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Original Research Article

Analysis of Safe Zone for Pre Contoured Plate Fixation in Dry Radii of Indian Origin

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Abstract

Management of radial head and neck fractures involves precontoured plate fixation.Proper plate fixation by determination of safe zone helps in restoration of normal mobility and function at radio ulnar and elbow joint. Aims and objectives of present study includes :1) To estimate bending radius of neck head curvature in the safe zone (BR), 2) Types of curvature classified as flat profile, low concave curvature and marked concave curvature at safe zone and 3) To estimate the differences in parameters between right and left radii. Results: Mean bending radii at safe zone was 25.66±9.64 and 29.97±10.40 in right and left side respectively. There was significant difference in values of bending radii between right and left sides. Low concave curvature was most prevalent type of curvature. Conclusion: Estimation of bending radii at safe and its morphology can help in reducing impingement and help in reducing postoperative complications.

Keywords: Radial head and neck fractures, safe zone, pre contoured plates, bending radius.

INTRODUCTION

Radial head and neck fractures represent approximately 1.7% to 5.4% of all fractures [1]. Radial head fractures account for approximately one third of all elbow fractures and are involved in approximately 20% of elbow trauma cases [2]. As a result, radial head replacement may be considered the first surgical option in elderly and low-demand patients, while every effort should be made to preserve the radial head and neck in young patients. In the last few years, several anatomical plates have been introduced to improve open reduction and internal fixation results in Mason Type II and III fractures. Hence safe zone for application of these pre contoured plates is important. Some of the currently available radial head implants may significantly alter elbow joint kinematics because of a mismatch between their design characteristics and the morphologic characteristics of the proximal radius. Complications that have been reported with current designs include persistent pain, loosening, implant fracture, implant wear, and particulate Synovitis. Hence proper fixation of pre contoured plates is important in improving post operative joint kinematics. In present study we have focused on determining safe zone and its morphological variants.

Aims and Objectives

- To estimate bending radius of neck head curvature in the safe zone (BR).
- Types of curvature classified as flat profile, low concave curvature and marked concave curvature at safe zone.
- To estimate the differences in parameters between right and left radii.

MATERIALS AND METHODS

142 adult dry cadaveric radii (71 right and 71 left) were randomly selected from the department of Anatomy, St John's Medical College, Bangalore. Radii with broken proximal end and ones showing obvious pathology like healed fractures were excluded from the study. Sample size was calculated using N Master software with mean and standard deviation from previous literature. Statistical analysis was done using SPSS software. Difference in sides was measured using independent sample T test.

Measurement of Bending Radius at Safe Zone (BR)
Image Acquisition

- The bone was placed on an osteometric board covered with a graph sheet on its anterior surface so that posterior surface was seen.
- The digital camera was fixed to a stand for proper focus and centralized along with the bone on the graph sheet.
- To assess the neck head morphology of the safe zone the radius was positioned in neutral rotation and the center of the safe zone was identified as a point placed 10^0 anteriorly from the lateral edge of the radial head and image was transferred into Auto CAD software [3, 4].

Fig-1: Method of taking photo for bending radius at safe zone

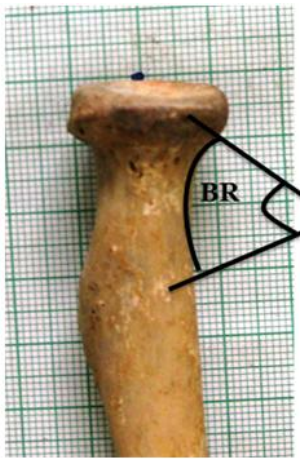

Image Analysis: Using Auto CAD software.

