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Comparison on outcome for closed fracture radius and ulna in children treated with cast and intramedullary K-wire

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V. Abstrak

Kajian ini bertujuan untuk mengkaji perbezaan di antara kaedah *intramedullary k-wire* dan *cast* dalam memberi rawatan terhadap masalah kepatahan bahagian tengah tulang radius dan ulna pada kanak-kanak

Seramai tiga puluh satu pesakit yang dirawat mengunakan *cast* dan dua puluh pesakit dirawat menggunakan kaedah *intramedullary k-wire* di Hospital Sultanah Bahiyyah, Alor Setar berjaya dikumpulkan dari tahun 2004 hingga 2009 yang berumur di antara 8 hingga 14 tahun. Pesakit dibahagikan kepada 2 kumpulan, satu kumpulan dirawat menggunakan *cast* dan satu lagi kumpulan dirawat menggunakan kaedah *intramedullary k-wire.* Kesemua pesakit dikaji akan keberkesan setiap kaedah rawatan melalui analisa ke atas X-ray yang diambil pada minggu pertama dan keenam selepas rawatan diterima, analisa ke atas kesan klinikal pada minggu keenam selepas rawatan pertama dari segi jarak pergerakan putaran lengan (*range of supination* dan *pronation)* berbanding dengan sebelah lengan yang sihat dengan menggredkan pergerakan tersebut menggunakan sistem *Daruwalla Grading* dan akhir sekali analisa terhadap komplikasi pembedahan pada pesakit yang dirawat menggunakan kaedah *intramedullary k-wire.*

Tidak terdapat perbezaan yang signifikan di antara kedua-dua kaedah rawatan dari segi keberkesanan kaedah-kaedah tersebut bagi mengelak berlakunya kebengkokan semula tulang radius dan ulna pada minggu pertama selepas daripada rawatan pertama diterima (mean IM k-wire 7.75; cast 6.39; $p>0.05$). Juga tidak terdapat perbezaan yang ketara pada minggu keenam di antara kedua dua kaedah rawatan (mean IM k-wire 7.85; cast 7.03;

p>0.05). Umur merupakan factor penentu yang paling penting ke atas kesan klinikal pesakit yang berpandukan kepada system 'Daruwalla Grading'. Walau bagaimanapun, jantina dan bahagian tangan yang dominant tidak mempengaruhi kesan klinikal pesakit . Jenis kedua dua rawatan yang diberi juga tidak memberi perbezaan yang ketara ke atas kesan klinikal pesakit menggunakan ujian Regresi Logistik.

Secara kesimpulannya, tidak ada perbezaan yang signifikan di antara *intramedullary k-wire* dan *cast* dalam merawat pesakit kanak-kanak yang mengalami kepatahan tulang radius dan ulna samada dari segi mengelakkan kebengkokan semula tulang atau dari segi kesan pergerakan putaran di bahagian lengan pesakit. Kajian ini juga mendapati bahawa umur pesakit merupakan satu satunya factor yang paling penting yang mempengaruhi kesan klinikal pergerakan putaran lengan pesakit diminggu keenam rawatan.

VI. Abstract

This is a retrospective study which was conducted to compare between intramedullary k-wire fixation and cast for the treatment of closed fracture midshaft of radius and ulna in children.

Thirty one patients treated with cast and twenty patients treated with intramedullary k-wire were traced from Hospital Sultanah Bahiyyah, Alor Setar from 2004 to 2009 between the age of 8 to 14 years old. . Cases were evaluated in 2 groups, one treated with cast and another group of patients treated with intramedullary k-wire. All patients were evaluated for radiological outcome at 1 week and 6 week, clinical outcome in terms of range of supination and pronation at 6 week follow-up by grading them using Daruwalla Grading and surgical complication of intramedullary k-wiring at 6 week.

