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Fracture of distal end radius management: An overview

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***Abstract*---**The fracture in the distal radius is an upper fracture which is the most often found. With the continuing Epidemiology of aging population that continues to rise, the incidence of this fracture tends to increase. This study aims to review the available treatments for the fractures in the distal of the radius management by using the distal radius fracture classifications management. The trauma mechanism and the classification system of Fernandez is used as a method to analyze in this study. According to the trauma mechanism and the classification system of Fernandez, there are 5 types of classification which depends on the mechanism of injury. This study focuses on the classification of injury and the treatments of injury. The treatment of injury is divided into 2 groups; non-surgical and surgical treatment. As a result, this study found that surgical treatment over the past decade has been increasing and the surgical treatment will lead to a better outcome in older patients and all ages. Significantly, this study also represents the complications that might happen during treatment that the patient should be aware of as well.

***Keywords*---**Colles' fracture distal, radius fracture end, Barton's fracture.

Introduction

Fractures of the distal end of Radius treatment still be challenging for orthopedic surgeons. Nowadays, the knowledge of injury mechanisms and anatomy is continually getting better. Therefore, we discovered a better surgical technique to help patients can live their lives normally after the injury. This article aims to review the available treatments for the fractures in the distal of the radius management. Distal end fracture of the radius is one of the most common injuries treated by an orthopedic surgeon (Jupiter, 1991; Jupiter, 1997) Fracture Distal End Radius is mostly the cause of arm fracture and it is 15% of the most severe fracture that have ever seen in an emergency department (Davis & Baratz, 2010). The age classification of radius injuries is often found in the age between 5-14

and elders. We have to separate the different injury that caused by the accident and Distal of Radius bone fracture which caused by osteoporosis in elderly too (Chung et al., 2009). Most radius bone fractures occurred in elder woman with a 1 per 4 of male per female ratios.

The healing of distal end radius fractures continues to evolve. Abraham Colles gave an explanation in his report, 1814 (Colles, 1814). Furthermore, Colles noted that these fractures tend to do well even there is a lot of abnormalities (Bone deformities) . This assertion was supported later by Cassebaum (Cassebaum, 1950) in 1950. In 1988, McQueen and Caspers (McQueen & Caspers,1988) demonstrated a clear correlation between the abnormally attached bone pieces of distal end radius and bad functioning outcomes. Fracture of the bone by the high energy of distal end radius is often associated with injuries of the joint bones and Radius-Ulnar, Distal Radio-Ulnar Joint, Triangular Fibro Cartilage Complex (TFCC) as well as wrist nerve injury (Knirk & Jupiter, 1986) We can see that surgical treatment for the fracture of distal end radius has an important evolution in the past decade coincided with the advent of locking plate technology and the study of anatomical structures. Likewise, using new medical appliances and all these innovation challenge and it required advanced treatment concepts as well as a variety of surgical options method (Putter et al., 2013; Diaz-Garcia et al., 2011).The information below is an explanation about how to suitable assessment method for distal end radius fracture by emphasizing various classifications.

Epidemiology

Distal end Radius fractures are found approximately 15% of all fractures in hospital emergency departments (Davis & Baratz, 2010) . These fractures are common in the upper extremity fracture, especially in the elderly who have fallen or have low energy trauma. Meanwhile, distal end Radius fractures in children, we have to find the cause of the accident which is unlike in adults. Distal end Radius fractures are often associated with the surrounding bones and organs; for example, the wrist bones, tendons around the wrist, joints between bones, and blood vessels and nerves (Chung et al., 2009).

