Malunion of distal radius fractures

Essay

Submitted for partial fulfillment of
master degree in orthopedic surgery

By

Mahmoud Fysal Mahmoud

M.B.B,Ch
Faculty of Medicine
Mansoura University

Under supervision of

Prof. Dr. Mohammed Mostafa El Mahy

Professor of orthopedic surgery

Faculty of Medicine
Ain - Shams University

Dr. Wael Ahmed Nassar

Lecturer of orthopedic surgery

Faculty of Medicine
Ain- Shams University

Faculty of Medicine
Ain- Shams University
2008

Acknowledgement

I would like to thank **Allah** for giving me strength, capability and opportunity to do this work.

My deepest appreciation goes to Prof. Dr. **Mohammed Mostafa El-Mahy** prof. of orthopedic surgery, Faculty of medicine, Ain shams university, as his supervision, continuous help, encouragement and suggestions helped me throughout this work.

I am also greatly indebted to Dr. **Wael Nassar** lecture of orthopedic surgery, Faculty of medicine, Ain shams university, for his helpful support, valuable guidance and advice.

I would also like to thank my family and friends for their cooperation, patience and encouragement which they gave me through out this work .

Introduction

The articular surface of the distal radius is composed of the lunate fossa and scaphoid fossa which articulate with the lunate and scaphoid bones to form the radiocarpal joint. On the ulnar aspect of the distal radius, the sigmoid notch articulates with the distal ulna to form the distal radioulnar joint. [(1)]

Fractures of the distal radius constitute about one sixth of all fractures seen in the emergency room. They range from insufficiency fractures in osteoporosis to high-energy multifragmentary fractures in young adults. [(2)]

Malunion is among the most common of the complications of distal radius fractures. [(3)] Malunion rate is as high as 23.5% for conservatively treated distal radius fractures, in those managed operatively the risk decreases to 10.1% .[(4)] It may be extra-articular with a metaphyseal angulation, loss of length relative to the ulna, and rotational deformity of the distal fragment with respect to the diaphysis. Distal radial malunion may be intra-articular with a step-off at the radiocarpal and/or the DRUJ or both intra-articular and extra-articular.[(5)] Symptoms can be very severe or only a slight discomfort for the patient depending on a number of factors related to the type of deformity and to the pain tolerance of the individual. They range from pain, sometimes very severe up to complex regional pain syndrome, weakness, limitation of active and passive range of motion. [(6)]

The aim of treatment is to reestablish the normal anatomical relationship of the wrist joint and normal kinematics of the midcarpal, radiocarpal, and distal radioulnar joints. This is accomplished by restoring palmar tilt in the sagittal plane and radial inclination in the coronal plane, correcting any rotational malalignment in the horizontal plane, restoring radial length, and restoration of articular congruity to maintain a functional, pain-free wrist. [(4)]

Several different surgical options exist to treat distal radius malunions and their sequelae. Each case must be approached meticulously with treatment individualized to the deformity. Operative treatment options include: Correction of the distal radius length, correction of dorsal angulation of the radius, shortening/excision of the distal ulna, osteotomy to realign the DRUJ, or ligament reconstruction of the DRUJ, wrist fusion or wrist arthroplasty. [(7)]

The goals of fixation after osteotomy of the distal radius are maintenance of reduction with preservation of motion and function. New fixed-angle volar plates can provide an alternative to the traditional techniques of distal radius osteotomy including structural bone grafting and dorsal plate fixation or external fixation. In addition these plates are rigid enough to allow for early postoperative motion.[8] Corrective osteotomy of malunited distal radius is a complex, demanding procedure and not without problems. Complications include infection, wrist stiffness, failure to fully correct the malunion, loss of reduction, nonunion, tendon rupture, persisting pain, and disability on the ulnar side of the wrist joint. [5]

Distraction osteogenesis has become an attractive alternative to the more traditional opening wedge osteotomy with plate fixation and bone graft. It minimizes the amount of periosteal stripping and eliminates the need for bone graft substitutes or autologous bone graft.[9] Computer-assisted techniques have been developed to assist surgeons in the appreciation of complex multidirectional deformities and to achieve improved outcomes with management of malunion of distal radius.[10]