There was no significant difference between the two methods of treatment in their effectiveness to prevent angulation at fracture site at week 1 follow-up (mean: IM k-wire 7.75°; cast 6.39°) with p value more than 0.05. The difference at week 6 follow-up also not significant (mean IM k-wire 7.85°; cast 7.03°) with p value more than 0.05. There was also no significant correlation between the two methods of treatment and the clinical outcome. Age was the most determinant factors on the clinical outcome based on Daruwalla grading system. However, gender and side hand dominant have no effect on clinical outcome. The treatment method have no effect on clinical outcome on Logistic Regression test.

As a conclusion, there was no significant different between intramedullary k-wiring and cast in the management of closed fracture midshaft of radius and ulna in children in terms of preventing fracture angulation and restoring range of supination and pronation. This study also showed that age was the single most important factor to determine the clinical outcome of the patients with this type of fracture.

1.0 Review of Literatures

1.1 Background

Fracture of midshaft of radius and ulna accounts for 18% of the incidence of both bone fractures in children. It is usually a result of low energy trauma and will end up in minimal displacement. The standard treatment for this type of fracture is Closed Manual Reduction followed by casting because it gives no major complication and the redisplacement on cast is usually acceptable with minimal deformity. However, in older children with unstable fracture of midshaftof radius and ulna, there is a higher tendency for the fracture to displace when treated with cast. Yung SH et al (1998) had pointed out that there was high incidence of redisplacement and subsequent limitation of function in patients treated with cast Through our experience, the need to do an operation for this type of fracture are also contributed by the high expectation from the parents side nowadays due to high level of awareness regarding the possible complication. Secondly, children age more than 8 years old will have a good remodelling potential but less time period to achieve full remodelling before maturity. They will have insufficient time for the residual deformity to correct by itself especially when we consider the time of closure of distal radial and ulna physis at 17 for boys and 16 for girls. This makes the period for remodeling to complete becomes limited. Thirdly because of the advent in technology, the use of image intensifier will make it possible to insert K-wires percutaneously with minimal soft tissue damage and minimal scar formation.

1.2 Problem Statement

Nowadays, because of higher knowledge level, the expectation has become higher especially in dealing with this type of fracture that may occur to their children. Parents will expect immediate recovery soon after the treatment is given. They will expect to see their children to have no deformity at all after receiving treatment due to the injury. Although there is remodeling potential especially in children, it would take years to effect which is not something that the parents nowadays would expect from doctors. This will create a tendency on the parents side to choose a treatment that is effective to correct the deformity and to restore immediate full function of the forearm without having to wait for the remodeling to complete. Therefore, this study is made to compare the effectiveness of treating fracture of the forearm in children using intramedullar K-wire and cast and to identify the complication that may occur as a result of this surgery so that an alternative option to cast can be given to parents that suit their expectation.

The use of intramedullay K-wire to fix the fracture of radius and ulna in children is mainly because it is a minimal access type of surgery that preserve the surrounding soft tissue condition as well as its capablity of maintaining good anatomic reduction and achieving union which results in good functional outcome mainly in terms of maintaining forearm range of supination and pronation. In acute injury, the oedematous surrounding soft tissue such as muscle can act as temporary splint to the fractured radius and ulna but the splinting effect will reduce after some time once the swelling has subsided causing the fragments to displace. Children less then 14 years old, especially at the age of 6 to 10 years old has got less developed musculature to support the fractured fragment reduction. As a result, there is relatively high tendency for redisplcement if treated only with cast immobilization. Children after the age of 14 normally will be treated with open reduction and plating without cast for early mobilization.

Although most orthopedists are well versed in conventional options for managing forearm fractures in children, recent studies have addressed some outstanding clinical questions regarding the subtleties of caring for these type of injuries. Several studies have shown to have no complication at all for patients treated with intramedullary K-wire such as (Yung, Lam et al. 1998), (Amit, Salai et al. 1985), (Shoemaker, Comstock et al. 1999) and (Qidwai 2001). except (Cullen, Roy et al. 1998) which reported few complications for using intramedullary K-wire.

