Factors Affecting the Redisplacement of the Conservatively Treated Extra Articular Fractures of Distal Radius

Sukrom Cheecharern MD*

** Department of Orthopaedic Surgery, Rajavithi Hospital, College of Medicine, Rangsit University, Bangkok, Thailand*

Background: *The objective of the study was to predict the amount of radiographic dorsal tilt angulation of extra articular fracture of distal radius with the size of dorsal cortical bone defect, radioulna index difference, age and gender of the patient.*

Material and Method: *Sixty two patients with close fracture of Colles type were treated by close reduction and short arm cast. They were evaluated radiographically for initial dorsal tilt angulation, initial radioulna index, radioulna index after reduction, dorsal cortical defect after reduction and dorsal tilt angulation at the end of immobilization at 4 to 6 weeks. Using the method of multiple regression analysis, The author tried to construct the equation to predict quantitatively the changing amount of dorsal tilt angulation of extra articular fracture of distal radius from the independent variables of dorsal cortical bone defect size, radioulna index difference, age and gender of the patients.*

Results: *The presence of dorsal cortical bone defect,age and sex of the patient were found to be the predictors of the increased dorsal tilt angulation of distal radius. For the estimation of dorsal tilt angulation, the correlation coefficient for dorsal cortical bone defect size was 0.177, for age was 0.201, and female gender was -8.206. The radioulna index difference was not found to have correlation with increased dorsal tilt angulation of distal radius.*

Conclusion: *The increased dorsal tilt angulation of extra articular fracture of distal radius at 4-6 week after reduction can be predicted from the initial data on size of dorsal cortical bone defect, age and gender of the patients. The radioulna index difference did not show the significant correlation with increased dorsal tilt angulation of extra articular fracture of distal radius treated conservatively.*

Keywords: *Colles fracture, Instability, Multiple regression*

J Med Assoc Thai 2009; 92 (Suppl 6): S239-43
Full text. e-Journal: *http://www.mat.or.th/journal*

Dorsal tilt angulation is one of the most common abnormal radiographic findings in healed extra-articular fracture of distal radius[1]. Palmar angle is found to correlate with wrist dysfunction, such as pain and grip strength[2,3]. Various risk factors have been studied for an association with redisplacement of extra articular fracture of distal radius such as initial dorsal tilt angulation[4,5], dorsal comminution[6-8], age[9,10] and gender of the patient[9,10]. Radial shortening was also reported as one of the risk factors by some authors[5,11].

The purpose of this study was to determine the correlatation of the size of dorsal cortical bone defect, radioulna index difference, age and sex of the patient to the amount of increased dorsal tilt angulation of extra articular fracture of distal radius at the end of the short arm cast immobilization. Radiographic indices used such as dorsal tilt angulation and radioulna index, are generally accepted with high consistency[12,13].

Correspondence to: Cheecharern S, Department of Orthopaedic Surgery, Rajavithi Hospital, College of Medicine, Rangsit University, Bangkok, Thailand.

Material and Method

An observational study was employed using patient records and wrist radiologic examinations as data sources. The database at a single instituition (Rajavithi Hospital, Bangkok, Thailand) was used to identify all patients with distal radius fractures over the course of the last 3 years.

Statistical analysis

Multiple regression analysis was used to predict the changing amount of dorsal tilt angle from multiple independent variables. Sample size was calculated from the equation[14]:

$n = (Z_{1-\alpha/2} + Z_{1-\beta})^2/C(r)^2 + 3$

where $C(r) = 1/2 \log((1+r)/(1-r))$

Pearson correlation from the pilot study for maximum sample size was 0.365

then $n_1 = 53$ cases

for this study of p independent variables; $n_p = n_1/(1- \rho^2_{1-4})$

then $n_p = 62$ cases

Inclusion criteria

1. Patients with extra articular fracture of distal radius

2. Every fracture was successfully manipulated into either anatomic or acceptable position.

3. Every fracture was immobilized in short arm cast for 4-6 weeks.

Exclusion criteria

1. Intra articular fracture

2. Irreducible fracture

The practical method to measure the size of dorsal cortical bone defect which was generally practiced in the study setting with moderate agreement within the same observer (R = 0.83) and mild agreement between observers (R = 0.64) was used. The size was measured in degree of angle formed by the lines joining dorsal and volar fracture sites of distal and proximal fragments. The size of dorsal cortical bone defect was measured from the lateral radiograph of the post-reduction extra articular fracture of distal radius in every patient.

