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Percutaneous Fixation of Distal Radius Fracture using kapandji Technique: A comprehensive Review

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Abstract: Distal radius fracture is a very common injury representing 17.5% of all fractures seen in the emergency room. However, the most effective treatment is still unclear and controversially debated. For ten years, we have been facing a true revolution by the increasing use of open reduction and fixation by volar locking plates as an alternative to previous less invasive treatment such as closed reduction and percutaneous k- wire pinning. Several meta-analyses have compared the clinical results after closed reduction and percutaneous pinning and volar locking plate fixation. Volar locking plate fixation achieves better early functional recovery, better radiological outcomes and less minor complications. However, long-term results were similar for both fixation methods. In addition, worse radiological outcomes and more minor complications after closed reduction and percutaneous pinning seem not to be clinically relevant. Interestingly, volar locking plate fixation continues to be a more dominant treatment method compared to percutaneous pinning in operative care of distal radius fractures. Surgeon characteristics such as age, profession as well as location and type of the clinic seem to play a role in the decision for the surgical treatment method. It appears that implant cost plays a minor role in treatment choice between closed reduction and percutaneous pinning and volar locking plate fixation.

1. INTRODUCTION

Fractures of the distal radius continue to be one of the most common injuries treated by orthopedic surgeon, accounts for about one six of all fractures seen and treated in the emergency room, the most common type of wrist fracture was first described by Abraham Colles in 1814; it is at the distal Radius and typically the lower radial fragment is dorsally and laterally angulated together with rotational deformity in supination **[1].**

Reducing a Colles fracture is not a problem, but maintaining the reduction certainly is. Various types of casts and positions have been recommended, but none have been uniformly accepted **[2].**

The maximally flexed and ulnar-deviated position of the wrist impairs function of the hand and increases pressure in the carpal tunnel and should be avoided. Neuropathies, ischemic complications, and stiffness are most often related to the type and position of cast immobilization **[3].**

Percutaneous pinning techniques are an attempt to bridge the therapeutic gap between the external fixators and pure casting alone. Although there is no doubt that external fixators have

a role in the treatment of some highly displaced distal radial fractures, many unstable distal radial fractures may be treated adequately with far less complicated percutaneous pinning techniques **[4].**

Kapandji pinning may be most appropriate for patient significant initial displacement, but with a minimum of dorsal comminution. In this patient early motion would like possible, reducing the over-all recovery period. Kapandji pinning is a simple procedure that requires minimal equipment and has been demonstrated to have satisfactory results **[5].**

Distal radius fractures

Biomechanical Considerations

In the wrist the compressive forces are transmitted from the articular cartilage to subchondral bone out in the metaphyseal bone to the cortical bone at the diaphysis of the radius. The subchondral bone is condensed and thick so that it maintains the articular cartilage strong and intact against fracture **[6].**

The subchondral bone is used in some of the surgical techniques as pins, pegs and screws are placed immediately under the subchondral bone to secure the position. In a "die punch" fracture the proximal carpal bones are pressed into the distal radius and fracture the subchondral bone. Manipulation alone cannot reduce these fractures, which have to be opened. The depressed subchondral bone is elevated and the void beneath is filled with bone graft or bone substitute. Also shearing fractures like a Chauffeur's fracture involve the subchondral bone but these fractures are most often non-comminuted and simpler to reduce **[7].**

Minor step-off the cartilage has no residual clinical symptoms but in the long term it can lead to a radiographical osteoarthritis so that should avoid it. An osseous mal-alignment can also lead to osteoarthritis

