# Heterotopic Ossification About The Elbow: Repair And Rehabilitation

Surgical Indications and Considerations

*Anatomical Considerations:* The complex anatomy of the elbow joint and its relation to the hand, forearm, and shoulder underlie the functional deficits associated with heterotopic ossificans (HO). Despite much study and newly gained insights into its development, treatment of HO of the elbow remains largely based upon the more widely studied HO of the hip joint. The elbow differs from the hip in a number of different ways, one of which being that the cross-sectional area of the elbow in comparison with the upper limb is relatively much larger than that of the hip in relation to the lower limb; thus, involvement of neighboring nerves and vasculature by HO is much more likely at the elbow.

*Pathogenesis:* Acquired HO is a recognized complication of various traumatic etiologies such as spinal cord injury, traumatic brain injury, burns, surgical resection and joint arthroplasty. However, while many theories have been put forth to explain HO of the elbow, the true mechanism of how ectopic bone forms around a joint, possibly causing severe functional limitations, and even total joint ankylosis, remains uncertain. The transformation of primitive mesenchymal cells in connective tissue into osteoblastic tissue and osteoid involve diverse and poorly understood biological triggers, ranging from bone morphogenic proteins, human skeletal growth factors, to genetic, neurological and traumatic factors. The presence of limb spasticity, fracture, infection, and pressure sores are generally believed to increase the likelihood of HO development.

*Epidemiology:* The incidence of clinically significant HO in the common settings of elbow injury (trauma, brain injury, spinal cord injury) has been reported to be as high as 10% to 20%. In addition, the elbow is the most frequent site of HO in burn patients, of whom 1% to 3% may be affected, although estimates as high as 35% have been given in the literature. Other risk factors include the following: male gender, trauma, full-thickness burns, spinal cord injury, deep local infection, overzealous joint manipulation, microtrauma to the musculotendinous apparatus with resultant hemorrhage, circulatory stasis, postoperative immobilization with limitation of joint movement, bone demineralization from prolonged bedrest or assisted ventilation.

*Diagnosis:* HO characteristically begins approximately two weeks after injury, however, diagnosis is often delayed. Common signs and symptoms include decreased range of motion, pain, swelling, and erythema. These non-specific clinical signs may not appear until eight to ten weeks after the initial injury. Positive radiological findings may not appear for four weeks. An acute rise in serum alkaline phosphatase and a transient depression in serum calcium may occur within the first two weeks. However, these are non-specific laboratory findings and may not be helpful in early diagnosis. The determining characteristics of HO include a radiologically verification of a periarticular location, an intact cortex, a lucent zone between cortex and ossification (“string sign”), peripheral density of calcification, and contraction of the ossification zone with maturity. Finally, while plain films are used for delineating the precise extent of HO at the elbow, bone scans remain the gold standard for diagnosis.

*Nonoperative Versus Operative Management:* Surgery plays a prominent role in many treatment plans, particularly when orthopedic trauma is the initiating injury and if certain prerequisites are met. As a rule, if the elbow is able to span an arc of 30° to 110° (range of motion as described here assumes that complete extension represents an arc of 145° measured at the elbow joint), the elbow is not considered functionally impaired. In addition, there should be no evidence of acute inflammation in the periarticular tissues. The skin overlying the proposed surgical site should be completely healed. It must not, however, be assumed that surgery is always required for the treatment of HO of the elbow. One recent report of established HO noted decreased pain and improved range of motion after radiation therapy to the elbow joint, even without excision of the heterotopic bone. Similarly, neuropathic pain may respond better to anticonvulsants (e.g., gabapentin) or tricyclics (e.g., amitriptyline) than to operative intervention. One surgeon even observed that range of motion is maximized when gradual physical therapy, rather than surgical excision, is used to release muscle contractures. The fundamental prerequisite for surgical intervention then, is not the mere presence of HO, but peripheral nerve compromise, pain, or an impaired range of motion affecting daily activities that would not be manageable by more conservative medical or physical therapy intervention.

*Surgical Procedure:* Surgery is usually performed once the lesion has stabilized radiographically. And in the case of brain-injured patients, the key principle is that surgery should follow, not precede, neurological recovery (persistent loss of neurological function is the setting in which HO gains a foothold, and if excised, tends to recur). Surgical approach depends on the location of the heterotopic bone and its relation to normal structures.

