ORIGINAL ARTICLE

Dorsally displaced distal radius fractures: Comparative study of Py’s and Kapandji’s techniques


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Accepted: 16 September 2011

Summary
Introduction: Within the framework of a regional clinical study, the radiographic results of Py's and Kapandji's fixation techniques for dorsally displaced distal radius fractures were compared.

Patients and methods: A prospective randomised monocenter and multi-operator study (phase III clinical trial) comparing the Py's (isoeelastic pinning) and Kapandji's (intrafocal pinning) techniques was conducted. Two comparable groups were established: the Py (P) and Kapandji (K) groups. The frontal radial tilt (FRT), sagittal radial tilt (SRT), radial length and ulnar variance were measured. Analysis of subjective and objective function was based on the range of motion according to six parameters, the DASH and Jakim scoring systems. The quality of anatomical restoration was assessed arthroscopically during pin removal 6 postoperative weeks.

Results: Ninety-seven patients were included in the study with a follow-up period of 1 year. The preoperative FRT was 15.1° and SRT was −19.2°. At one-year follow-up, the FRT was 25.5° in the PY group and 22.6° in the K group (p = 0.009), the SRT was 10.5° in the PY group and 6.7° in the K group (p = 0.04). For fractures with postero-medial fragment and Gerard Marchand’s fractures, the DASH score at last follow-up was 22 in the PY group, 42 and 32 respectively in the K group. The Jakim score was 71 in the PY group and 58 in the K group (p = 0.03) for fractures with postero-medial fragment. There was no report of tendon rupture in our study.

Discussion: Besides the good results achieved with both pinning techniques in the treatment of distal radius fractures, this series also underlines the importance to adapt the type of fixation to the fracture pattern and patient.

Conclusion: Pinning for treating dorsally displaced distal radius fractures appears a suitable option provided that the indications and the surgical technique for each method are respected. However, pinning is not suitable for all types of fractures.

Level of evidence: Level II. Randomised prospective therapeutic study.

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Introduction

Dorsally displaced distal radius fractures account for 89% of all wrist fractures (SOFCOT symposium, November 2000). Numerous treatment options are available: conservative treatments which have been progressively abandoned due to the loss of reduction and high rate of complex regional pain syndromes [1], percutaneous pinning as well as palmar or dorsal locking and non-locking plates, which are considered by some authors as a reliable option in maintaining anatomical reduction [2].

The two most common techniques used in our practice are Kapandji’s intrafocal pinning and Py’s isoeastic pinning. These techniques are used indifferently by operators in the majority of distal radius fractures, except for complex or comminuted cases.

We aimed at comparing the results of both techniques through a randomised prospective study within the frame of an hospital protocol of clinical research.

Analysis of the radiographic scoring system of Jakim/40 points is our main criteria for judgement.

Patients and methods

We conducted a prospective randomised monocenter and multi-operator study (phase III clinical trial) with parallel open groups, comparing Py (P group) and Kapandji (K group) techniques for dorsally displaced distal radius fractures. The main objective of that study was to compare the radiographic results achieved with both techniques.

Ninety-seven patients were included randomly in one of the two groups (P or K group) between October 1st 2006 and January 29th 2008 that is 75% of all patients admitted to the emergency department for distal radius fracture. Adult patients aged over 18 years with intra- or extra-articular dorsally displaced distal radius fracture requiring surgical treatment were included in our study.

All patients signed the informed consent for participation in the study.

Open fractures, fracture-dislocations, palmarly displaced distal radius fractures, previous history of trauma to the upper limbs and protected or minor individuals were excluded from the study.

Four types of dorsally displaced distal radius fracture were identified:

- extra-articular fractures:
  - associated with fracture of the ulnar styloid process = Gerard-Marchand (GM) fracture,
  - not associated with fracture of the ulnar styloid process = Pouteau-Colles (PC) fracture;
- intra-articular fractures:
  - simple: fractures with postero-medial fragment (PMF),
  - complex: T-shaped intra-articular fractures (sagittal and/or frontal).

