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The results of surgical treatment for posttraumatic heterotopic ossification and ankylosis of the elbow

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Objectives: Heterotopic ossification which may develop following elbow injuries or elbow surgery may result in complete loss of elbow functions. We evaluated the results of surgical treatment for ankylosis of the elbow due to posttraumatic heterotopic ossification.

Methods: The study included seven patients (6 males, 1 female; mean age 36 years; range 23 to 55 years) who developed heterotopic ossification and ankylosis of the elbow joint following surgical treatment of high-energy fractures in the circumference of the elbow. Two patients had comminuted olecranon fractures and elbow luxation, and five patients had comminuted intra-articular distal humeral fractures. Three patients had open fractures. Involvement was in the right elbow in two patients, and in the left elbow in five patients. One patient was monitored and treated in the intensive care unit for head trauma for 22 days. Initially, six patients were treated with plate osteosynthesis and one patient with tension band wiring. Foci of heterotopic ossification were detected on the radiographs taken after a mean of 24 days (range 20 to 32 days) following surgical treatment of fractures. The patients were followed-up with conventional radiography and scintigraphy for a mean of 11 months (range 7 to 15 months) before surgical treatment, during which functional loss in elbow joint movements deteriorated and ankylosis developed. All the patients had Hastings type IIIC ankylosis and poor Mayo elbow performance scores (mean score 50.7). A posterior incision was used in three patients, and a double-column incision was used in four patients. At surgery, the ulnar nerve and the lateral and medial collateral ligaments were preserved, and a posterolateral capsular release, removal of heterotopic ossification, purging of the olecranon fossa, and resection of the tip of the olecranon were performed. After completion of capsular release, cartilage pathologies were evaluated. Four patients were found to have no definite cartilage damage, whereas in three patients the joint cartilage was seriously damaged. At final controls, the patients were assessed with the Mayo elbow performance score. The mean follow-up period was 23.4 months (range 10 to 36 months).

Results: In all cases, the range of motion and stability of the elbow joint were controlled and were found to be complete and stable at the end of the operation. At final controls, the Mayo elbow performance scores were good in three patients, moderate in one patient, and poor in three patients. All the patients with a poor elbow score had severe joint cartilage damage intraoperatively.

Conclusion: Patients who develop heterotopic ossification and ankylosis of the elbow following trauma or elbow surgery may benefit from removal of heterotopic ossification foci and elbow relaxation procedures provided that there is not severe damage to the articular cartilage.

Key words: Ankylosis/surgery; elbow joint/injuries; ossification, heterotopic/surgery.

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Compared with the other joints, the elbow joint is the first place for the development of heterotopic ossification. This susceptibility pertains to the severity of trauma, the frequency being 3% in simple fractures, and up to 20% in fracture dislocations. The incidence of heterotopic ossification rises due to the increases in blood osteoblasts and growth factors after head injuries.[1] The likelihood of heterotopic ossification in the elbow joint reaches up to 90% in elbow injuries accompanied by head injuries.[2,3] Heterotopic ossification was previously thought to result from delay in surgical intervention in the elbow, but adequate evidence supporting this relationship could not be obtained. Although the osteosis associated with heterotopic ossification histologically resembles the lamellar structure of the bone, it is more active metabolically and does not have a true periosteal layer.[4] Once heterotopic ossification begins to develop, there are no treatment options to prevent or revert this process. Clinical presentation of heterotopic ossification includes pain, swelling of soft tissues, tenderness, increased temperature, and progressive loss in the joint range of motion. These postoperative symptoms can be mistaken for an early infection. Laboratory findings are decreased blood calcium, increased serum phosphate, and increased blood alkaline phosphatase levels within 2 to 4 weeks reaching a culmination at three months.[5] Scintigraphic evaluation with technetium^{99} is helpful for determining the metabolic activity of the bone mass and bone maturity after the development of heterotopic ossification. Abnormal metabolic activity observed within the first few weeks may last about a year and can give information about maturation.[6] The most reliable and practical information about the maturation of heterotopic ossification is the appearance of cortical boundaries that can be seen on serial direct radiographs.[7]

Fig. 1. Postoperative ankylosis of the elbow.