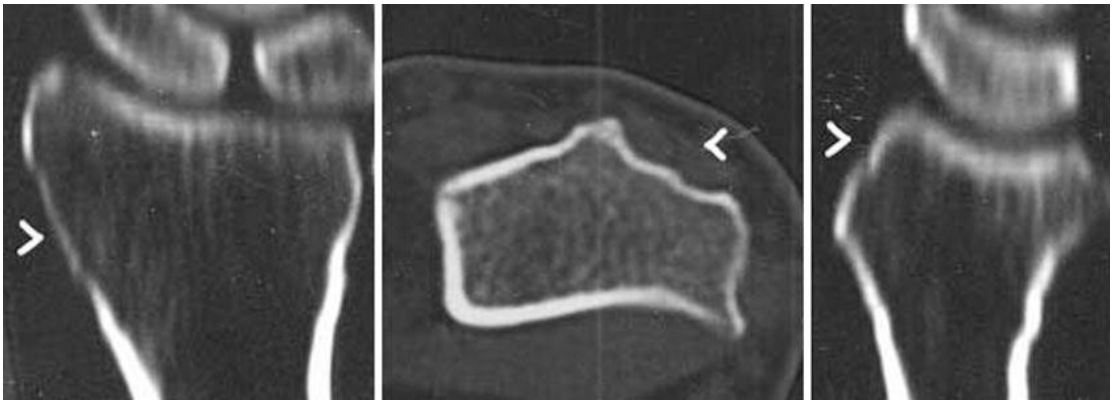

Fig. 1: CT of the distal radius of a 49 years-old man showing the thickness of the cortical bone. Note the thin cortical bone on the dorsal and radial border [8].

DRF and Osteoporosis

Researches confirm increasing the incidence of DRF, especially in female greater than 60 years. The increase incidence of osteoporosis in elderly people is the main cause of DRF **[9].**

A screening of patients greater than 50 years with wrist fractures showed that 81 % had abnormal bone mineral density (BMD) in the hip and vertebrae. Female patient over 60 with DRF in high risk for a later hip fracture. In a Swedish study an overall relative risk to sustain a hip fracture after a previous DRF was 1.54 for women and 2.27 for men and in an American study the relative risk for a hip fracture was 1.4 for women and 2.7 for men. So, these patients should produce in Medical program to treat osteoporosis **[10].**

Mechanism of injury

Fall on an outstretched hand is common cause of DRF. Falling with wrist in dorsiflexion and forearm pronated compression forces transmitted to dorsal cortex and cause comminution of it, incongruence falling with wrist in palmar flexion cause DRF with volar displacement. Die punch fracture occurs when falling with wrist in palmar flexion and forearm supinated as compression forces transmitted to lunate which because lunate fossa split into volar and dorsal fragment **[11]**.

Classification for distal radius fractures

Defining a useful classification system

The purpose of any classification system should be to name and describe characteristics in an easy to follow universal language, to allow ordering into hierarchy, to guide action or intervention and to predict the potential outcomes of an intervention. In addition, we suggest that they should be simple, easy to remember and have acceptable interobserver agreement (reliability), intra-observer agreement (reproducibility) and validity **[12].**

Reliability and reproducibility are demonstrated by the ability of a classification to return the same result for a particular patient's data when shown to multiple observers (reliability) or to the same observer viewing the same patient's data at different time points (reproducibility). Validity is the accuracy with which the classification determines the true fracture type. This requires a gold standard for identifying the true fracture type, such as intra-operative findings and corroboration, which is not always appropriate or possible, so this aspect can be difficult to test. Once validated as a functional classification system, it should undergo prospective clinical studies to determine whether it has significant prognostic value **[13].**

Reliability and reproducibility are commonly tested in studies by subjecting a series of radiographs to review by a panel of observers. Instead of using percentage agreement on radiographs, a more precise measure – the kappa statistic – is used, which adjusts for any chance agreement. A value of +1 represents perfect agreement, 0 chance agreement and –1 perfect disagreement. A suggested interpretation of the kappa statistic is presented in Table 1.

Table 1: Interpretation of kappa statistic [14].

Kappa (κ)	**Reliability/reproducibility**
0–0.2	Slight
0.21–0.4	Fair
0.41–0.6	Moderate
0.61–0.8	Substantial
0.81–1	Excellent

Some examples of well-known classifications in orthopedics include the Garden classification for proximal femoral fractures and the Neer classification for proximal humeral fractures. These are examples of ordinal classification systems, ordered I to IV to indicate increasing severity, greater instability and higher risk of complications. They are simple and easy to remember, and they guide treatment. However, they have been shown to have poor reliability and reproducibility **[15].**

Kapandji´s technique and evolution of treatment

In France as well as in other European countries, Closed Reduction Percutaneous Pinning (CRPP) was the preferred opera- tion technique in standard cases. Since its description in 1976, the Kapandji's technique of intra focal pinning gained popularity **[16].** Adalbert, son of Mehmed Kapandji who is well known for his development of Sauvé-Kapandji procedure, initially described a double intrafocal pinning technique. Indications were extraarticular, dorsally displaced Colles-type fractures with only