Results

Demographic and baseline data

Of 62 subjects (14 males and 48 females), 63 extra articular fractures of distal radius were included in this study. the gender distribution for subjects was 21% males and 79% females. The average age was 53.51 $\pm$ 18.02 years old, ranging from 15 to 82 years old. The average age of male patients was 43.07 years old and the average age of female patients was 56.49 years old. The mean of dorsal tilt angulation before reduction was 14.79 $\pm$ 11.82 degrees ranging from -13 to 40 degrees. The mean of dorsal tilt angulation after reduction was -0.70 $\pm$ 8.18 degrees, ranges from -19 to 13 degrees.

The mean of dorsal tilt angulation at the end of immobilization was 8.71 $\pm$ 10.70 degrees, ranging from 21 to 33 degrees. Of the total number of 63 extra articular fractures of distal radius treated, 50 fractures (79%) increased their dorsal tilt angulation. The mean of redisplacement of dorsal tilt angulation was 9.41 $\pm$ 9.96 degrees, ranging from -8 to 43 degrees. The mean of increasing angle of radioulnar index before reduction was 2.32 $\pm$ 2.89 mm, ranging from -1.6 to 9.2 mm. The mean of radioulnar index after reduction was 1.34 $\pm$ 2.14 mm, ranging from -2.5 to 8.45 mm. The mean of radioulnar index at the end of immobilization was 3.13 $\pm$ 3.05 mm ranging from -1.9 to 13 mm.

The estimated size of dorsal cortical bone defect measured in degrees was 19.73 $\pm$ 14.50 degrees, ranging from 0 to 55 degrees. There was a statistically significant correlation between size of dorsal cortical bone defect, age, and gender of the patient and increased dorsal tilt angulation of extra articular fracture of distal radius (multiple coefficient correlation $R = 0.508$, $p < 0.000$).

From the coefficient of partial correlation of three independent variables, the constructed equation used to predict the redisplacement of dorsal tilt angle of extra articular fracture of distal radius extra articular fracture of distal radius at the end of immobilization from size of dorsal cortical bone defect, and patients' age and gender was:

$$Y = 1.512 + 0.177x_1 + 0.202x_2 - 8.207x_3$$

Where y = redisplacement of dorsal tilt angle of Colles' fracture at the end of immobilization

x_1 = size of dorsal cortical bone defect

x_2 = patients' age

x_3 = patients' gender where male = 0 and female = 1

Discussion

The size of dorsal cortical bone defect showed the same direction with the increased dorsal tilt angulation with regard to its coefficient of partial correlation of 0.177. This result also confirmed the finding of other studies about dorsal cortex comminution and instability of Colles' fractures using different approaches[5,6,8,15,16].

According to the coefficient of partial correlation of patients' age: 0.202, it showed a stronger effect on the redicplacement of dorsal tilt angle of Colles' fracture than the size of dorsal cortical bone defect which was consistent to what have been reported previously[4,5,10,15,17].

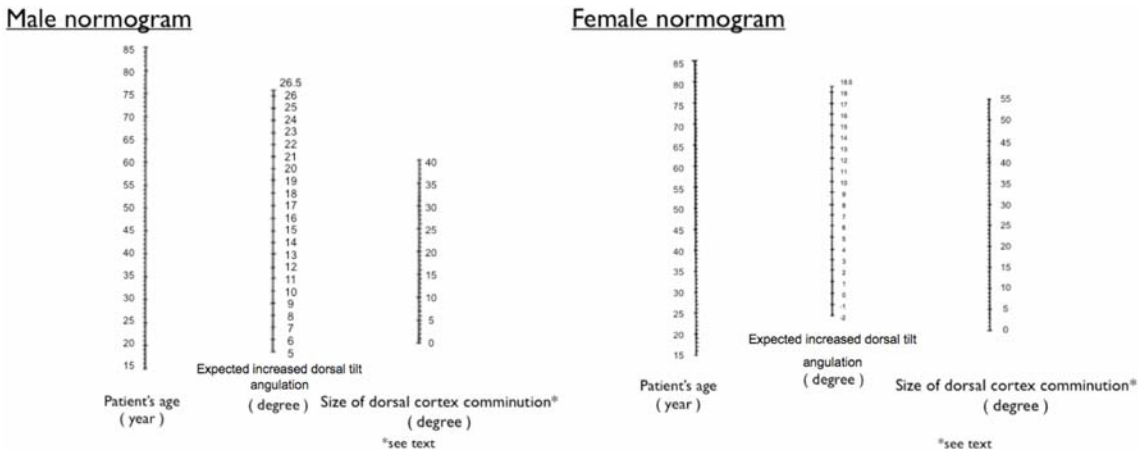

Fig. 1 Gender-specific normogram
The instruction for this normogram was as the following steps:
1. Age range within 84-15 years old
2. Size of dorsal cortex comminution range within 50-0 degrees
3. Sex-specific
4. Dorsal cortex comminution measurement method

For patients' gender, it showed that gender was quite strong predictive factors of increased dorsal tilt angulation of extra articular fracture of distal radius in which males had worse prognosis than females, in contrast to previous studies[9,10].