Anatomy

The distal end Radius consists of a continuous part with the Scaphoid bone and the Lunate bone; furthermore, there are still parts that connect to the Ulnar bone as well. In the part of the distal Radioulnar joint, there are an important role in Pronation-supination forearm. Moreover, there is also a ligament that is important for strengthening the Radioulnar joint too. These include Dorsal, Volar radioulnar ligament, and Joint capsule segments. Besides, there are also various tendons with wrist strengthening such as extensor Carpi ulnaris (ECU) tendon, Flexor carpi radialis (FCR) tendon, and Flexor carpi ulnaris (FCU) tendon. There is also a Triangular fibrocartilage complex (TFCC) that connects the Radius, Ulnar and Carpal bone (Linscheid, 1992) which makes the wrist strong and stable.

Clinical evaluation and diagnosis

History taking related to mechanism of injury or underlying disease. We should examine the physical examination of the skin area that there are open wounds or not. If there is an open wound, be careful of an open fracture and the wrist injuries in these locations should be assessed to ensure the correct physical examination, such as snuff box (carpal bone), elbow joint, radial head, shoulder joint and clavicle (Goldfarb et al., 2001). Physical examination by examination neurovascular of the injured hand. Thumb extension tests to detect extensor pollicis longus (EPL) tendon that there is a tear of the tendon across the Lister tubercle or not. The carpal tunnel compression condition causes numbness of the injured hand, which caused by bleeding or compression of the nerve in a fracture fragment.

Radiographic anatomy, Surgical Anatomy and Pathophysiology

An analysis of standard radiographic anteroposterior, Lateral, we can set guidelines for determining the appropriate position of the distal end radius as follows; Radial inclination is more than 15 degrees, 5 degrees of Dorsal tilt to 20 degrees of Volar tilt, Ulnar variant is less than 5 mm at the distal end radioulnar, and less than 2 mm of intra-articular radiocarpal (Graham, 1997) according to table 1.

Table 1 Radiographic criteria for acceptable treatment of Radial fracture

Radiography criteria	Normal	Possible measurements
Radial height	12 mm.	Radius minimization <5 mm. relative to the wrist contralateral
Radial inclination	20 degrees	inclination on film PA ≥ 15 degrees

Table 1 (Cont.)

Radiography criteria	Normal	Possible measurements
Tilted Radius (Palmar tilt)	Volar 11 degrees	Sagittal tilt in the lateral projection during Dorsal tilt <5 degrees and Volar tilt 20 degrees
Particular incompatibility (Intra articular step)	None	Intra-articular fracture incompatibility is 2 mm. at the radiocarpal joint.
Ulnar variance	More than 2 mm.	Not more than 2 mm.

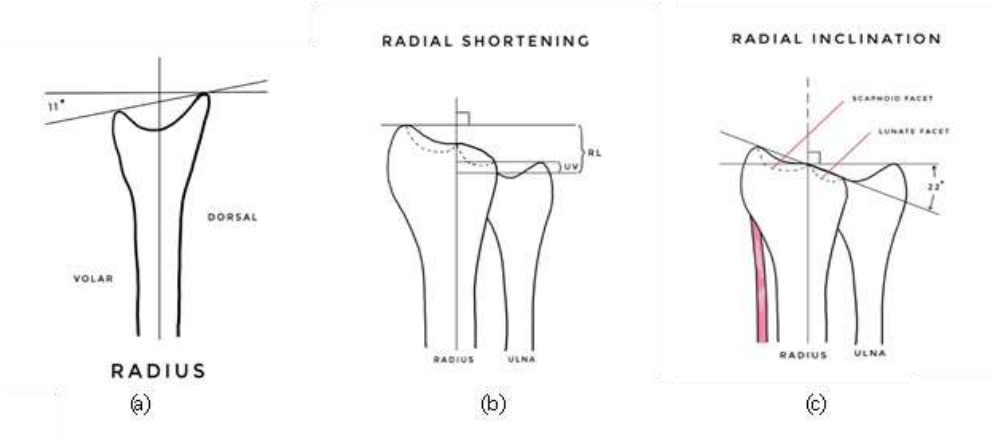


Figure 1 Radiographic measles of distal radius Facture ; (a). Volar Tilt (b). Radial Shortening (c). Radial Inclination

However, the standard radiography view may not be enough to classify characterize complex radius fracture. Complicated fracture must be performing a computer tomography that will be useful for patients who are suspect die-punch, volar rim, or scaphoid facet fractures as well. Today, three-dimensional computed tomography technology can provide the detailed to the surgeon for appropriate pre-operative planning. For complicated radius fracture, we can select x-ray scanning to help surgery planning(Pruitt et al., 1994).

