Open reduction, ulnar osteotomy and external fixation for chronic anterior dislocation of the head of the radius

C. C. Hasler, L. Von Laer, A. K. Hell
From the University Children’s Hospital, Basel, Switzerland

We reviewed 15 patients, nine girls and six boys, with chronic anterior dislocation of the radial head which was treated by ulnar osteotomy, external fixation and open reconstruction of the elbow joint but without repair of the annular ligament. Their mean age was 9.5 years (5 to 15) and the mean interval between the injury and reconstruction was 22 months (2 months to 7 years).

All radial heads remained reduced at a mean follow-up of 20 months (6 months to 5 years). Normal ranges of movement for flexion, extension, pronation and supination were unchanged in 96.1% (49/51) and worse in 3.9% (2/51). Limited ranges of movement were improved in 77.8% (7/9), unchanged in 11% (1/9) and further decreased in 11% (1/9). There were two superficial pin-track infections and two cases of delayed union but with no serious complications. Reconstruction of the radiocapitellar joint is easier using external fixation since accurate correction of the ulna can be determined empirically and active functional exercises started immediately. Only patients with a radial head of normal shape were selected for treatment by this method.

The outcome of surgical reconstruction of long-standing dislocation of the radial head is uncertain. Further subluxation and dislocation may occur in more than 20% of patients.1-8 Complications such as restriction of movement, nonunion of the osteotomies, avascular necrosis of the radial head, radio-ulnar synostosis with loss of rotation of the forearm, nerve palsies and infection may lead to a poor outcome, despite successful relocation.1,5,6,9-13 There are many surgical options available including combinations of ulnar and radial osteotomies, open or closed reduction, reconstruction of the annular ligament or temporary fixation with a transarticular wire. Most studies have involved a heterogeneous group of patients treated by a variety of operations.1-8,10,14 In this retrospective study we have analysed patients who underwent a standardised reconstruction of the radiohumeral joint, including open reduction of the radial head, ulnar osteotomy and external fixation, based on clearly defined indications.

Patients and Methods
Since 1998 we have only performed surgical reduction of chronic dislocation of the radial head in patients with no evidence of deformity of the head, capitellar dysplasia or osteoarthritic changes. Between January 1998 and October 2002, 15 patients, nine girls and six boys, were treated by open reduction, ulnar osteotomy and external ulnar fixation (Table I). All the operations were performed or supervised by two of the authors (CCH/LVL). The mean age of the patients at operation was 9.5 years (5 to 15). The right elbow was affected in seven and the left in eight patients. Three had undergone closed reduction of the ulna and radial head at the time of the injury. In four, previous attempts at open reduction for chronic dislocation of the radial head had failed. Before reconstruction no patient had a nerve palsy. In the 12 patients who had a history of injury, the mean interval between the injury and reconstruction was 22 months (2 months to 7 years).

The mean period of follow-up was 20 months (6 months to 5 years). Patients were questioned regarding pain in the elbow, instability and restrictions of daily and sporting activities. The pre- and post-operative clinical assessment of all patients included assessment of the carrying angle, flexion and extension of the elbow, pronation and supination of the forearm and standard anteroposterior and lateral radiographs, as well as photographic documentation. The radiographs were studied for congruency of the radiocapitellar joint, deformity of the radial head, the relative
lengths of the radius and ulna, deformities of the radius and ulna and osteoarthritic changes.

Operative technique. Under image-intensifier control a self-cutting 3-mm pin (Apex pin; Stryker-Howmedica, Osteonics, Grand Leacy, Switzerland) is inserted perpendicular to the posterior border of the ulna at the level of the coronoid process. With the clamp of the fixator as a template, two other pins are inserted distally to the first. A second clamp with three pins is positioned about 3 to 4 cm distal to the first. A transverse ulnar osteotomy is performed with a chisel through a short subperiosteal approach between the clamps. The ulna is angulated into flexion and, if necessary rotation, varus or valgus and elongation are added. If closed reduction of the radial head is not possible, open reduction through a Kocher approach is performed. Any fibrous scar tissue and remnants of the annular ligament are removed. The correct position for the ulna is found by observing the position of the radial head in the radio-capitellar joint under direct vision. After successful relocation of the radial head an external fixator (Hoffmann II compact; Stryker-Howmedica) is applied and the stability of the head tested using an image intensifier in all combinations of full flexion, extension, pronation and supination in both anteroposterior and lateral projections. If there is persistent subluxation or dislocation in any of these positions, the clamps of the fixator are released and the ulna re-oriented. The radiological assessment and re-orientation of the ulna are repeated until a stable reduction of the radial head is achieved. The annular ligament is not reconstructed. No temporary transarticular radiocapitellar wire was used.