The differences of radioulna index between before and after reduction was not found to be significant predictive factors. Radial axial shortening has been studied with a different methodology and found to be one of the predictive factors in previous studies[5,11,15].

To eliminate steps of calculating redisplacement of dorsal tilt angle from variable from dorsal cortical bone defect, and patients' age and gender, and to simplify the equation for clinical use, we made the gender-specific normograms to predict the increasing dorsal tilt angulation of extra articular fracture of distal radius at the end of immobilization as shown below.

The size was measured in degree of angle formed by the lines joining dorsal and volar fracture sites of distal and distal fragments on lateral radiograph (Fig. 2).

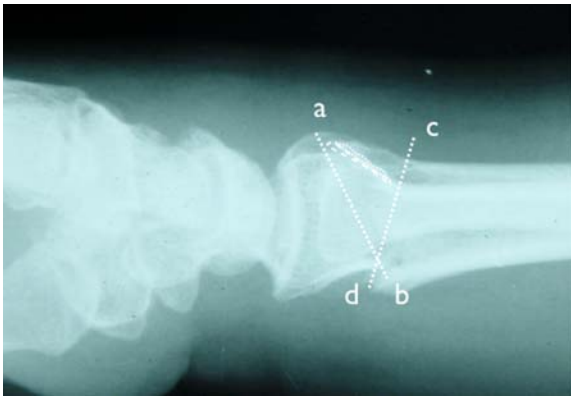

Fig. 2 Measurement of angle formed by the lines joining dorsal and volar fracture sites of distal and distal fragments on lateral radiograph

Conclusion

The increased dorsal tilt angulation of extra articular fracture of distal radius at 4-6 week after reduction can be predicted from the initial data of the size of dorsal cortical bone defect, age and gender of the patients. The differences of radioulna index were not significantly correlated with the increased dorsal tilt angulation extra articular fracture of distal radius.

References

1. Altissimi M, Antenucci R, Fiacca C, Mancini GB. Long-term results of conservative treatment of fractures of the distal radius. Clin Orthop Relat Res 1986; (206): 202-10.
2. Karnezis IA, Panagiotopoulos E, Tyllianakis M, Megas P, Lambiris E. Correlation between radiological parameters and patient-rated wrist

dysfunction following fractures of the distal radius. Injury 2005; 36: 1435-9.
3. Warwick D, Field J, Prothero D, Gibson A, Bannister GC. Function ten years after Colles' fracture. Clin Orthop Relat Res 1993; (295): 270-4.
4. Hove LM, Solheim E, Skjeie R, Sorensen FK. Prediction of secondary displacement in Colles' fracture. J Hand Surg Br 1994; 19: 731-6.
5. Leone J, Bhandari M, Adili A, McKenzie S, Moro JK, Dunlop RB. Predictors of early and late instability following conservative treatment of extra-articular distal radius fractures. Arch Orthop Trauma Surg 2004; 124: 38-41.
6. Jenkins NH. The unstable Colles' fracture. J Hand Surg Br 1989; 14: 149-54.
7. Hastings H, Leibovic SJ. Indications and techniques of open reduction. Internal fixation of distal radius fractures. Orthop Clin North Am 1993; 24: 309-26.
8. Flinkkila T, Nikkola-Sihto A, Raatikainen T, Junila J, Lahde S, Hamalainenn M. Role of metaphyseal cancellous bone defect size in secondary displacement in Colles' fracture. Arch Orthop Trauma Surg 1999; 119: 319-23.
9. Young BT, Rayan GM. Outcome following nonoperative treatment of displaced distal radius fractures in low-demand patients older than 60 years. J Hand Surg Am 2000; 25: 19-28.
10. Nesbitt KS, Failla JM, Les C. Assessment of instability factors in adult distal radius fractures. J Hand Surg Am 2004; 29: 1128-38.
11. Dixon S, Allen P, Bannister G. Which Colles' fractures should be manipulated? Injury 2005; 36: 81-3.
12. Steyers CM, Blair WF. Measuring ulnar variance: a comparison of techniques. J Hand Surg Am 1989; 14: 607-12.
13. Kreder HJ, Hanel DP, McKee M, Jupiter J, McGillivary G, Swiontkowski MF. X-ray film measurements for healed distal radius fractures. J Hand Surg Am 1996; 21: 31-9.
14. Hsieh FY, Bloch DA, Larsen MD. A simple method of sample size calculation for linear and logistic regression. Stat Med 1998; 17: 1623-34.
15. Mackenney PJ, McQueen MM, Elton R. Prediction of instability in distal radial fractures. J Bone Joint Surg Am 2006; 88: 1944-51.
16. McQueen MM, MacLaren A, Chalmers J. The value of remanipulating Colles' fractures. J Bone Joint Surg Br 1986; 68: 232-3.
17. Foldhazy Z, Tornkvist H, Elmstedt E, Andersson G, Hagsten B, Ahrengart L. Long-term outcome of nonsurgically treated distal radius fractures. J Hand Surg Am 2007; 32: 1374-84.