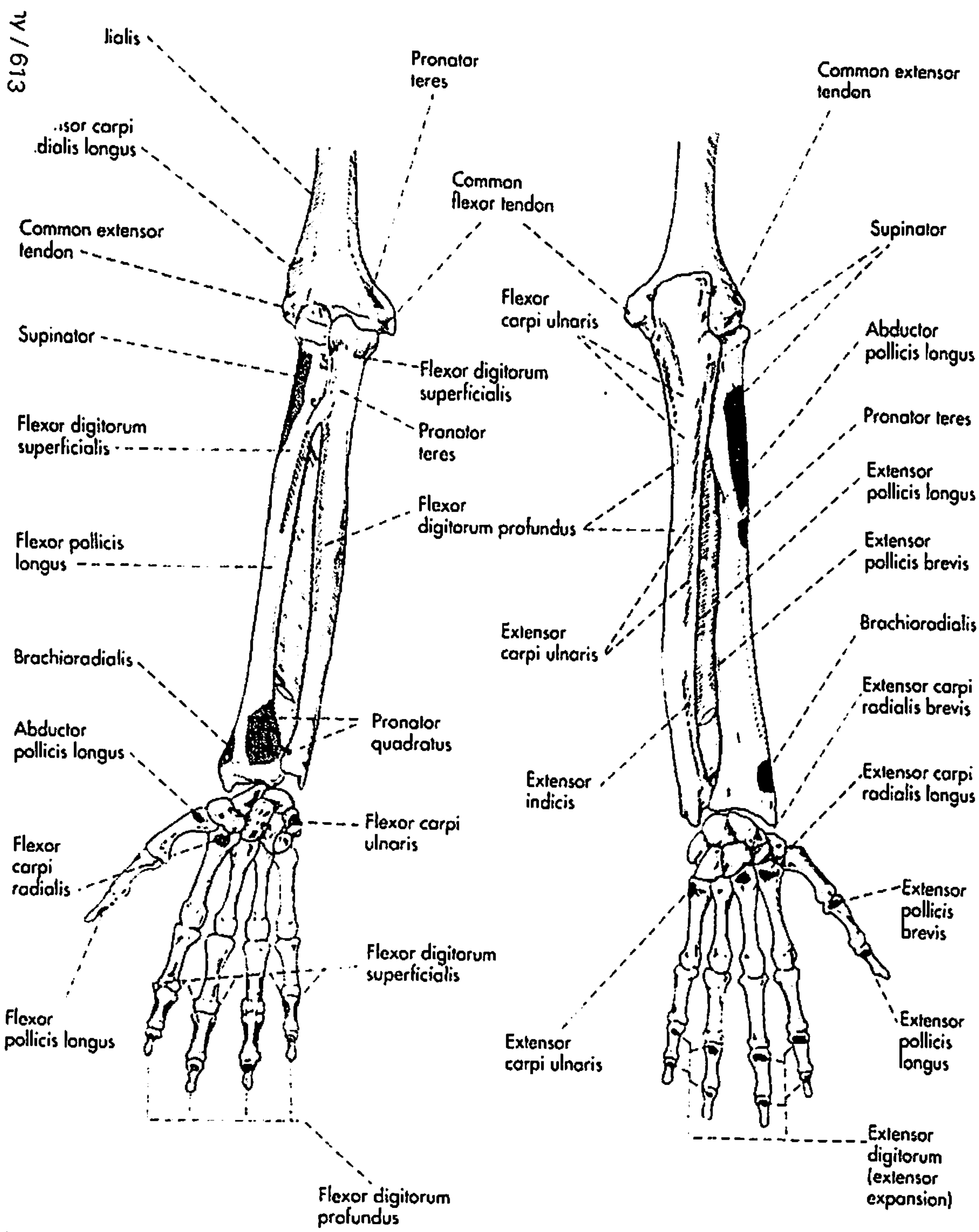
1.3 Embryology

1.3.1 Radius

The radius starts ossifying in cartilage from a centre in the middle of the shaft at the 8^{th} week. There are secondary centres for the head and the lower end. The lower end is the growing end. The proximal epiphysis fuses at about 15 years of age while the distal epiphysis fuses at the age of 17.