Active and passive exercises are started as tolerated on the first post-operative day but without formal physiotherapy. Instructions on care of the pin site are given to the patient and carers by the nursing staff. Patients are encouraged to take daily showers or baths as soon as the stitches have been removed. At the time of the removal of metal, all pin sites are debrided and closed by a self-absorbable, intracutaneous running suture.

Results
The results are summarised in Table I and two illustrative cases are shown in Figures 1 and 2.

Reduction of the radial head. All the heads were reduced at the latest follow-up. In two patients (cases 1 and 13), the head redislocated one week after reconstruction. Both were reduced by increasing the ulnar correction. None of the radial heads have shown dysplastic or osteoarthritic signs at the latest review.

Deformity. Two patients (cases 13 and 14) with a pre-operative valgus deformity showed improvement of the carrying angle to that of their normal elbow at follow-up. None of

Table I. Details of the results in the 15 patients

| Case | Gender | Age (yrs) | Interval from injury to reconstruction | Previous procedures* | Indication for surgery | Ulnar lengthening | Elbow flexion/extension (˚) Pre-op Follow-up Forearm pronation/supination (˚) Pre-op Follow-up Radial head |
|------|--------|-----------|----------------------------------------|----------------------|-----------------------|-------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1    | F      | 9         | 6 mths                                 | OR radial head       | Short interval to trauma | 130-20-0         | 110-10-0                | 60-0-80                  | 40-0-90                  | Reduced†                |
| 2    | M      | 8.5       | 15 mths                                | CR of ulnar fracture | Loss of flexion         | 80-0-0           | 110-0-0                | 80-0-80                  | 80-0-80                  | Reduced                |
| 3    | F      | 7         | 2 wks                                  | CR of ulnar fracture | Loss of flexion         | 100-0-0          | 140-0-0                | 90-0-80                  | 90-0-80                  | Reduced                |
| 4    | M      | 7         | 5 mths                                  | CR of ulnar fracture | Short interval to trauma | 125-0-10        | 125-0-10              | 80-0-80                  | 80-0-80                  | Reduced                |
| 5    | F      | 5         | 16 mths                                | OR radial head       | Loss of flexion         | 150-0-10         | 150-0-10              | 90-0-90                  | 90-0-90                  | Reduced                |
| 6    | F      | 5         | Unknown                                 | Transarticular wire | Young age               | 120-0-5          | 135-0-5              | 80-0-80                  | 80-0-80                  | Reduced                |
| 7    | M      | 9         | 10 mths                                 | OR radial head       | Loss of flexion         | 115-0-0          | 140-0-0              | 80-0-80                  | 80-0-80                  | Reduced                |
| 8    | F      | 15        | 7 yrs                                  | OR radial head       | Loss of flexion         | 150-0-0          | 150-0-0              | 90-0-90                  | 90-0-90                  | Reduced                |
| 9    | M      | 9.5       | 5 yrs                                   | OR radial head       | Loss of flexion         | 110-0-0          | 130-0-0              | 80-0-90                  | 80-0-90                  | Reduced                |
| 10   | F      | 10        | 1 yr                                    | CR of ulnar fracture | Loss of flexion         | 140-0-0          | 140-20-0              | 80-0-80                  | 80-0-80                  | Reduced                |
| 11   | M      | 6         | 7 mths                                  | OR radial head       | Loss of flexion         | 140-0-0          | 140-0-0              | 80-0-80                  | 80-0-80                  | Reduced                |
| 12   | M      | 8         | 8 mths                                  | OR radial head and   | Loss of flexion         | 150-0-5          | 150-0-5              | 90-0-90                  | 90-0-90                  | Reduced‡               |
| 13   | F      | 10        | 2 yrs                                   | OR radial head, ulnar OT and plate | Loss of flexion | 130-20-0          | 140-0-0              | 90-0-90                  | 90-0-90                  | Reduced‡               |
| 14   | F      | 12.5      | Unknown                                 | Valgus deformity     | Loss of extension       | 140-0-0          | 140-0-0              | 80-50                    | 80-90                    | Reduced                |
| 15   | F      | 15        | Congenital                              | Discomfort           | Callotasis 10 mm        | 140-0-0          | 140-0-0              | 80-80                    | 80-80                    | Reduced                |