Treatment of malunion of distal radius is continually evolving. The better understanding, advent of new computer technologies, plating systems, and bone graft substitutes will likely have a significant impact upon the way distal radius malunions are corrected in the near future. Prevention of malunion through optimal fracture management remains the best option.[4]

Aim of the work

The aim is to review the anatomical, clinical, and pathological considerations of the malunion of distal radius fractures, and to discuss the consequences of malunion of the distal radius and the different methods of management

References

1. Cardoso R, Szabo RM: Wrist anatomy and surgical approaches. Orthop Clin N Am 38: 127–148 (2007).

2. Ruch DS: Fractures of distal radius and ulna, Rockwood and Green's Fractures in Adults. Bucholz RW, Heckman JD, Koval KJ, Tornetta P, Wirth MA, Brown CM(Eds), 6th edition, Lippincott Williams & Wilkins, Philadelphia, volume 1, chapter 26, pp. 909–964 (2006).

3. Viegas SF: A new modification of corrective osteotomy for treatment of distal radius malunion. Techniques in Hand and Upper Extremity Surgery 10(4): 224–230 (2006).

4. Slagel BE, Luenam S, Pichora DR: Management of post-traumatic malunion of fractures of the distal radius. Orthop Clin N Am 38: 203–216 (2007).

5. Prommersberger KJ, Lanz UB: Corrective osteotomy of distal radius through volar approach. Techniques in Hand and Upper Extremity Surgery 8(2): 70–77 (2004).

6. Brunelli GA: Dome-shaped osteotomy for distal radius fracture malunions. Techniques in Hand and Upper Extremity Surgery 7(2): 75–79 (2003).

7. Turner RG, Faber KJ, Athwal GS: Complications of distal radius fractures. Orthop Clin N Am 38: 217–228 (2007).

8. Malone KJ, Magnell TD, Freeman DC, Boyer MI, Placzek JD: Surgical correction of dorsally angulated distal radius malunions with fixed angle volar plating. J Hand Surg 31A: 366–372 (2006).

9. Lubahn JD, Hood JM, Nechleba J, Williams DP, Green T: Gradual reduction of distal radial malunion using distraction osteogenesis. J Hand Surg 32A: 795–800 (2007).

10. Athwal GS, Ellis RE, Small CF, Pichora DR: Computer-assisted distal radius osteotomy. J Hand Surg 28A: 951–958 (2003).

الملخص العربي

كسور أسفل عظمة الكعبرة تعتبرمن أكثر كسور العظام شيوعا حيث تمثل تلك الكسور نحو ما يقرب من سدس كسور العظام. تعتبر هشاشة العظام من اهم الاسباب المصاحبة لحدوث كسور أسفل عظمة الكعبرة.

إن استعادة أربعة حدود حاسمة تشريحيّة (الطول الكعبرى، الميل الراحي، الميل الكعبرى و التّوافق المفصليّ) متّصل بالنّتيجة الجيّدة. تعطيل هؤلاء يؤثّر على الميكانيكا المشتركة التي يمكن أن تقود الى حدوث الايلام.

سوء الالتئام يعتبر من اكثرالمضاعفات شيوعا لكسور أسفل عظمة الكعبرة. الأعراض المصاحبة لسوء الالتئام تتراوح من الإيلام إلى تقييد مدى حركة المفصل أو حدوث تيبس للمفصل حيث أنها تعتمد على عدد من العوامل التي تتعلق بنوع العاهة أو مدى تحمل الفرد للألم.

وسائل علاج سوء التئام كسوراسفل عظمة الكعبرة تتطور بشكل مستمر حيث بمساعدة التقنيات التكنولوجية المختلفة و الأنظمة الحديثة المختلفة من الشرائح و بدائل ترقيع العظام لها تأثير هام على علاج سوء الالتئام في المستقبل القريب. يوجد العديد من الخيارات الجراحية من اجل علاج سوء التئام كسور أسفل عظمة الكعبرة التي يتم استخدامها تبعا لنمط العاهة أو المتطلبات الفردية الخاصة بالمريض.