Surgical techniques

Py’s technique was first described by Claude Py in 1969 and is derived from the Leslie Rush technique (1949). Two K-wires featuring a spatulated tip for easier progress along the medullary canal of the radius were introduced into the epiphysis of the distal radius after reduction by close manipulation, the first one being inserted from the tip of the radial styloid and the second one from inside the Lister’s tubercle. The entry point of each K-wire was radiographically controlled. Retrograde pinning of the radius was then performed up to the sub-chondral bone of the radial head. Two 18/10 K-wires were systematically used in this series.

For Kapandji’s technique [3], three 15/10 K-wires were used to perform intrafocal pinning. After intraoperative reduction by close manipulation, the first K-wire was introduced laterally while the two others were inserted postero-laterally and postero-medially, at a minimum 40° angle relative to the vertical axis of the radius. Each K-wire positionning and orientation was assessed radiographically.

In both cases, pins were inserted through a small incision taking care to retract the tendons of the extensor compartments for dorsal wires and the sensory branch of the radial nerve for lateral wires. A frontal and sagittal radiographic control was systematically performed at the end of the surgery.

A plaster splint was then applied for a 3-week immobilisation period followed by a removable splint in all cases allowing the patient to start daily self-rehabilitation exercises prior to the pin removal [1] after 6 postoperative weeks.

Analysis modalities

All patients included in the series were clinically and radiographically controlled at day 0, 1, 21, 45, 90 and at one year.

The radiographic analysis was performed by a single operator and included frontal radial tilt (FRT), sagittal radial tilt (SRT), radial length (RL) and ulnar variance (UV). The target values (from the criteria used in the Jakim scoring system [4]) were FRT: 22°, SRT: 9°, RL: 11 mm, DRUJ: ±2 mm. Under-reduction corresponded to a FRT ≤ 20° or SRT ≤ 0°. Over-reduction corresponded to a FRT ≥ 30° or SRT ≥ 10° [5].

The clinical analysis included complication assessment, measurement of range of motion, Jakim score evaluation [4] (radiographic scoring system /40 points as main criteria of judgement and radioclinical scoring system /100 points), grip strength measurement using the Jamar dynamometer (expressed in percentage relative to the healthy side) and DASH score evaluation [6].

Statistical analysis was performed by the Medical Information Department using the Epilinfo software©. The descriptive study of the two groups constituted the first phase of the analysis followed by a stratum analysis between the two techniques (age, fracture type). The radiographic results of the two groups were compared using the ANOVA (ANalysis Of Variance) or Mann-Whitney test. The Student t-test was used and the level of statistical significance set at \( p \leq 0.05 \).
Table 1 Epidemiologic data.

<table>
<thead>
<tr>
<th></th>
<th>P group</th>
<th>K group</th>
<th>Total</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>48</td>
<td>49</td>
<td>97</td>
<td>nc</td>
</tr>
<tr>
<td>&gt; 65 years</td>
<td>22</td>
<td>30</td>
<td>52</td>
<td>nc</td>
</tr>
<tr>
<td>Males</td>
<td>10</td>
<td>4</td>
<td>14</td>
<td>nc</td>
</tr>
<tr>
<td>Dominant arm</td>
<td>25</td>
<td>25</td>
<td>50</td>
<td>0.89</td>
</tr>
<tr>
<td>Mean age</td>
<td>64.18</td>
<td>61.93</td>
<td>63.06</td>
<td>0.41</td>
</tr>
</tbody>
</table>

K group: Kapandji; P group: Py; nc: non-calculated.

Results

Epidemiologic data

The epidemiologic data were similar in both groups (Table 1). Among the 97 patients included in the study, 79 were reviewed at 3 postoperative months that is 18% of the patients lost to follow-up, and 64 reviewed at one-year (31 in the K group and 33 in the P group, that is 34% lost to follow-up at one year). Female patients predominated in both groups (p = 0.002).

Thirty-three patients could not be assessed at one year. Among these patients, eight elderly individuals died of causes that were not related to wrist fracture, one patient decided to leave the study and went to another medical center, 16 patients refused distance follow-up and eight patients could not be contacted.

Results independently from the type of fracture

There was no difference between the two groups regarding radial length (RL) and distal radio-ulnar index (DRUI) at 3-month and 1-year follow-up (Table 2).

No significant difference could be established between the radiographic measurements and the age of the patients. No significant tendency toward over-reduction could be observed in the P group (Table 3).