1.3.2 Ulna

The ulna starts ossifying in cartilage at the 8^{th} week. There is secondary centre for the head which ossifies with the shaft at the age of 18. there are 2 ossification centres for the olecranon which join the shaft at the age of 16



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(Picture adopted from Review of Orthopaedics by Miller)

Figure 1 : Picture shows sites of muscles attachment on the radius and ulna seen on volar and dorsal aspect of the forearm

1.4 Anatomy

1.4.1 Radius

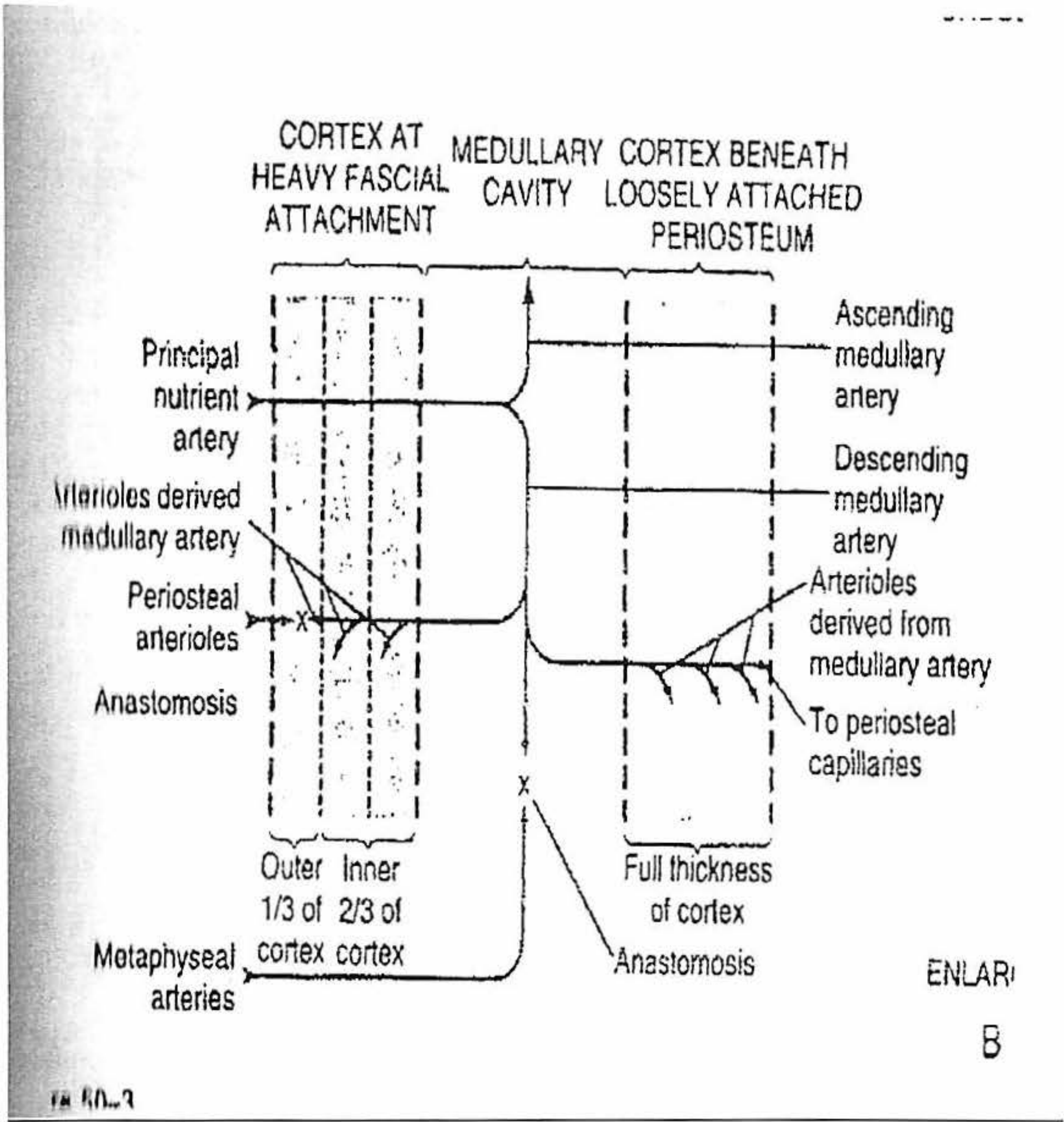
The radius has a cylindrical head and articulates with capitulum of humerus. Its distal end articulates with scaphoid and lunate. The proximal part of the radius consists of head with central fovea, a neck, radial tuberosdity for the insertion of biceps femoris. The head is covered with hyaline cartilage. It articulates medially with the ulna through radial notch of the ulna while the rest of the circumference articulates with the annular ligament. The shaft of radius has a gradual bend which it convex laterally and gradually increase in size distally. During fixation of the radial shaft, it is important to restore the radial bow. The distal part of the radius consists of carpal articular surface, ulna notch, a dorsal tubercle called Lister's tubercle and a lateral styloid process.