إن الهدف الاساسى من علاج سوء التئام كسور أسفل عظمة الكعبرة هو الحصول على التوافق المفصلى و الترتيب التشريحى للمفصل و ذلك من اجل استعادة الدور الوظيفى للمفصل دون أن يصاحب هذا بحدوث إيلام. التقويم التصحيحى لسوء التئام كسور أسفل عظمة الكعبرة هو عملية معقدة قد تصاحب بعدد مختلف من المضاعفات مثل تيبس المفصل أو عدم التئام الكسر أو الفشل في حدوث التصحيح التام لسوء التئام الكسر اوالايلام او حدوث التهاب الأوتار . يظل منع حدوث سوء الالتئام عن طريق التثبيت المثالي للكسر هو الخيار الأفضل.

List of figures

Fig.	Title	Page
2-1	The osseous anatomy of the wrist.	4
2-2	The articular surface of the distal radius	5
2-3	The anatomy of the palmar wrist ligaments	7
2-4	Anterior (A) and posterior (B) views of the wrist with detail of the extrinsic and intrinsic ligaments	8
2-5	(a) Diagram of TFCC anatomy. (b) Correlative coronal MR arthrogram image provides detailed view of the TFCC anatomy.	9
2-6	The arterial supply of the dorsal aspect of the wrist	12
2-7	The arterial supply of the palmar aspect of the wrist	13
3-1	(A) Radial inclination. (B) Radial tilt. (C) Radial height. (D) Ulnar variance.	15
3-2	(a) The biomechanics of a colles' fracture, (b) the biomechanics of a Smith's fracture	20
3-3	A volar shearing intra-articular fracture of the distal radius	22
3-4	A compression intra-articular fracture of the distal radius	23
3-5	Types of melone classification.	28
3-6	McMurtry classification of intra-articular fractures.	29
3-7	Mayo Clinic classification of distal radius fractures.	30
3-8	AO comprehensive classification.	31
3-9	Fernandez classification	32

4-1	Ulnar impaction syndrome secondary to fracture of the distal radius	37
4-2	A, B: Lateral schematic of the malunion that shows two types of carpal adaptive patterns.	41
4-3	(A, B) Late sequelae of fracture malunion.	42
5-1	Technique of dorsal open wedge osteotomy.	57
5-2	Volar osteotomy for malunited distal radial fracture.	62
5-3	Some of the options for volar fixed angle plating	64
5-4	Technique for malunion repair using a fixed angle volar plate and cancellous bone grafting.	65
5-5	Schematic drawings demonstrating the correction achieved with a sliding osteotomy.	66
5-6	Trapezoidal osteotomy of the dorsal distal radius with 90° rotation of the osteotomized corticocancellous fragment into an opening wedge–type transverse recipient site.	67
5-7	The biplanar closing-wedge osteotomy with cuts in the frontal (A) and sagittal (B) planes. C, The wedge removed and the stable bone-to-bone contact that result.	67
5-8	Example of correction of distal radius malunion a dome-shaped osteotomy plus Kapandji–Sauvé procedure.	68
5-9	Corrective radial osteotomy using non-spanning external fixation.	72
5-10	(a) Placement of two 1.6-mm K-wires into distal radius with template. (b) Image intensifier control of correct positioning parallel to the joint space	73