Classification

Different classification systems are proposed for distal end radius fracture. Each distal end radius fracture, there is varied with the mechanism and severity of the injury, and the level of joint fracture and associated injury. Defining the different styles of distal end radius fracture in the past, there was divided into several species (Colles, 1814; Frykman, 1967; Melone, 1993) provided an important information about the extent and direction of distal end radius fracture. Newer classification helped to improve understanding of fracture patterns and injury severity. Fracture classification, according to the trauma mechanism and the classification system of Fernandez (Fernandez & Wolfe, 2005) is divided into 5 types depend on the mechanism of injury.

Colles fracture

The distal fragment bone of the radius was dorsal displaced (Figure 2) , mostly found in the high energy trauma (Colles, 1814)



Figure 2 Colles fracture

Smith fracture

Another type of fracture at the distal end of radius, which shows a deformation in contrast to the Colles fracture. Perhaps called reverse Colles fracture which is the bone fracture that less commonly found than the Colles fracture.



Figure 3 Smith fracture

Barton fracture

Barton fracture is the fracture at the distal end radius, but the fracture is an oblique fracture from the articular surface (intraarticular) to the dorsal lip (Figure 4). If ruptured to the volar lip, it is called reverse (or volar) Barton fracture (Figure 5). The fracture is located in the coronal line so it is clearly seen in the lateral view.



Figure 4 Dorsal Barton fracture



Figure 5 Volar Barton fracture

Type 1 fracture is a simple bending Metaphysis fracture as a result of the fall of the wrist falling onto the ground. This includes the extraarticular Colles or Smith's fractures.
Type 2 fracture is an injury caused by direct machining through part of the articular surface. These fractures are unstable.
Type 3 fracture, there is an injury and compression of distal end radius surfaces that caused injuring of the subchondral bone.
Type 4 fracture is fracture – There is a fracture of movement of distal end radius through radial styloid and cause to the intercarpal movement.
Type 5 fracture is an injury caused by high energy that associated with wrist tissue injury and fracture of the distal end radius and Ulnar bone, which is considered as a complex injury.

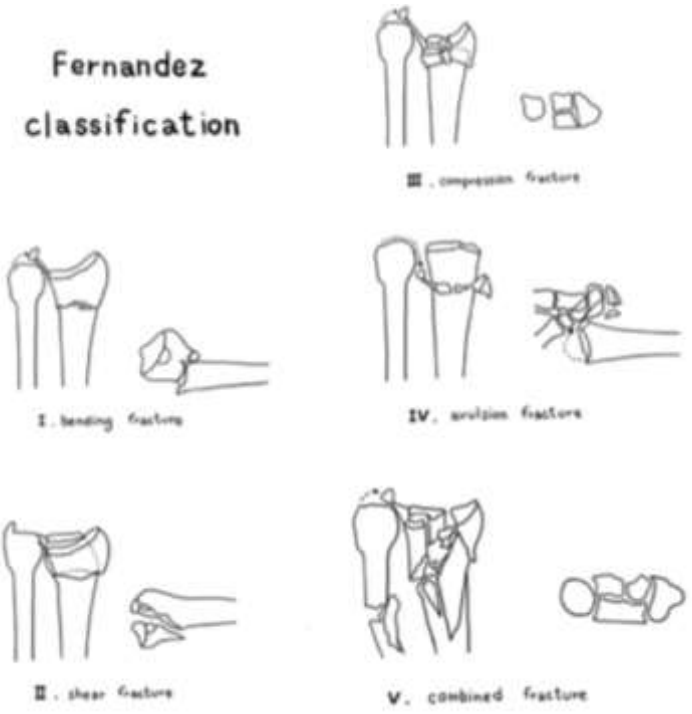


Figure 6 Fernandez Classification

The surgery of distal end radius fracture is determined by requirement of the patient and the radiographic results at the time of injury. For the patients who has the activity to do and want to reduce wrist use, nonsurgical therapy may be used. However, patients with much wrist use may need corrective surgery.

