Children’s orthopaedics

Measurement of bowing of the radius

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Fractures and plastic deformities of the forearm are common in children. While axial deformities are easily recognised and treated, bowing of the radius may be overlooked. Physiological bowing is essential for full rotation of the forearm. We have used the method of Schemitsch and Richards to estimate the degree of bowing in 100 children who had not suffered a fracture of the forearm.

The site of maximum bowing remained constant at 60.39% of the length of the radius (95% CI 59.65 to 61.14). The value of maximum bowing did not exceed 10% of the total length (mean value 7.21%; 95% CI 7.00 to 7.41). This study provides information that can be useful for the diagnosis of bowing and for the evaluation of post-traumatic deformities.

Bowing of the radius is of crucial importance to the normal range of rotation of the forearm and to the strength generated by the muscles. Alteration of the normal bowing may result from fractures of the radius and from plastic deformation, a typical injury of childhood. While axial deformities of the forearm are easily recognised, changes of bowing may be subtle, and minor fractures which may influence it, are frequently missed. A method of measuring bowing in children and the normal values for different age groups would be of interest. The kinematics of pronation and supination are complex, but a simple method of assessment has shown good correlation with clinical parameters in adults. In 1992, Schemitsch and Richards described a method based on the measurement of three basic distances of the radius on the anteroposterior (AP) radiograph. Radial bowing was characterised by a maximum distance and site referred to as the total radial length. We investigated whether this method could be adopted for children. We studied children who had not sustained a fracture of the forearm and compared the results with those of one patient with an appropriate fracture who had reduced rotation and delay in union of the fracture of the ulna. We found that a slight modification of the method of Schemitsch and Richards is useful for the diagnosis of fractures causing bowing and for the evaluation of post-traumatic deformities in children.

Patients and Methods

Bowing of the radius was measured in 100 children aged from one to 15 years using the method of Schemitsch and Richards. A retrospective study was conducted on clinical charts and radiographs from children who had been seen for suspected injury to the forearm. Their parents gave written consent to scientific evaluation of the data obtained from diagnostic and therapeutic studies. For inclusion in the survey we required standardised AP and lateral radiographs of the forearm, including the wrist and elbow and with identification of the bicipital tuberosity. In order to exclude evidence of fracture or bowing the radiographs were assessed by two independent observers experienced in paediatric trauma and blinded to the scope of the study. Children were excluded if they had persistent pain or limitation of movement in the forearm, if the observers disagreed or if the radiographs were inadequate. During follow-up no patients showed clinical evidence of a fracture and all had full rotation of the forearm and a normal grip.

Radial bowing is best measured on standardised projections taken in neutral rotation. On an AP radiograph of the forearm, the length of the radius (y), the location of maximum radial bow and the maximal distance of the radius from this point is measured. The distance (y) is measured from the bicipital tuberosity to the distal radioulnar joint. As most of our patients had incomplete ossification the distal radial epiphysis was used as the refer-
ence point. This modified method of Schemitsch and Richards\(^1\) is shown in Figure 1. At the point of maximum radial bow, a perpendicular line (r) is drawn to (y) and the distance is measured. This value indicates the maximum radial bow. To determine the site of maximum radial bow, the distance from the bicipital tuberosity to the point of maximum bow is divided by the length of the entire bow and expressed as percentage (x/y \times 100). By applying this method, bones of different length can be compared. Due to the highly variable bone length in our patients, the maximum radial bow (r) was also reported as a percentage of the radial length (y), calculating r/y \times 100. Data were evaluated using the statistics program STATISTICA (Statsoft Inc, Tulsa, Oklahoma).

**Results**

The distribution of values for the site of maximum bowing is shown in Figure 2. The mean value was 60.39% (SD ± 3.74%; 95% CI 59.65 to 61.14). The mean value of maximum radial bow was 7.21% of the total radial length (SD ± 1.03%; 95% CI 7.00 to 7.41). While the length of the radius and the maximum bowing increased with age, the site of maximum radial bowing (x/y \times 100) remained constant.

**Clinical application.** A 13-year-old boy sustained an injury to the forearm after a fall. On the initial radiographs an undisplaced fracture of the ulna was diagnosed and fracture or subluxation of the radius excluded. A long-arm cast was applied for three weeks. After six weeks pronation was to 70° and supination to 50°. Healing was delayed and progressive displacement of the fracture of the ulna became evident (Fig. 3). Analysis of radial bowing revealed a maximum bow (r) of 18 mm, a radial length (y) of 170 mm and a site of maximum radial bow at 100 mm. Expressed as percentage this showed the site of maximum bowing as 58.82%, which was 10.59% of the radial length. These values are outside the normal figures outlined above and indicate the presence of a fracture of the radius.
The median site of maximum bowing was 60.39% (SD ± 3.74%) and a similar value of 59.9%; (SD ± 0.7%) was observed by Sche-
mitsch and Richards.5 They compared the radial bowing of
similar value to that of the uninvolved forearm. Radial length (y) and the maximum radial bow (r)
tonic description of radial bowing in the AP plane in chil-
dren. Radial length (y) and the maximum radial bow (r)
ments and allows more detailed estimation of the process of
diaphyseal remodelling. Our modification of the method of
Schemitsch and Richards5 allows for estimation of the
shape of the radius based on its length, which is independ-
ent of age. This may be useful clinically because it is based
on standard radiographs.

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