Radiation therapy for the prevention of heterotopic ossification at the elbow

R. Heyd, G. Strassmann, B. Schopohl, N. Zamboglou
From the Kliniken Offenbach and the Hospital of the J. W. Goethe University, Frankfurt am Main, Germany

We present nine patients (five men and four women) who underwent surgical excision of clinically significant heterotopic ossification at the elbow. They also received perioperative radiation therapy using total doses between 600 and 1000 cGy. Five received fractionated radiotherapy, with two fractions of 500 cGy applied on the first two postoperative days, and the remaining four were irradiated with single doses of 600 and 700 cGy.

After a mean period of observation of 7.7 months (6 to 13) none had radiological recurrence of heterotopic ossification and eight showed clinical improvement. Assessment of the functional outcome showed a mean improvement in the Morrey score from 33.3 to 84.5 points indicating a high therapeutic efficacy of prophylactic irradiation.

Received 12 June 2000; Accepted after revision 20 October 2000

The occurrence of heterotopic ossification (HO) is a well-known sequel to dislocation, fracture or surgical procedures on the elbow, but the reported incidence varies. After isolated dislocation of the elbow an incidence of 3% was reported which increased to between 15% and 20% when the dislocation was combined with a fracture. Bromberg and Morrey found that 9% of patients with dislocation of the elbow had evidence of HO. In a more recent report, Ilahi et al found an overall incidence of 49% in a series of 41 patients with fractures of the elbow. Mikic and Vukadinovic observed HO in 57% of patients whose fractures involving the elbow had been treated with resection of the radial head.

The morphological origin of HO is thought to be from pluripotential mesenchymal cells which are ubiquitous in soft tissues. Various stimuli cause them to migrate to the local site within three to five days, proliferate, and then differentiate into chondrocyte-like precursor cells. These then further differentiate into osteogenic stem cells which produce a bone matrix, mineralisation of which is detectable radiologically within six to 12 months. Risk factors which influence the development of HO include a genetic predisposition, local tissue trauma, mechanical factors, neurological abnormalities and systemic factors.

Treatment includes prevention, or resection of clinically significant HO. Whereas surgical excision is the treatment of choice for manifest HO, perioperative irradiation and the administration of non-steroidal anti-inflammatory drugs have been shown to be effective for prophylaxis. Diphosphonates have been used without great success in the past. While the value of prophylactic radiotherapy has been extensively investigated after total hip replacement, results are available for only small numbers of cases at sites other than at the hip.

Patients and Methods

We performed excision of clinically significant HO combined with preoperative or postoperative irradiation on nine patients (five men and four women) with a mean age of 48.2 years (32 to 62). In one patient the HO followed intracerebral bleeding, in another it had developed spontaneously with no history of trauma, and in the remaining seven after fractures involving the elbow. The ossification was either anterior or anterolateral and therefore an anterolateral surgical approach was chosen. No patient was given anti-inflammatory medication during the postoperative period.

In four patients a single dose of irradiation of 600 or 700 cGy was given four to six hours before the excision or on the first postoperative day. The remaining five were irradiated with two fractions of 500 cGy applied on each of the first two days after surgery. Two were treated with Co gamma rays, six with 6 MV photons from a linear accelerator and one with 42 MV photons from a Betatron (Siemens). Table I gives the clinical details.
All patients were examined regularly during the first six months after the combined treatment. The system of scoring devised by Morrey et al\(^\text{19}\) was used for the assessment of the clinical outcome, a total of 95 to 100 points being classified as excellent, 80 to 95 points as good, 50 to 80 points as fair and less than 50 points as poor.

### Results

None of the patients developed complications related to the use of radiation therapy. All wounds healed normally without infection. No patient had a recurrence of HO during the mean follow-up period of 7.7 months (6 to 13). The functional outcome, according to the Morrey score, improved in eight patients; the mean total before initiation of the combined treatment was 33.3 points (31 to 74) which increased to 84.5 points (64 to 100) at follow-up. Preoperative and postoperative radiographs of one patient (case 9) are shown in Figure 1. Two patients were classified as excellent, five had a good result and two were fair, one of whom (case 5) had no functional improvement with persistence of intermittent pain and recurrent swelling of the elbow (Table II).

### Discussion

The analysis of the results from our small group of patients confirmed previous observations that low-dose radiation therapy is effective for the prevention of HO. The use of perioperative irradiation was associated with no recurrence of HO and only one of the nine patients did not benefit clinically. A number of different irradiation schedules was employed with total doses varying between 600 and 1000 cGy. Each seems to have been effective. The reason for the difference in dosage is that the patients were collected over a period of seven years from two different institutions.

The results from other studies which have investigated the value of prophylatic irradiation at sites other than the hip,\(^{11-18}\) are summarised in Table III, the most common being the elbow\(^{12,13,16-18}\) and the forearm for radio-ulnar synostosis.\(^{13-16}\) The use of radiotherapy at the knee,\(^{16}\) the cervical spine,\(^{16}\) the humerus\(^{13}\) or the temporomandibular joint\(^{11}\) has been described but only in single case reports. Our review reveals that only five of the published cases (12.5\%) had recurrence of the bone formation. Lo et al\(^{16}\) reported recurrences in two patients with involvement of
the elbow and of the cervical spine which were irradiated with a single dose of 600 cGy. In a series of 13 patients with comminuted fractures of the elbow three showed a recurrence of HO, occurring after fractionated radiation therapy using three doses of 300 cGy.\textsuperscript{18}

From our observations we conclude that patients with HO of the elbow should be considered for perioperative radiation therapy in order to avoid recurrence. We believe that early radiotherapy on the first postoperative day or preoperative irradiation within four to six hours of surgery is necessary for prevention. The total doses, between 600 and 1000 cGy, which are shown to be effective for prophylaxis, are not associated with an increased risk of radiation-induced sarcoma.\textsuperscript{20,21}

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

References