The clinical DASH score at one year was 29.7 in the P group and 34.5 in the K group (p = 0.36). At 3 months, the grip strength was 39.7% in the K group and 44.2% in the P group (p > 0.05) whereas is was 75.6% in the K group and 79.8% in the P group at one year (p > 0.05).

Results according to the presence or not of an articular fracture line

Regarding extra-articular fractures, the FRT was 25.7° in the P group and 22.8° in the K group (p < 0.05) at 3 postoperative months and the SRT was 9.14° in the P group and 4.8° in the K group (p = 0.03). These significant radiographic differences had disappeared at 1-year follow-up.

Regarding intra-articular fractures, no radiographic differences according the type of fixation could be observed. For these fractures, the clinical DASH score was 27 in the P group and 41 in the K group with p = 0.08.

Results according to the fracture pattern

Fractures with postero-medial fragment demonstrated no radiographic significant difference between the two groups despite a SRT of 8.14° in the P group versus 3.14° in the K group at 3 months and 1 year (Tables 4 and 5). At one-year follow-up, the 100 points Jakim radioclinical score was 79.5 in group P and 58 in group K (p = 0.01). The DASH score was 22 in group P and 42.6 in group K (p = 0.08).

Regarding Gerard-Marchand fractures, the FRT was 25.4° in the P group and 19.1° in the K group at 1 year (p = 0.0007). At 3 postoperative months, the SRT was 8.6° in the P group and 4.7° in the K group (p = 0.05). The 40 points Jakim radiographic score was 35.8 in group P and 31.1 in group K (p = 0.01).

Regarding Pateau-Colles fractures, the FRT was 26° in group P and 22.8° in group K at 1 year (p = 0.05). The SRT was 11.07° in the P group and 7.44° in the K group (p = 0.04). The DASH score was 22.8 in the K group and 35 in the P group (p = 0.25) at one year.

Complex T-shaped intra-articular fractures demonstrated no radiographic significant difference according to the type of fixation. The DASH score was 34 in group P and 40 in group K (p = 0.6). The Jakim radioclinical score was 51.2 in group P and 64.1 in group K (p = 0.5).

Complications

The two techniques reported a similar complication rate (Table 6). All cases of pin migration occurred in the K pinning group, associated or not with superficial infection. Necrosis of the semilunar bone was noted in one elderly patient but did not require any specific treatment.

One patient with severe malunion (FRT = 38° and SRT = 34°) underwent radius osteotomy and grafting associated with palmar plating.

Discussion

Radiographic results

In this study, a better long-term radiological reduction when achieved during the immediate postoperative period was seen in the P group [7] with significant differences regarding FRT and SRT. These data correlate those reported in previous comparative studies of Py’s and Kapandji’s techniques [4–9]. Despite some significant differences observed
Table 3  Range of motion according to the type of fracture.

<table>
<thead>
<tr>
<th></th>
<th>PMF</th>
<th>GM</th>
<th>PC</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PY/K</td>
<td>p</td>
<td>PY/K</td>
<td>p</td>
</tr>
<tr>
<td>3 months</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FE</td>
<td>91.5/93.7</td>
<td>0.43</td>
<td>108/122</td>
<td>0.32</td>
</tr>
<tr>
<td>TILT</td>
<td>32.5/33.2</td>
<td>0.8</td>
<td>39.5/41</td>
<td>0.7</td>
</tr>
<tr>
<td>PS</td>
<td>139/127</td>
<td>0.43</td>
<td>146/148</td>
<td>0.8</td>
</tr>
<tr>
<td>1 year</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FE</td>
<td>120/112</td>
<td>0.6</td>
<td>118/122</td>
<td>0.8</td>
</tr>
<tr>
<td>TILT</td>
<td>52/45</td>
<td>0.37</td>
<td>53/55</td>
<td>0.7</td>
</tr>
<tr>
<td>PS</td>
<td>165/156</td>
<td>0.36</td>
<td>168/167</td>
<td>0.89</td>
</tr>
</tbody>
</table>

FE: flexion + extension; TILT: radial + ulnar tilt; PS: pronation + supination; PMF: postero-medial fragment; GM: Gerard-Marchand; PC: Pouteau-Colles; T: T-shaped fractures (frontal and/or sagittal).

Table 4  DASH clinical score and JAKIM radio-clinical score.