Heterotopic ossification developing around the elbow joint may result in elbow ankylosis. Treatment of this condition which is reported to be quite frequent following burns or trauma is quite difficult.[8-10]

The first functional classification of heterotopic ossification around the elbow joint was proposed by Hastings and Graham.[11] This classification is quite helpful in the clinical assessment and treatment. This classification was then widened by addition of several subgroups.[7]

Patients and methods

The study included seven patients (6 males, 1 female; mean age 36 years; range 23 to 55 years) who developed elbow ankylosis secondary to posttraumatic heterotopic ossification. The causes of elbow injuries were high-energy trauma such as road accidents and fall from height in six cases, and simple fall in one case. Two patients had comminuted olecranon fractures (Morrey type IIIb) and elbow luxation, and five patients had comminuted intra-articular distal humeral fractures (AO type IIIC). Three patients had open fractures, being Gustilo-Anderson grade 2 in two patients and grade 1 in one patient. Initial surgical treatment of all patients but one was performed in our clinic. One patient was monitored and treated in the intensive care unit for head trauma for 22 days.

Initially, six patients were treated with plate osteosynthesis and one patient was treated with tension band wiring (Zuggurtung) technique. Postoperatively, early phase infection developed in one patient and was treated with antibiotherapy. One patient with type 2 open fracture developed skin necrosis that required skin grafting by plastic surgery. Postoperatively, all the patients received prophylactic indomethacin at a dose of 3 x 25 mg for 10 days. Active-assisted passive elbow exercises were began on the second postoperative day up to the pain threshold. During outpatient follow-up, foci of heterotopic ossification were detected on X-rays in an average of 24 days (range 20 to 32 days). In spite of physical therapy performed in all cases, progressive loss of elbow functions was observed. The patients were followed-up for a mean of 11 months (range 7 to 15 months) with direct radiographs and scintigraphy for evaluation of the matu-

ration of heterotopic ossification. Hastings type IIIc ankylosis was detected in all the patients (Fig. 1).

All the patients were examined with computed tomograph for a better evaluation of the articular surface, which showed aliasing (stairing) in the articular surface in two cases.

According to the Mayo elbow performance scoring system, the mean elbow score was 50.7 showing a poor elbow performance.

Surgical technique

All the patients underwent surgery under general anesthesia and with tourniquet application. A posterior incision was used in three patients, and a double-column incision was used in four patients. A certain sequence was followed during surgery in all the patients. First, the ulnar nerve was exposed and preserved during the operation, and transferred anteriorly to the subcutaneous tissue at the end of surgery. Then, a posterolateral capsular release, removal of heterotopic ossification, purging of the olecranon fossa, and resection of the tip of the olecranon were performed. After completion of capsular release, cartilage pathologies were evaluated and an excision arthroplasty of the fascia lata was performed in one case with cartilage damage involving more than 50%.

The location of heterotopic ossification was taken into consideration in the selection of incisions. The ulnar nerve was explored in all the patients and was transferred anteriorly to the subcutaneous tissues. All foci of heterotopic ossification were removed until normal bone tissue was reached (Fig. 2).

After exploration of the ulnar nerve, the posterolateral articular capsule was resected and the olecranon fossa was purged. The brachial muscle was elevated after access from the lateral and medial sides, and an anterior capsular release was performed. At each stage of the operation, the motion of the elbow joint was controlled after necessary releases were accomplished. The lateral and medial collateral ligaments were preserved in all the patients. In order to ensure the desired extension and flexion degrees, the tips of the olecranon and coronoid were resected. In all cases, the range of motion and stability of the joint were controlled and were found to be complete and stable at the end of the operation.

Fig. 2. Heterotopic ossification foci removed.

Four patients were found to have no definite cartilage damage, whereas in three patients the joint cartilage was seriously damaged. One of these patients underwent fascia lata interposition arthroplasty due to near-complete damage to the joint surface and near-complete loss of the cartilage tissue. In another patient whose joint surface was damaged and in whom fascia lata interposition arthroplasty was applied, radius head resection was performed to restore pronation and supination movements.

Following bleeding control, a drainage tube was placed, incision was closed, and the extremity was held in a long-arm brace.

Postoperative care and follow-up

Passive flexion-extension exercises were initiated on the second postoperative day after pain control. To maintain the range of joint movements, a long arm brace adjustable from the elbow was applied. All the patients received indomethacin for five weeks at a dose of 25 mg three times daily. Postoperatively, one patient developed radial nerve damage that disappeared in three months. After discharge, the patients were called for weekly controls for the first six months. The angled device was removed at four weeks. Then, the patients were called at three and six months, and at one year for radiographic controls and assessment of range of joint movements (Fig. 3). At final controls, the patients were assessed with the Mayo elbow performance scoring system. The mean follow-up period was 23.4 months (range 10 to 36 months).