Treatment

The treatment is divided into 2 groups: 1. Non-surgical 2. Surgical

Treatment guidelines

There are two factors to consider in choosing a treatment plan:

1. Fracture pattern according to the pathological classification (classification)
2. Stability of the distal end radius.

This has to be compared between the radiographs before and after reduction. The easily applicable stability criteria are Lafontaine's criteria (Lafontaine et al., 1989) (Table 2), which this information are the factors that indicate the risk of secondary fracture displacement or not.

Table 2 Lafontaine's criteria

1. Dorsal tilt > 20 degree
2. Dorsal radius comminution
3. Intra-articular fracture
4. Associated ulnar fracture
5. Age > 60 years

If there are three or more of these factors, there is a greater chance of displacement of the distal radius if treated with conservative methods. (Conservative treatment) (Leone et al, 2004).

Non-surgical

Putting on a cast is the preferred treatment for mild fractures. This is suitable for patients with low requirements and who cannot tolerate surgery for medical reasons. Fracture which cannot heal with cast insertion is a totally unstable fracture type. Cast insertion treatment consists wearing a three weeks of sugar – tong. After that, it will change into a short arm cast pattern for an additional three weeks. Patients will usually have taken the cast (or splint) off after six weeks and do wrist movement exercises. Radiographic examinations should be performed after the splint is removed to ensure the stability of the fracture.

Conservative Treatment

In the stable distal end radius fracture when considered by Lafontaine criteria and without intra articular fracture, it can be given supportive treatment. After closed reduction of distal end radius and sugar-tong splinting on the patient's

wrist and elbow, we should consider whether the bone line is in good criteria or not. Also, this has to be compared between the radiographs before and after reduction by considering criteria as follows: (Table 3) (American Academy of Ortho- paedic Surgeons. 2013).

Table 3 Acceptable criteria of radiographic evaluation

AP view	Radial height < 5 mm shortening
	Radial inclination change < 5°
Lateral view	Dorsal tilt < 10 degree
	Volar tilt < 20 degree
Any view	Articular stepoff <2 mm

For the follow-up of supportive therapy, radiographs should be sent weekly for the first 2 weeks to monitor fracture displacement. At the end of 2 weeks, it should be replaced from sugar-tong splinting to Short arm cast and keep wearing for 6 weeks (American Academy of Ortho- paedic Surgeons. 2013).

Surgical

Surgical Techniques

Putting the fixing material through the skin (K-wire fixation)

This technique is still widely used for fracture within the distal end radius in places where resource facilities are scarce worldwide (Cooney et al., 1979). Wire fixation is a fairly simple and effective method. In the fixation is chosen in case of extraarticular, simple intraarticular, or fractures that are nondisplaced and in patients with good bone quality. There are several different techniques that are described for radius fracture fixation. Two or three K-wire can be used through the fracture segment. Closed reduction techniques and percutaneous pinning lead to good results, and when performing surgery with expertise (Depalma, 1952), some techniques can be used, such as: transfixation through distal radioulnar to increase stability. Kapandji's technique (Kapandji, 1995) commonly used along with K-wire and intrafocal to reduce and heal radius fractures. This step is probably the best way for uncomplicated fractures. Kapandji's technique requires K-wire. The first K-wire will be used to elevate the Radial inclination and to create a distal end radius inclination. The second K-wire will be used to keep the Palmar tilt level.