* CR, closed reduction; OR, open reduction; OT, osteotomy
† after redislocation and open rereduction
‡ after redislocation and closed rereduction
Case 13. A ten-year-old girl with anterior post-traumatic dislocation of the radial head, a valgus deformity, pain and loss of extension. Figure 1a – Pre-operative anteroposterior and lateral radiographs showing a normal radial head and capitellum with slight lengthening of the radius. Figure 1b – Lateral radiograph one week after open reduction and ulnar osteotomy. Redislocation has occurred due to anterior translation of the distal fragment and insufficient angulation at the osteotomy. Figure 1c – Intra-operative assessment under the image intensifier at the time of closed remanipulation two weeks after the initial surgery showing a stable radial head in all positions of the elbow. Figure 1d – Lateral radiograph five weeks after closed reangulation of the ulna and compression of the osteotomy showing satisfactory reduction of the radial head. Figure 1e – Lateral radiographs one year later showing an anatomical position of the radial head. The patient is asymptomatic with symmetrical carrying angles and a full range of movement of the elbow and forearm.
the patients complained about the angulation of the ulna or the scars.

**Function.** Marked limitation of flexion was the main indication for reconstruction in four patients (cases 2, 3, 7 and 9), and limited pronation or supination in two (cases 1 and 14). Before operation, nine of the 15 patients had limitation of movement of the elbow and forearm of more than 10°, six in flexion and one each in extension, pronation, and
After operation, five patients had some limitation of movement, three in flexion, one in pronation, and one in supination. If the 60 ranges of movement in four planes (flexion, extension, pronation and supination) are considered in the 15 patients, maintenance of a normal range of movement, restoration of a normal range of movement or improvement of a restricted range of movement was achieved in 93.3% (56/60). Limitation of a previously normal range of movement, persistence or worsening of a limited range of movement occurred in 6.3% (4/60). Significant improvement of more than 20˚ was seen in four patients (cases 2, 3, 7 and 9) with limited flexion, in one with limited extension (case 13) and in one with restricted supination (case 14). In one patient (case 1) restricted pronation deteriorated further. One patient (case 8) who had a full range of supination before operation lost 60˚. At the time of removal of metal all patients had an elbow flexion-extension arc within 20˚ and a forearm pronation-supination arc within 30˚ of the value at the latest follow-up. Of the normal ranges of movement for flexion and extension, pronation and supination, 96% (49/51) were maintained but 3.9% (2/51) worsened; 78.8% (7/9) of the restricted ranges of movement were improved, 11.1% (1/9) persisted and 11.1% (1/9) became worse.

Pain, discomfort, and elbow instability. All six patients with pre-operative pain or discomfort in the elbow were asymptomatic at follow-up. None suffered from pre- or post-operative instability of the elbow or restriction of activities.

Radiological changes. None of the pre- and post-operative radiographs showed osteoarthritic changes in the elbow. At the time of reconstructive surgery only four ulnae showed anterior angulation of a mean of 7˚ (5 to 10). At operation all were corrected to a mean posterior angulation of 13˚ (5 to 20).

Bony union. The external fixators were removed after a mean of ten weeks (7 to 13). Two patients with delayed union of the osteotomy needed bone grafting, one (case 14) after acute ulnar distraction of 7 mm and the other (case 15) after continuous distraction of 10 mm.

Complications. There were no serious complications. Two patients had superficial pin-track infections which responded well to a short course of oral antibiotics.

Discussion

The decision to reconstruct a chronic dislocation of the radial head can be difficult because of the variety of causes and surgical techniques. The outcome of surgery may be unpredictable. Persistent or recurrent instability of the head and post-operative deterioration of movement of the elbow and forearm are the main causes of failure.2,3,5,10,15,16 Favourable outcomes are based on careful selection of patients and good surgical technique. There are well-recognised clinical and radiological criteria which have to be assessed before considering surgery.17