<table>
<thead>
<tr>
<th></th>
<th>PMF</th>
<th>GM</th>
<th>PC</th>
<th>T</th>
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<tbody>
<tr>
<td></td>
<td>PY/K</td>
<td>p</td>
<td>PY/K</td>
<td>p</td>
</tr>
<tr>
<td>3 months</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DASH</td>
<td>43.3/42.25</td>
<td>0.9</td>
<td>38.3/39.8</td>
<td>0.8</td>
</tr>
<tr>
<td>JAKIM/100</td>
<td>68.12/58.4</td>
<td>0.04</td>
<td>69.7/66.75</td>
<td>0.57</td>
</tr>
<tr>
<td>JAKIM/40</td>
<td>34.4/33</td>
<td>0.7</td>
<td>37.5/34.5</td>
<td>0.2</td>
</tr>
<tr>
<td>1 year</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DASH</td>
<td>22/42.6</td>
<td>0.1</td>
<td>24/32.6</td>
<td>0.4</td>
</tr>
<tr>
<td>JAKIM/100</td>
<td>79.5/58</td>
<td>0.01</td>
<td>88/80.2</td>
<td>0.2</td>
</tr>
<tr>
<td>JAKIM/40</td>
<td>36.6/33.4</td>
<td>0.09</td>
<td>35.8/31.1</td>
<td>0.01</td>
</tr>
</tbody>
</table>

PMF: postero-medial fragment; GM: Gerard-Marchand; PC: Pouteau-Colles; T: complex T-shaped fractures (frontal and/or sagittal). For the Jakim score, the higher the score, the better the result.

between these two techniques, the FRT and SRT values remain within acceptable limits in both groups and it appears difficult to determine whether these radiographic differences have a strong clinical impact on joint mobility or functional score [10].

In this series, the overall rate of frontal over-reduction at 3 months was 10% (eight cases). In two cases, an associated fracture of the ulnar head was reported and in five cases, over-reduction was present in the immediate post-operative period (patients from group K). Unlike reported by Flisch and Della Santa [11] and Delattre et al. [5], we did not find any over-reduction in the P group. Over-reduction might be induced by a major anterior cortex comminution [6], the selected pin diameter [12,13], number and entry point or any associated fracture of the ulnar head. The initial intraoperative reduction should be performed under fluoroscopic control in order to identify the fracture pattern and select the best adapted type of fixation.

In our study, the Py’s technique is associated with better functional and radiographic outcome in Gerard-Marchand fractures or those with postero-medial fragment. In Pouteau-Colles fractures, Kapandji’s intrafocal pinning provides a better functional outcome whatever the age of the patient whereas it reports poorer radiographic results. As reported in the literature, these initial differences tend to disappear on the long-term [14—17].

For complex T-shaped intra-articular fractures (frontal and/or sagittal), both techniques achieve unsatisfactory outcome despite slightly superior results claimed for the Py’s pinning group. These fractures are commonly treated using mixed multiple pinning or palmar plating combined with pin fixation. In such fractures, associated fracture of the styloid or ulnar neck is a pejorative prognostic factor [18].

**Comparison with data from the literature**

The main goal of distal radius fracture fixation is to achieve a long-term stable outcome. Radiographic reduction of
Dorsally displaced distal radius fractures: Comparative radiographic study

Table 6  Comparison with data from the literature.

<table>
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</thead>
<tbody>
<tr>
<td></td>
<td>PY Kapandji</td>
<td>Plate</td>
<td>DRP 2.4</td>
<td>LCP 3.5</td>
<td>DLP + substitute</td>
<td>Mixed pinning</td>
<td>VLP</td>
<td>VLP</td>
</tr>
<tr>
<td>FRT</td>
<td>25.57 22.5</td>
<td>23.09</td>
<td>22.7</td>
<td>23.95</td>
<td>21</td>
<td>21</td>
<td>24</td>
<td>22</td>
</tr>
<tr>
<td>SRT</td>
<td>10.27 6.8</td>
<td>6.8</td>
<td>2.1</td>
<td>5.45</td>
<td>8</td>
<td>4.69</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>RL</td>
<td>9.9    9</td>
<td>9</td>
<td></td>
<td></td>
<td>9.94</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UV</td>
<td>–1.46 –1.73</td>
<td>0.04</td>
<td>0.1</td>
<td>0.78</td>
<td></td>
<td>0.3</td>
<td>–1</td>
<td>–1.8</td>
</tr>
<tr>
<td>DASH</td>
<td>29.7 34.5</td>
<td>13.5</td>
<td>38.4</td>
<td>23.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