Results

The Mayo elbow performance scores were good in three patients, moderate in one patient, and poor in three patients. In all the patients with a poor elbow

Table 1
Postoperative range of motion and functional results

Patient	Flexion-extension (°)	Pronation-supination (°)	Complication	Mayo elbow score
1	20-130	70-70		85
2	Ankylosis	Ankylosis		40
3	10-120	50-50	Radial palsy	80
4	Ankylosis	Ankylosis		40
5	0-130	70-70		80
6	Ankylosis	Ankylosis		45
7	10-90	45-45		60

score, there was severe joint cartilage damage intraoperatively. These patients had good or satisfactory range of joint movements in the short-term, but functional results worsened in the long-term (Table 1).

Discussion

After measurements in voluntary individuals, Morrey et al.[12] determined that a flexion-extension range of 100° (range 30°-130°) and a rotation range of 100° (supination and pronation of 50°) were sufficient for daily activities.

Articular movement limitation resulting from elbow injuries is one of the frequent complications and restricts daily activities. Predisposition to elbow stiffness has been attributed to two major anatomic structures of this joint.[13] One is the susceptibility and complex anatomy of the elbow joint, and the other is the response of the articular capsule and surrounding soft tissues to trauma.[14] Morrey[15] classified the factors that contribute to the development of stiff elbow into two major groups based on etiologic and anatomic considerations. The first group involves extrinsic factors including the joint capsule, collateral ligaments, extra-articular union problems, and heterotopic ossification; the second group involves intrinsic factors including intra-articular adherence, articular surface damage, and cartilage loss.

Functional loss in the elbow joint is a condition that seriously limits daily activities. Limitations occur as a result of intra-articular or extra-articular pathological factors. Both problems may exist in some cases. Movement limitations in the elbow joint may vary from functional grades to ankylosis in which no movement is present. Particularly in ankylosis associated with heterotopic ossification, surgical treatment is both risky and difficult.

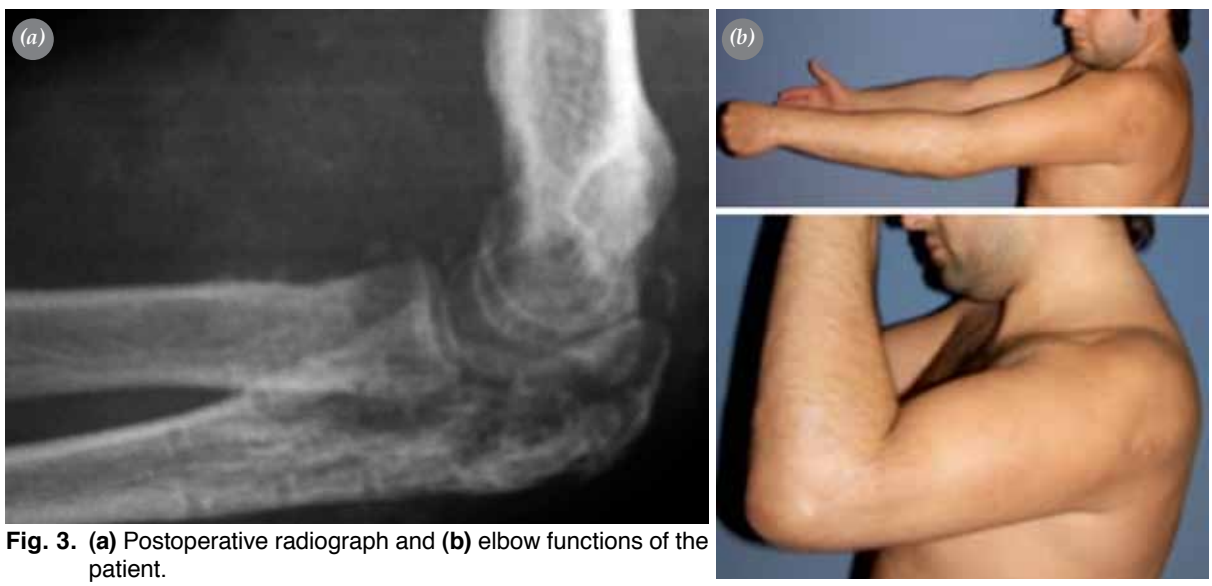

Fig. 3. **(a)** Postoperative radiograph and **(b)** elbow functions of the patient.