The morphology of the radial head and the capitellum is of great importance since it is not correctable and has a major effect on the outcome.3,7,8,16,17 The joint surface of the dislocated head in long-standing post-traumatic cases and congenital dislocations is convex because of the lack of capitellar counter pressure. There may be deformation of the whole head. Abnormality of the capitellum due to flattening or osteochondritis dissecans is rare. Dysplastic changes such as these prevent congruence of the radiocapitellar joint and render successful surgery unlikely.7 The interval between traumatic dislocation and reconstruction affects the outcome since secondary changes in the head and overgrowth of the radius develop in time. Most Monteggia fractures occur between five and seven years of age when there is a high potential for secondary changes in radial morphology because of the amount of growth remaining.18 There is usually some proximal migration of the radial head. This may be secondary to relative ulnar shortening due to a post-traumatic flexion deformity. More commonly, the lack of joint restraint leads to secondary radial overgrowth. A mismatch of ulnar and radial length does not hinder reconstruction of the radiocapitellar joint, but lengthening of the ulna or shortening of the radius should be considered.

In elbows with marked radiological changes in the radial head, congenital dislocation should be considered. Its distinction from traumatic dislocation is often difficult but important, since the results of reconstruction are poor in congenital dislocation.1,10,19 Posterior dislocation, bilateral involvement, associated anomalies, generalised laxity, a positive family history, a long history of decreased elbow movement, significant proximal migration and marked secondary changes of the radial head are typical features of a congenital problem.4,20 Increased ulnar length at the wrist may be a diagnostic sign.20 Careful clinical assessment of this joint is recommended.4,15 Instability of the distal radio-ulnar joint may become symptomatic during ulnar lengthening.

Most authors recognise the importance of a proximal ulnar angular osteotomy.1-3,8,15,16,21,22 This concept seems to be a logical basis for reconstruction since missed Monteggia lesions result in ulnar malunion with anterior bowing which contribute to the persistence or irreducibility of the dislocated radial head. Most ulnar deformities have partially or fully remodelled at the time of late reconstructive surgery. In some cases such a deformity may never have been present.1,23-26 We could only detect minor deformities of 5˚ to 10˚ of ulnar extension in the lateral radiographs of four of 12 patients with a history of injury. Other authors have reported anterior bowing of the ulna in 75% to 100% of post-traumatic dislocations.5,17 Ulnar malunion may not only be in the sagittal plane. A varus deformity was found to be most common in other series.4,18 Shortening and malrotation may also occur. No coronal deformity was seen in any of our patients and malrotation is difficult to assess by clinical and radiological methods. This makes accurate pre-operative planning difficult. Even when there is a visible and defined deformity, simple straightening of the ulna is
rarely adequate to achieve reduction of the radial head. We created a new ulnar deformity which we call 'overcorrection'. The associated tightening of the interosseous membrane helps to stabilise the radial head. Since we cannot plan the direction and extent of ulnar orientation preoperatively this has to be guided empirically by the position necessary to reduce the radial head at operation. It is usually achieved by simple flexion or in combination with movement of the distal fragment in the frontal or axial plane.

Radiological analysis in our patients showed a mean of 13° (10 to 20) of posterior bowing at the site of the osteotomy similar to previously reported values. In practice, external fixation with multidirectional clamps simplifies the attainment of the most satisfactory position of the ulna since the system can be easily adjusted until a stable reduction has been achieved. Preliminary fixation is sufficiently stable to allow intra-operative testing of all ranges of movement, definition of the carrying angle and radiological assessment of the anteroposterior and lateral position of the radial head. The appropriate amount of ulnar lengthening can also be determined.

Complications related to the ulnar osteotomy such as delayed union and loss of correction are either due to lengthening or unstable fixation. Ulnar lengthening is preferred to acute radial shortening to compensate for proximal displacement of the radial head. Acute shortening of the radius is more difficult to gauge while balancing reduction, stability and excessive pressure on the radial head relieves the mechanical block. Pronation and supination are the most likely to deteriorate. Ligamentous reconstruction seems to have a negative effect on pronation with reported deterioration in 20% to 100% of patients even with the use of functional postoperative exercises.

Angular ulnar osteotomy and open joint reconstruction can lead to stable reduction of the radial head with minimal complications. Exclusion of patients with marked deformation of the radial head is a prerequisite for a favourable outcome. Reconstruction of the annular ligament is not necessary if satisfactory re-orientation of the ulna is achieved in all planes. External fixation of the ulna is a simple technique which facilitates ulnar correction; it gives continuous lengthening of the ulna when necessary, allows immediate active post-operative exercises and is easily removed after bony union. However, the long-term benefit of reconstruction of the radiocapitellar joint in general and of this surgical technique in particular requires a further period of observation.

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