There are many muscles attached to the surface of radius. On its flexor surface, flexor digitorum superficialis is attached to the anterior oblique line while flexor pollicis longus attached below to this line. Pronator teres muscle is an important muscle for pronation of the forearm is attached to the middle part of the lateral convexity of the radius. The site of fracture at this region be it proximal or distal to the insertion of this muscle will determine the direction of displacement and also its stability. Laterally over the distal end where the radial styloid is formed, there is insertion of brachioradialis muscle. Fracture at midshaft of radius will have distal fragment angulated towards ulna side due to the pull by brachiradialis muscle which is attached over the lateral aspect of radial styloid. Over the dorsum aspect of the distal end of the radius lies the Lister's Tubercle which on its ulna site passes the tendon of extensor pollicis longus. Insertion of K-wire through this tubercle may injure either the extensor pollicis longus tendon or the superficial radial nerve.

1.4.2 Ulna.

The ulna tapers in the reverse way to the radius. It is large proximally and small at its distal extremity where the head is located. Proximally ulna is composed of two curved processes, the olecranon and the coronoid process with an intervening trochlear notch. The distal end tapers and ends in a lateral head and medial ulna styloid process. Since ulna is broader and bigger proximally, the ideal site of insertion of intramedullary k-wire is through its proximal site as it is easier and more accessible to the intramedullary region. Furthermore. The proximal ulna especially the olecranon is more subcutaneous and easily palpable. The coronoid process projects forwards from the upper end of the ulna shaft and is a site of attachement of brachialis muscle. Medial to coronoid process lies the ulna tubercle for the insertion of flexor digitorum superficialis. The shaft of the ulna is angled slightly laterally from the trochlear notch to form the carrying angle and of important to be restored during fixation of the ulna.

1.4.3 Blood Supply of The Radius and Ulna



(Picture adopted from Review of Orthopaedic by Miller)

Figure 2: Picture shows pattern of blood supply of long bones

The adequate knowledge of blood supply or vascularity of one is paramount important in the management of long bone fracture. Any discussion of the management must be prefaced by review of blood supply.

Trueta pointed out three main source of long bone lood supply i.e the nutrient artery, the metaphyseal artery and the periosteal vessel (Trueta and Caladias 1964).

Trueta also stressed the importance of intact periosteum acting a periosteal seal to prvent fibrous tissue ingrowth. Whereas in resting bone the periostal vessel play little part in the nutrition of the cortex, following fracture, the vessel could be seen to penetrate the cortex and help to reestablish the ndosteal circulation righ up o the fracture site.

A functional classification of normal circulation of a long bone has been devised (Rhinelander 1968). It is made up of the afferent, efferent and intermediate vascular system.