minimal comminution. The Kapandji technique is as effective as simple. After closed reduction a radial to ulnar pin is introduced at the fracture site. After reaching the center of the fracture gap, the pin has to be elevated and then to be driven through the ulnar cortex. The same technique is applied in a dorsal to volar fashion to reach volar tilt and dorsal buttressing. In the following years modifications of the initial technique were performed. Most of them use additional k-wires to improve the buttressing of the fracture **[17]**. Three or four instead of initially two K-wires, with a mixed trans-styloid-transfocal and intrafocal pinning are well accepted modifications to achieve better stability **(Fig. 1).** Furthermore, temporary arthrodesis by K-wire fixation in case of unstable distal radioulnar joints and rigid immobilization by forearm casts are routinely applied. Noteworthy, with time expansion of indications of the initial method described by Kapandji was observed. In particular, intraarticular fractures, multi-fragment fractures with larger comminution and even anterior displaced fractures were considered suitable for CRPP as long as closed reduction could be maintained. Not only expansion of indications but also reduction in complications could be achieved by technique modifications. Mini- incisions have been demonstrated useful to avoid nerve and tendon injuries **[18]**.
Nonetheless, open reduction and internal fixation with VLPs is
performed more frequently since VLPs have been established as therapy alternative in dislocated DRF. For example, in the department of the senior author, an average number of 150 DRF is treated surgically per year. The proportion of DRF treated by VLP has steadily increased over time from 40% in 2007 to 80% in 2017. This observed trend is reported in literature for European countries, the United States of America as well as Korea **[19]**. If we exclude some type C fractures (AO/OTA classification), for which better results have been reported by Tronci with VLPs **[20]**, neither the pattern of fracture nor the age of patients seemed to be the main choice's determinant.

CRPP vs. VLP

In 2015, Chaudhry et al. [21]. performed a meta-analysis of 7 randomized control trials (RCTs), in which surgical treatment of 875 DRF cases were pooled to compare the results of CRPP and ORIF with VLP. The functional outcome evaluated by the disabilities of the arm, shoulder and hand (DASH) score was significantly better for patients treated with ORIF by VLP at 3 months ($p < 0.001$) and 12 months ($p = 0.004$). However, the determined threshold of clinical importance was not different comparing both groups. Early advantages such as better range of motion (ROM) after VLP fixation disappeared in the later follow- ups. Surprisingly, no differences were noted in radiographic alignment between both groups. There were significantly more complications in the CRPP group, due to the number of the superficial infection. Other complications such as nerves and tendons injuries as well as reoperation rates were found to be similar. The authors concluded that differences were small and unlikely to be clinically important between the two types of treatment **[22]**. Francheschi et al. performed another systemic review and meta-analysis in 2015. They included 14 publications with 1306 patients for a pooled analysis of DRF treated either by CRPP or VLP. Five publications, which were included by Chaudhry and coworkers, have also been included in Francheschi´s analysis. AO type of fracture was assessed in 13 over 14 studies: 49% of the patients suffered from an extraarticular fracture (AO type-A), and 49% of patients had an intra-articular fracture (AO type-B or C). In 3.7% of cases, the fracture type was not reported. The recovery was faster in the VLP group. The functional outcome was better at interim evaluation with significantly better DASH scores, whereas the differences decrease with time to be comparable in studies

with amid or long-term evaluation. No differences were seen for ROM. Nevertheless, the radiographic parameters were better restored in the VLP group (radial shortening and ulnar variance); complications occurred more often in the CRPP group, the difference, however, was not significant except for superficial infections in the CRPP group. The authors concluded that both, VLP and CRPP provide excellent clinical and radiological results in patients with DRF. Due to the analysis, no clear superiority of either fixation method could be demonstrated **[23]**. In another meta- analysis of **2015, Zong et al [24]**. came to the same conclusion. VLP fixation improved the ROM and grip strength at 3- and 6-months follow-up but became similar after one year. There were significantly fewer complications in the VLP group. Superficial pin track infections after CRPP did not cause clinical debility in the vast majority of the cases **[25]**. Diaz-Garcia et al. addressed minor and major complications DRF treatment in their systematic of 2011. If complications were compared in the groups of VLP (n = 298) and CRPP (n = 163), differences were as follows: minor complications: 0.5% vs. 7% (including pin tract infection: 0% vs. 1%), major complications not requiring surgery 6% in both groups and major.

2. CONCLUSION

Surgical treatment of DRF has increased within the last years. VLP fixation achieves a better early functional recovery compared to CRPP. However, excellent functional results could be demonstrated for both CRPP and VLP fixation in long-term follow ups in several meta-analysis studies. The decrease of CRPP in distal radius fractures runs contrary to potential cost savings by CRPP compared to the more expensive use of VLPs.

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