5-11	(a)Placement of fixator screws parallel to the joint surface after replacing the K-wires and after predrilling. (b) Placement of the proximal screws in the diaphysis of the radius dorsally. (c) Osteotomy is performed and the fixator is reattached. (d) Gap is filled with corticocancellous bone	74
5-12	(a) application of the external fixator after subtotal osteotomy with intact cortex (b) Under distraction (four steps 0.5 mm each per day) the bone gap opens on the dorsal aspect of the radius (c) Correction is completed after achieving the planned position.	76
5-13	Computer-assisted distal radius osteotomy planning. (A) Computer-assisted 3-dimensional surgical planner uses the contralateral wrist as a template. (B) The malunited wrist undergoes a (C) virtual osteotomy and is aligned to the template. (D) The surgical planner then digitizes a plate onto the realigned radius	83
5-14	Radioulnar convergence in distal radius malunion. After having performed the virtual osteotomy, the proximal fragment (solid) remains ulnarly deviated compared with the superimposed opposite limb.	83
5-15	Carbonated hydroxyapatite was introduced into the bony defect, filling it in completely.	84
5-16	Technique the Darrach procedure	86
5-17	Sauve–Kapandji procedure with fusion of the DRUJ. (a) Immediately after Sauve–Kapandji procedure. (b) 1 year after Sauve–Kapandji procedure showing fusion of the DRUJ.	89
5-18	The Bowers (HIT) Figure A and B show the resection and autogenous tissue placement between the radius and ulna. Figure C a modification to add an ulnar shortening to the procedure	90
5-19	Postoperative X-ray after implantation of Herbert ulnar head prosthesis.	91

5-20 The dome of the distal ulna is systematically excised, represented by darkened area. B. Transverse schematic view depicting the position of distal ulna resection (darkened area). 92

List of tables

Table	Title	Page
3-1	Biomechanical effct of distal radius malunion	19
3-2	Gartland and Werley classification.	24
3-3	Types of Frykman classification	26
3-4	Types of thomas classification	26
3-5	Types of sarmiento classification.	27
3-6	Types of jekins classification	28
3-7	Types of universal classification	29
3-8	Types of Fernandez classification	32
5-1	The radiographic assessment of distal radius malunion	48
5-2	Relative contraindications to distal radius corrective osteotomy	51
5-3	Indications for distal radius corrective osteotomy	53

List of abbreviation

Abb.	Description
TFCC	Triangular fibrocartilage complex.
DRUJ	Distal radioulnar joint.
RSC	Radio scaphocapitate.
ECU	Extensor carpi ulnaris.
EPL	Extensor policis longus.
FCU	Flexor carpi ulnaris.
UCL	Ulnar collatellar ligament.
RUL	Radio ulnar ligament.
VISI	Volar intercalary segement instability.
DISI	Volar intercalary segement instability.
CRPS	Complex regional pain syndrome.
CTS	Carpal tunnel syndrome.
PRC	Proximal row carpectomy.
CAD	Computer aided design.
CAM	Computer aided manufacture.
ROM	Range of motion.
DASH	Disabilities of the arm, shoulder and hand.

Introduction

Malunion is the most common complication of distal radius fractures; significant malunion can cause considerable disability. Overall malunion rates may be as high as 17%, and reported rates with initial nonsurgical treatment are higher than those with primary surgical intervention. [1] Malunion of the distal radius alter the normal anatomic and biomechanical relationships of surrounding joints, the resultant changes in position, load-bearing relationships, stability and kinematics can cause or accelerate symptoms or degenerative disease in each particular joint and in the wrist as whole. [1] Fernandez, in a comprehensive review, stated, "In general there is a strict parallel between the anatomic result and residual function of the wrist." [2] Patients who have symptomatic malunions of the distal radius present with pain, loss of motion, cosmetic deformity, and decreased grip strength, arthritis at the radiocarpal and distal radioulnar joints can be late sequelae of fracture malunion. Other complications of radial malunion include tendon rupture, most commonly the extensor pollicis longus, compression neuropathy has also been described. [3] Radiographic key parameter used in assessment of distal radius malunion are radial inclination, radial length, ulnar variance and radial tilt; although variation exist among individual patients, average normal values for each of these parameters provide a starting point for evaluation of the extent of the deformity. [1] There are certain clinical situations in which malunion of the distal radius is tolerated. This scenario often involves the treatment of elderly or low demand patients, or patients in whom surgical intervention is contraindicated. [2]

The goals of surgery for symptomatic malunions of the radius should be to reduce or eliminate pain and improve function. Several different surgical options exist to treat distal radius malunions and their sequelae, these surgical procedures designed to restore normal anatomic