- Arc is drawn along neck head curvature of safezone.
- Angle subtended by this arc is directly measured by the software which gives bending radius at safezone.

b) Type of curvature at safezone

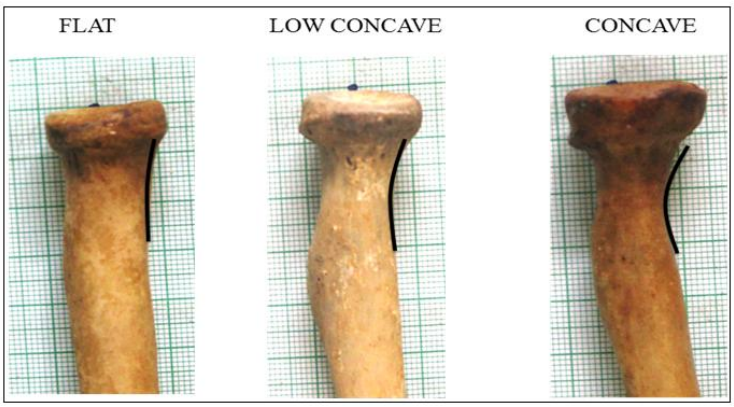

Fig-2: Types of curvature at safezone

RESULT

Table-1: Mean values of the angles of left radii

Parameter	Mean ± SD Left radii	Mean ± SD right radii
Bending radius at safezone (º)	25.66±9.64	29.97±10.40

Table-2: Side differences in angles by Independent sample t-test

Parameter	p value	95% C.I
Bending radius at safe zone	**0.012***	0.981 to 7.68

There was significant difference in value of bending radius at safe zone between right and left sides.

Table-3: Prevalence of type of curvature at safe zone

CURVATURE	RIGHT	LEFT	TOTAL	PERCENTAGE (%)
Concave	1	7	8	5.63
Flat	27	27	54	38.02
Low concave	43	37	80	56.33

DISCUSSION

In present study there was significant difference in values of bending radius at safe zone between right and left sides. This should be considered during selection of precontoured plates. Low concave type of curvature was most prevalent which should be considered while designing plates. Very few previous studies has been done on estimation of safe zone in proximal radius for plate fixation. In 1996, Smith and Hotchkiss defined the safe zone as the posterolateral aspect of the radial head that does not articulate with the radial notch of the ulna during forearm rotation [3]. They found that when the forearm was positioned at neutral rotation, the safe zone corresponded to an arc of 110° included between 2 lines bisecting the radial head at 65° anterolaterally and 45° posterolaterally. Caputo *et al*., suggested a method to identify the safezone irrespective of surgical approach used. Their safezone corresponds to an arc of 90° between projection of radial styloid and Lister's tubercle of radial head [5]. Soyer *et al*., suggested identifying the safezone through the application of a device positioned in the lateral portion of the radial head with forearm in neutral rotation [6]. Such a zone should be considered as the only portion of the radial head where osteosynthesis may be safely performed with low risk of mechanical impingement. Giannicola evaluated the congruence between the proximal radius and a currently used plate. Forty-four radial dried cadaveric bones were analyzed. The plate congruence was evaluated qualitatively and quantitatively. The congruence of the tested plate with the proximal radius was good in 27.3% of specimens, while it was moderate or poor in the remaining 43.2% and 29.5% of cases, respectively. The profile of the proximal radius in the ''safe zone'' shows substantial morphologic variations which should be taken into account to avoid a malunion of the proximal radius [4]. Giannicola evaluated morphologic aspect of the neck-head curvature of the safe zone of 71 dry cadaveric radii qualitatively and quantitatively. The proximal radius at the level of the safe zone exhibited different radii of bending. In particular, they identified a morphologic type A, which showed a flat profile (25% of cases), morphologic types B and C, which showed a low concave curvature (64%), and a marked concave curvature (11%), respectively, of the safe zone which correlates with our study. He also described bending radius at head neck curvature zone as 13.5° [7]. Difference in values of bending radii may be due to differences in sex, occupation and population. Knowledge of the proper bending radius of the safe zone allows the surgeon to select the most appropriate plate, and to achieve good fracture reduction and anatomical restoration of the proximal radius.

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