Heterotopic ossification resulting from elbow trauma or elbow surgery radiographically appears within 2 to 12 weeks.[4,14,16] Maturation of the ossified heterotopic mass is important with respect to recurrence after surgical excision. Some studies have demonstrated that maturation develops within six months to one year, so cartilage damage would be less when relaxation operations are performed in the earliest term of maturation.[17]

The most important factor to ensure normal cartilage structure and function is movement; thus, the sooner joint relaxation, the easier to obtain a positive response of the cartilage and prevention of soft tissue stiffness. In three cases in which the functional results were poor, we observed that the extent of cartilage damage noted intraoperatively was worse than that thought based on preoperative assessments. The mean time to elbow relaxation surgery for heterotopic ossification was 13 months (range 12 to 14 months) in these cases. In all these cases, including the one who underwent fascia lata resection arthroplasty, complete elbow movements were obtained intraoperatively and elbow movements were in functional degrees in the early postoperative period. However, joint movements could not be maintained and functional results worsened during the follow-up of these patients with articular surface damage. In four patients in whom the results were good or moderate, elbow relaxation surgery and excision of heterotopic ossification were performed a mean of 3.5 months earlier than the cases with poor results. Considering that all the affected elbows in our cases were ankylosed, we suggest frequent radiographic monitoring of heterotopic ossification and excision of the ossified mass within six months to one year following the development of maturation in order to get good results. In all our cases, passive active-aided and active elbow exercises were initiated on the second postoperative day, and indomethacin (3 x 25 mg for 5 weeks) was used. Postoperative radiotherapy was not applied in any of the cases. It has been proposed that, in cases with 50% or more cartilage involvement, radiotherapy can be used concurrently with the external fixator to keep the range of movement that has been obtained by joint distraction after relaxation surgery and may prevent recurrence of ankylosis and increase the success rate.[18] Arthroplasty should be considered as the treatment of choice in elderly patients with elbow arthrosis and cartilage loss of more than 50%.[19]

There is not a standard incision for relaxation surgery for elbow ankylosis due to heterotopic ossification. Ring and Jupiter[20] preferred the posterior incision in patients with ankylosis caused by heterotopic ossification. Husband and Hustings[21] recommended the lateral incision in cases with elbow stiffness. The double-column incision was preferred in stiff elbows in several studies.[22-24] There are also authors who use only the medial incision for relaxation surgery of stiff elbows.[25] It is difficult to reach all the compartments of the elbow through unilateral incisions particularly in cases with ankylosis. Postoperative ulnar nerve neuropathy due to increased elbow flexion has been reported in cases undergoing relaxation surgery only through the lateral incision.[26] We took previous incisions into consideration for selection of incision in our cases. However, it is our opinion that, rather than using a standard incision, the surgeon should select the most appropriate incision that would allow to reach all the compartments of the elbow comfortably. It would be appropriate to select the double-column incision or posterior longitudinal incision in order to remove heterotopic ossification and to perform complete relaxation of the capsule particularly in cases of ankylosis.

A certain sequence of interventions must be followed and elbow movements and stability must be controlled at the end of each stage during relaxation operations in cases with ankylosis.

Although our main objectives are to begin postoperative movements as early as possible and to enhance elbow movements, stability of the elbow remains intact by preserving the lateral and medial ligaments. In cases where elbow stability is not intact, external fixator application may be necessary in order to commence elbow joint movements.[18] In all our cases, an angle-adjustable hinged brace was used for three weeks and no problem was experienced as to elbow stability.

Movement limitation of the elbow joint is a challenge for orthopedic surgeons during the treatment stage. In the literature, data are limited on the results of surgical treatment of ankylosis of the elbow. Removal of heterotopic ossification and capsular relaxation operations should be performed without hesitation when necessary in young patients with ankylosis due to heterotopic ossification. Therefore, maturation of heterotopic ossification in the injured elbow should

be closely monitored and surgical intervention should be performed before the progression of cartilage damage.