ปัจจัยที่มีความสัมพันธ์กับการโก่งงอของส่วนปลายกระดูกเรเดียสในผู้ป่วย กระดูกเรเดียสส่วนปลายหักชนิดหักอยู่นอกข้อด้วยวิธีการรักษา แบบไม่ผ่าตัด

สุกรม ชีเจริญ

วัตถุประสงค์: *เพื่อศึกษาความสัมพันธ์ระหว่างภาวะการโก่งงอของส่วนปลายของกระดูกเรเดียส ในผู้ป่วยกระดูกเรเดียสส่วนปลายหักชนิดหักอยู่นอกข้อ เมื่อสิ้นสุดการรักษาด้วยการใส่เฝือกกับขนาดของชิ้นกระดูก dorsal cortical comminution, เพศ อายุ และ radio-ulna index difference*

วัสดุและวิธีการ: *การศึกษานี้เป็น การศึกษาเชิงวิเคราะห์ ณ จุดเวลาใดเวลาหนึ่ง ณ โรงพยาบาลราชวิถี ภาพรังสีของข้อมือผู้ป่วยกระดูกเรเดียสส่วนปลายหักชนิดหักอยู่นอกข้อ ที่คัดเลือกมาอย่างสุ่ม จำนวน 63 ภาพ จากผู้ป่วย 62 ราย เป็นชาย 14 ราย หญิง 49 ราย ได้นำมาวัดค่าภาวะโก่งงอของส่วนปลายกระดูกเรเดียส ภายหลังการดึงกระดูกให้เข้าที่ เปรียบเทียบกับ เมื่อสิ้นสุดการรักษา, ขนาดของ dorsal cortex comminution, ความแตกต่างของ radio-ulna index ก่อน และ หลัง การดึงกระดูกให้เข้าที่, เพศ และอายุของผู้ป่วย นำมาคำนวณหาค่าความสัมพันธ์ระหว่างตัวแปรตามคือ ความแตกต่างของค่าความโก่งงอของส่วนปลายกระดูกเรเดียส ภายหลังการดึงกระดูกให้เข้าที่ เปรียบเทียบกับ เมื่อสิ้นสุดการรักษา กับตัวแปรอิสระคือ ขนาดของ dorsal cortex comminution, ความแตกต่างของ radio-ulna index ก่อนและหลังการดึงกระดูกให้เข้าที่ เพศ และอายุของผู้ป่วย โดยใช้สัมประสิทธิ์สหสัมพันธ์เชิงพหุ*

ผลการศึกษา: *ความแตกต่างของค่าความโก่งงอของส่วนปลายกระดูกเรเดียสภายหลังการดึงกระดูกให้เข้าที่ เปรียบเทียบกับ เมื่อสิ้นสุดการรักษามีความสัมพันธ์กับตัวแปรอิสระคือ ขนาดของ dorsal cortex comminution, เพศ และอายุของผู้ป่วย โดยมีสัมประสิทธิ์สหสัมพันธ์ตามค่าสมการดังนี้ $Y = 1.512 + 0.177x_1 + 0.202x_2 - 8.207x_3$ เมื่อ Y = ความแตกต่างของค่าความโก่งงอของส่วนปลายกระดูกเรเดียสภายหลังการดึงกระดูกให้เข้าที่ เปรียบเทียบกับเมื่อสิ้นสุดการรักษา, X1 = ขนาดของ dorsal cortex comminution, X2 = อายุของผู้ป่วย, X3 = เพศของผู้ป่วย เมื่อเพศชาย = 0 และ เพศหญิง =1*

สรุป: *ความแตกต่างของค่าความโก่งงอ ของส่วนปลายกระดูกเรเดียสภายหลังการดึงกระดูกให้เข้าที่ เปรียบเทียบกับเมื่อสิ้นสุดการรักษามีความสัมพันธ์กับขนาดของ dorsal cortex comminution, เพศ และอายุของผู้ป่วย*