External fixation

External fixators are generally used for the treatment of unstable fractures or severe injuries. External fixators devices can help fractures treatment and it will help to prevent collapse. Most external fixators are often used with other forms of fixation. Several biomechanics studies support the use of supplementary external fixation with the Kirschner line. Wolfe (Wolfe et al., 1998) and his colleagues conducted a comparative study in case the stability of the external fixator alone or with Kirschner supplementation. They found that in combination with external fixators is more effective than K-wire fixation alone. Although reducing motion

fracture is useful but the rate of complications from the use of External fixators is high. Complications such as pin tract infections or pin loosening. Peripheral nerve injury may be avoided to some extent by avoiding carpal over distraction or excessive flexion of the wrist and prolonged treatment with a fixator.

Dorsal and volar open reduction

The internal open correction has a noticeable advantage over other methods. It allows for easy direct restoration of the anatomy and enables a good return of wrist function. In the last 2 decades, locking plate systems are widely accepted for severe fracture patterns (Orbay, 2000). There are several indications for open reduction such as unstable fracture, joint fracture, and complex fracture. The surgical method must be selected individually to handle critical fragments and conformity of the clause and alignment as used to fix a specific part. Since the using locking plates have an opening for correcting fractures in peripheral radial bone, the use of this method is increasing in all age groups, especially in older patients (Benson et al., 2006; Ilyas, 2011; Megerle et al., 2013).

The interior opening became more popular, especially when it was observed that the articular surface leads to better results (Harness & Meals, 2006). The mentioned methods are often determined by the location of the important fracture. The complications that we have to be aware of. For example, tendon injury and hardware irritation. These are the disadvantage of the Plate. Even though the plate is properly arranged, Ligament irritation or irritation was reported up to 30% (Axelrod & McMurtry, 1990; Carter et al., 1998; Karambouroglu & Axelrod, 1998; Rikli & Regazzoni, 1996). To prevent tendon injury, some surgeons recommend that the plate's quadratus pronator be sutured to reduce the incidence of tendon hardware irritation (Jupiter et al., 2002; McQueen et al., 1999; Castaing, 1964). The available data showed that volar and dorsal tendon injuries were reduced through a safe volar surgical approach and based on the surgeon's experience (Mortier et al., 1983). Several studies compared the results of dorsal and volar fractures of peripheral radial fracture (Mudgal & Jupiter, 2006). Ruch and Papadonikolakis (Ruch, 2006) performed retrospective checks of 34 patients; 20 cases were dorsal and 14 cases were given a Volar graft. The authors found that both subjects had similar DASH scores, but the working performance in the Gartland and Werley scores is better than putting on the steel plate Volar.

Complication

The complications are often found in surgical treatment more than in conservative treatment. It can be prevented in many ways, such as tendon injuries and the surgeon's experience with surgery can reduce these injuries (Imatani et al, 2012; Soong et al., 2011). Treatment of distal end radius is often found in many complications, such as Median nerve compression, which is a condition found in approximately 10% of patients with distal end radius fracture. In patients who treated with supportive methods, they have to be careful when wearing a splint because an excessive wrist flexion position until it depresses median nerve can be happen (Dyer et al., 2008). In patients undergoing surgical treatment, we must

find the causes of the median nerve compression condition. For instance, there are some bones pressing on the nerve, etc.

Radiocarpal arthrosis

Osteoarthritis between the distal end radius and the carpal bone is often caused by the radiocarpal joint having an articular step off> 2 mm (mm.). This condition should begin to be treated by surgery.

Malunion and nonunion condition

This condition is often seen in patients who are not hospitalized, but self-medicating. Deformation of the bone is often associated with injury or damage to the carpal bone (Benson et al., 2006).

Wrist joint stiffness condition

This is often found in case of prolonged supportive treatment.

Conclusion

A fracture in the distal radius is an upper fracture which is the most often found. With the continuing Epidemiology of aging population that continues to rise, the incidence of this fracture tends to increase. We found that surgical treatment over the past decade has been increasing and the surgical treatment will lead to a better outcome in older patients and all ages.

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