FRT: frontal radial tilt; SRT: sagittal radial tilt; RL: radial length; UV: ulnar variance; DLP: dorsal locking plate; VLP: volar locking plate; LCP: locking compression plate; DRP: distal radius plate.

frontal and sagittal radial tilt achieved with mixed multiple pinning techniques or screw plating appears satisfactory [9,17,19–23]. All authors recommend proper restoration of ulnar variance whatever the chosen fixation technique [12,21,24,25].

Some authors [10,16,26] report good long-term functional results in patients managed with closed reduction and cast immobilization, despite the loss of reduction. Studies conducted on screw plating failed to demonstrate the superiority of this technique over conventional pinning [17] despite earlier recovery of joint mobilities [16,27,28]. Obert et al. in 2004 [23] suggested the use of bone substitute associated with plate fixation to reduce the loss of radial length, which is the main prognostic factor for satisfactory long-term functional outcome [25,29,30]. They achieved good results with a mean DASH score of 23.6 at 46-month follow-up.

All these techniques aim at restoring normal anatomy although the anatomical results may not be systematically correlated with functional outcome [10]. However, very few studies have been conducted on anatomical restoration of each individual by taking into account the contralateral wrist measurements. In our series, major interindividual variations could be observed regarding the radiographic values of the healthy wrists, therefore the radiographic reduction for each individual should be taken into account rather than the target values.

A more precise radiographic analysis of the healthy wrists is currently conducted in our center.

Another point should be taken into account: pinning of distal radius fractures requires a second operation for pin removal. In young patients, pin removal is usually performed, whatever the fixation material, whereas in elderly patients, such procedure should only be performed after having thoroughly evaluated the benefits and drawbacks of a second surgery, anaesthesia and hospitalization but also the additional cost related to this procedure.

Bad prognostic factors influencing anatomic and functional outcome have been clearly identified:

- fracture of the ulnar styloid process [18];
- fracture of the ulnar head [5,18,31] resulting in frontal over-reduction with Py’s pinning technique [5]. In some cases, the authors advocate the use of plate fixation for better long-term stability [31];
- amount of initial displacement. The amount of displacement is correlated with the degree of intra-carpal ligamentous lesions and lesions of the distal radio-ulnar joint, these lesions being at the origin of poor long-term functional results [24,32];
- Cortex comminution [12,33], which influences the treatment modality, due to the common risk of secondary displacement. Anterior comminution may lead to sagittal over reduction in Py’s pinning technique [6,7,10] whereas posterior comminution may induce sagittal loss of reduction [23,33];
- the presence of a secondary fracture line, which is a long-term bad prognostic factor [32,34] particularly in complex articular fractures with major displacement. Therefore, it is crucial to achieve the best anatomical reduction.

Analysis of complications

Both groups report a similar complication rate with a prevalence of complex regional pain syndrome. Pin migration, associated or not with superficial infection, is the main complication reported in patients with intrafocal pinning. These results correlate those reported by Delattre and Sillaert [11]. There was no report of tendon rupture in our series whereas it is commonly observed after screw-plate fixation [2,35–37].

Conclusion

The results of the two pinning techniques used in our series for distal radius fractures correlate those reported in the literature either for multiple pinning fixation or plating techniques, with a low rate of complications.

Differences were noted depending on the chosen technique and fracture configuration.

Py’s technique provides good results in the management of intra-articular fractures with postero-medial fragment and those associated with fracture of the ulnar styloid process. Kapandji’s technique remains the treatment of choice for simple dorsally displaced extra-articular fractures [38] whatever the age of the patient.
In other types of fracture, a more rigid fixation is advocated.

Preoperative analysis of the patient, fracture type, age of the patient, functional requirement of the patient and intraoperative data during reduction should help provide the best indication adapted to each situation.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

References

[35] Al-Rashid M, Theivendran K, Craigen MA. Delayed ruptures of the extensor tendon secondary to the use of volar locking