References

1. Bidner SM, Rubins IM, Desjardins JV, Zukor DJ, Goltzman D. Evidence for a humoral mechanism for enhanced osteogenesis after head injury. J Bone Joint Surg [Am] 1990; 72:1144-9.
2. Garland DE. A clinical perspective on common forms of acquired heterotopic ossification. Clin Orthop Relat Res 1991;(263):13-29.
3. Roberts JB, Pankratz DG. The surgical treatment of heterotopic ossification at the elbow following long-term coma. J Bone Joint Surg [Am] 1979;61:760-3.
4. Jupiter JB, O'Driscoll SW, Cohen MS. The assessment and management of the stiff elbow. Instr Course Lect 2003;52: 93-111.
5. Bolger JT. Heterotopic bone formation and alkaline phosphatase. Arch Phys Med Rehabil 1975;56:36-9.
6. Orzel JA, Rudd TG. Heterotopic bone formation: clinical, laboratory, and imaging correlation. J Nucl Med 1985; 26:125-32.
7. Viola RW, Hastings H 2nd. Treatment of ectopic ossification about the elbow. Clin Orthop Relat Res 2000;(370): 65-86.
8. Hoffer MM, Brody G, Ferlic F. Excision of heterotopic ossification about elbows in patients with thermal injury. J Trauma 1978;18:667-70.
9. Peterson SL, Mani MM, Crawford CM, Neff JR, Hiebert JM. Postburn heterotopic ossification: insights for management decision making. J Trauma 1989;29:365-9.
10. Seth MK, Khurana JK. Bony ankylosis of the elbow after burns. J Bone Joint Surg [Br] 1985;67:747-9.
11. Hastings H 2nd, Graham TJ. The classification and treatment of heterotopic ossification about the elbow and forearm. Hand Clin 1994;10:417-37.
12. Morrey BF, Askew LJ, Chao EY. A biomechanical study of normal functional elbow motion. J Bone Joint Surg [Am] 1981;63:872-7.
13. Morrey BF. The posttraumatic stiff elbow. Clin Orthop Relat Res 2005;(431):26-35.
14. Akai M, Shirasaki Y, Tateishi T. Viscoelastic properties of stiff joints: a new approach in analyzing joint contracture. Biomed Mater Eng 1993;3:67-73.
15. Morrey BF. Post-traumatic contracture of the elbow. Operative treatment, including distraction arthroplasty. J Bone Joint Surg [Am] 1990;72:601-18.
16. Ellerin BE, Helfet D, Parikh S, Hotchkiss RN, Levin N, Nisce L, et al. Current therapy in the management of heterotopic ossification of the elbow: a review with case studies. Am J Phys Med Rehabil 1999;78:259-71.
17. Tsionos I, Leclercq C, Rochet JM. Heterotopic ossification of the elbow in patients with burns. Results after early excision. J Bone Joint Surg [Br] 2004;86:396-403.
18. Mader K, Koslowsky TC, Gausepohl T, Pennig D. Mechanical distraction for the treatment of posttraumatic stiffness of the elbow in children and adolescents. Surgical technique. J Bone Joint Surg [Am] 2007;89 Suppl 2:26-35.
19. Mansat P, Morrey BF. Semiconstrained total elbow arthroplasty for ankylosed and stiff elbows. J Bone Joint Surg [Am] 2000;82:1260-8.
20. Ring D, Jupiter JB. Operative release of ankylosis of the elbow due to heterotopic ossification. Surgical technique. J Bone Joint Surg [Am] 2004;86 Suppl 1:2-10.
21. Husband JB, Hastings H 2nd. The lateral approach for operative release of post-traumatic contracture of the elbow. J Bone Joint Surg [Am] 1990;72:1353-8.
22. Tosun B, Gündeş H, Buluç L, Şarlak AY. The use of combined lateral and medial releases in the treatment of post-traumatic contracture of the elbow. Int Orthop 2007; 31:635-8.
23. Itoh Y, Saegusa K, Ishiguro T, Horiuchi Y, Sasaki T, Uchinishi K. Operation for the stiff elbow. Int Orthop 1989;13:263-8.
24. Tsuge K, Mizuseki T. Debridement arthroplasty for advanced primary osteoarthritis of the elbow. Results of a new technique used for 29 elbows. J Bone Joint Surg [Br] 1994;76:641-6.
25. Wada T, Ishii S, Usui M, Miyano S. The medial approach for operative release of post-traumatic contracture of the elbow. J Bone Joint Surg [Br] 2000;82:68-73.
26. Mansat P, Morrey BF. The column procedure: a limited lateral approach for extrinsic contracture of the elbow. J Bone Joint Surg [Am] 1998;80:1603-15.