification.¹⁶ Due to the limited level of evidence available, it is difficult to draw conclusions regarding the effects of aggressive ROM and/or manipulation on joints affected by HO.

In children, HO can resolve spontaneously.^{7,17} When pediatric HO is treated, management differs from that of adults. Pharmacological intervention has had differing success rates in children than in adults^{18,19} and surgical resection is only rarely needed.²⁰

Physical treatment in children includes maintaining ROM through passive and active-assisted exercises²⁰ although the evidence to support this intervention is limited.

What should I do if I "suspect" HO?

Clearly document the signs and symptoms you observe as well as any changes in the child's normal routine. You should notify the child's physician of your concerns and document the actions you have taken. Ask the child's parents or other caregivers if they have noticed changes in the child's appearance or behaviour. A prompt and thorough physical examination by a physician should be completed as well as detailed documentation of findings in the chart. Persistent irritability especially with localizing symptoms should alert the physician to consider radiography, even in the absence of obvious signs.

How can HO be prevented?

HO prophylaxis with drugs and radiation treatment is performed when there are indicators of high risk of HO

development,^{1,3} although their use is still controversial. Primary prevention should include avoiding risk factors such as pressure ulcers, deep venous thrombosis, and limb contractures.³ Rehabilitation can play an important role in preventing contractures and maintaining physical conditioning, although controversy exists as to how to best do this. Some argue that forcible ranging of joints should be avoided due to the possibility of inducing microtrauma and haemorrhages, which may lead to HO. Recent yet limited adult brain injury and spinal cord injury research has demonstrated that active and passive ROM within a pain-free range can have a positive effect on patient outcome.^{15,21} Further research is needed to better understand how to prevent HO in the pediatric brain injury population.

This evidence summary was updated by Tanja Mayson (MSc, BScPT) on April 30th, 2007. The original literature review was written by Colleen Sloan (BScPT) in 2003. A literature search was completed using the search terms: heterotopic ossification, myositis ossificans, ectopic ossification, ectopic bone formation, brain injury, passive range of motion, passive exercise, and exercise. CINAHL, Medline, EMBASE, and EBM Reviews were searched with limits for publication date (1975 or more recent).

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