Afferent system carries blood, bearing nutrients to all part of the body, consists of

1. The principle nutrient artery
2. The metaphyseal artery
3. The periosteal artery.

The efferent system takes blood bearing wastes products away from bone comprises of

1. The large emissary veins and vena comitans of the nutrient artery which drain the medullary contents exclusively.
2. The cortical venous channels, which drain the deeper portion of the compactum into periosteal venules and
3. The periosteal capillary, which are in the continuity with the cortical capillary of the superficial cortical lamellae

All these convey blood in an external direction.

Like all long bones,in addition to metaphyseal artery, the radius ad ulna usually has single nutrient artery that branches off the radial artery and ulna artery to penetrate the midshaft of the diaphyseal cortex. The nutrient artery forms medullary arteriesin canal and extend proximally and distally (Rhinelander 1968). These medullary arteries penetrate the endosteum of the bones to supply the inner two third of the cortex. These medullary arteries can supply the endosteum of the diaphyseal cortex through their communications if the nutrients artery is interrupted. The outer third of the cortex is supplied b the periosteal arterioles, which enter the cortex from the fascial compartment.

The Radial artery which is one of the two terminal branches of brachial artery at the level of radial neck runs initially on the pronator teres, deep to brachioradialis, and continues to the wrist between brchioradialis and flexor carpi radialis. It disappears deep to the tendons of abductor pollicis longus and extensor pollicis brevis to cross the anatomical snuff box. Thus, the insertion of K-wire through the radial styloid is basically away from the course of the artery and is quite safe.

The ulnar artery is the larger of the two branches. It enters forearm by passing deep to the deep head of pronator teres and beneath the fibrous arch of the flexor digitorum superficialis and the median nerve. It runs between Flexor Digitorum Superficialis and Flexor Digitorum Profundus (FDP). Distally the artery lies on the FDP between the tendons of Flexor Carpi Ulnaris and Flexor Digitorum Superficials

Three important nerves that run across the forearm are the radial nerve, ulnar nerve and median nerve. The Radial nerve runs anterior to the lateral epicondyle of the humerus between Brachialis medially and Brachoradialis laterally. It divides into superficial and deep branch or Posterior Interosseous Nerve (PIN). The superficial branch passes to dorsal radial surface of the hand in the distal third of the hand by passing between the Brachioradialis and Extensor Carpi Radialis Longus. This is a nerve that is susceptible to injury during insertion of intramedullary K-wire through Radial Styloid. The Median nerve enters forearm in between the two heads of pronator teres and runs between flexor digitorum superficialis and flexor digitorum profundus. It becomes more superficial at the flexor retinculum where it continues into the hand. It supplies all the flexors of the forearm except flexor carpi ulnaris. The Ulnar nerve enters forearm in between two heads of flexor carpi ulnaris and runs between flexor carpi ulnaris and and flexor digitorum profundus. It lies more superficial at the wrist and enters hand through Guyon's Canal. Ulnar nerve is spared from injury during intramedullary K-wire insertion at the ulnar side because the K-wire is inserted through olecranon process and not through the distal part of the ulnar.

1.5 Injury

1.5.1 Incidence

Fractures of radius and ulna account for 40 to 50 percent of total childhood fractures. Forearem fractures are most common in pediatric age group (Chung and Spilson 2001). Because radius and ulna fractures are so common, orthopedic practitioners are comfortable managing this type of injury. Skeletally immature patients have the potential to remodel bone; therefore, children generally have good outcomes after forearm fractures. However there is a subset of pediatric patients with forearm fractures exists that are either irreducible or susceptible to redisplacement after reduction. These fractures will require some type of fixation. Younger children are much more common to suffer from this type of fractures presumably because their bone is much less stronger. This injury occurs usually from age 8 to 14 years. When considering the closure of the distal radius physis at the age of 17 for boys and 16 for girls, the remaining period for remodeling process to occur is around 3 to 9 years which may not be adequate to fully correct the residual deformity. This will result in some functional impairment and deformities of the forearms. Thus, this group of children may need a surgical fixation to