A posterior approach is recommended to avoid traumatizing previously damaged skin. Access to the anterior capsule can be accomplished by removing the radial head. Once the capsule has been entered, the ulnar nerve should be transposed so heterotopic bone and ossified periarticular ligaments in surrounding soft tissue can be removed. The entire bridge of bone and its bony attachments must be removed.

A posterolateral approach is recommended when the elbow ankylosis in extreme flexion. In this setting, heterotopic impingement on the olecranon may be present. Here, the olecranon should be excised and the fibrofatty tissue within the fossa left in, because adipose tissue tends to prevent recurrence of heterotopic bone that has already formed. An incision is then made proximal to the mass on the posterolateral arm across the olecranon. The triceps aponeurosis is exposed, incised, and retracted medially to expose the subperiosteal heterotopic bone joining the lateral condyle of the humerus to the posterolateral olecranon. If the proximal forearm is involved, with compromise of supination and pronation, the incision is extended distally. An osteotome is used to remove the heterotopic bone, whereas the fat pad in the fossa is left in place. The elbow is passively flexed to facilitate removal of the bone from its attachments to the olecranon and humerus.

A medial approach is used if the posteriorly situated heterotopic bone extends medially, if its presence near the ulnar collateral ligament compromises range of motion, or if the ulnar nerve is to be transposed anteriorly. If bone encircles the ulnar nerve, it must be removed so that the ulnar nerve can be released before complete resection proceeds. If heterotopic bone follows the brachialis muscle in the direction of the coronoid process or follows the path of the biceps

tendon, anterior synostosis of the forearm may occur. In this setting, an anterolateral approach allows the brachialis and brachioradialis muscles to be identified and retracted from the radioulnar joint. The radial nerve is retracted laterally with the brachioradialis muscle. Heterotopic bone is then dissected subperiosteally, and the central bridge of bone is resected, with anterior capsule left intact. Postoperative hematomas are common in this setting.

*Preoperative Rehabilitation*

- Activity as tolerated (continue to assess function/lack of function)
- Infection control/integument healing
- In brain injury patients, continue with neurological recovery
- Pain management
- Instructions/review post-operative rehabilitation plan

## POSTOPERATIVE REHABILITATION

Note: The following rehabilitation progression is a summary of the guidelines provided by Calandruccio, Akin, Griffith, Andrews, Hurd, and Wilk. Refer to their publication to obtain further information regarding criteria to progress from one phase to the next, anticipated impairments and functional limitations, interventions, goals, and rationales.

**Phase I** for Early Motion and Rehabilitation: Week 1

Goals: Prevent infection
Decrease stress on surgical site
Decrease pain
Control and decrease edema
Protect surgical site
Elbow PROM to within 80% available limits structurally
Maintain ROM of joints proximal and distal to surgical site

Intervention:

- Monitoring of surgical site
- Instruction of patient in activity modification
- Continuous passive motion (some MDs place CPM immediately post-op on the patient)
- AROM: exercises for hand, shoulder, elbow (within patient's tolerance)

**Phase II** for Early Motion and Rehabilitation: Weeks 2-8

Goals: Reduce pain
Manage edema
Encourage limited activity of daily living performances
Promote scar mobility and proper remodeling
Promote full elbow PROM
Encourage quality muscle contraction

Intervention:

- Continuation of edema and pain management techniques as in Phase 1
- Soft tissue mobilization myofascial restrictions are present
- Retrograde or lymphatic massage if tissue edema is present
- Scar desensitization/mobilization after sutures are removed and incision is closed
- AROM: Elbow flexion/extension/pronation/supination
- PROM: Elbow flexion/extension/pronation/supination
- Isometrics: wrist and shoulder, sub-maximal

**Phase III** for Early Motion and Rehabilitation: Weeks 9-24

Goals: Self-manage pain
Prevent flare-up with progression of functional activities
Improve strength: Grip strength to 75% of uninvolved side
Wrist strength to within 80%
Improve ROM if it still limited
Return to previous activity level

Intervention:

- Continue pain and edema management as indicated
- Patient education regarding activity modification and performance of activities with good mechanics
- Progressive resistance exercises for shoulder, elbow, and wrist
- Putty exercises-finger pinch and grip
- Work simulator (at 16-20 weeks)

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