

# Percutaneous Headless Cannulated Screw versus Pinning in Fixation of Scaphoid Waist Fracture: Comparative Study

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## Abstract

**Background:** Scaphoid waist fractures are common among young adults, often necessitating surgical fixation for optimal recovery.

**Aim:** This study compares percutaneous headless cannulated screw fixation (Herbert screw) versus Kirschner wire (K-wire) pinning in terms of radiological union and functional outcomes.

**Methods:** This prospective study included 30 patients (15 per group) with recent, non-displaced scaphoid waist fractures treated at Al Azhar University Hospitals. Group I received closed reduction and Herbert screw fixation; Group II received closed reduction and percutaneous pinning with K-wires. Cases have been followed for six months with clinical assessments (Mayo Modified Wrist Score, grip strength, pain score) and radiological evaluations to monitor union and complications.

**Results:** Both groups were similar in age, BMI, injury mechanism, and surgical time. Screw fixation resulted in significantly faster radiological union (mean 4.07 vs. 4.73 weeks,  $p=0.009$ ) and earlier return to work/sports (mean 3.4 vs. 7.2 weeks,  $p<0.001$ ). The screw group demonstrated significantly better grip strength ( $p=0.003$ ), less pain (VAS,  $p=0.001$ ), and higher functional scores ( $p=0.04$ ). Insignificant variances have been found in range of motion or complication rates, though infections were seen only in the K-wire group.

**Conclusion:** Percutaneous headless screw fixation offers superior functional recovery, faster union, and earlier return to activity compared to K-wire pinning, making it a preferable option for treating non-displaced scaphoid waist fractures in active adults.

**Keywords:** Scaphoid fracture; screw fixation; K-wire; wrist function; Herbert screw

## 1. Introduction

The scaphoid is the most frequently fractured carpal bone, representing sixty percent to seventy percent of all carpal fractures. About eighty percent of the scaphoid's surface is covered by cartilage, which restricts its ligamentous attachment and vascular supply.<sup>1</sup>

In adults, seventy percent of all scaphoid fractures include the waist of the scaphoid, twenty percent include the proximal pole, and the remaining ten percent include the distal pole.<sup>2</sup>

The scaphoid contributes significantly to wrist stability and biomechanical function. The fracture usually results from a forceful extension of the wrist, predominantly in young

healthy adults between 18 and 45 years of age, and is uncommon in young kids and elderly people due to the relative weakness of the distal radius in comparison with the scaphoid bone in this age group.<sup>3</sup>

Following sufficient conservative treatment, union is attained for about ninety percent of non-displaced or minimally displaced fractures of the scaphoid waist  $\leq 1$ mm. Internal fixation, especially percutaneous kershinier wires or cannulated screw, is suggested for all fractures of the scaphoid waist, non-displaced  $\geq 1.5$  millimeters.<sup>4</sup>

This method prevents devascularization of the scaphoid bone and division of the carpal ligaments and gives a much more aesthetic scar.<sup>5</sup>

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The management of scaphoid waist fractures needs careful evaluation and planning before surgery, and the aim of the management is to confirm reduction and a stable fixation without compromising blood supply.<sup>6</sup>

Undisplaced stable fractures are managed conservatively with a scaphoid cast for eight to twelve weeks, until the fracture unites. Nevertheless, this might be rejected by the young, active population wanting to participate in professional or sports-related activities.<sup>7</sup>

Our research aimed to compare the outcomes of management of recent scaphoidal waist fracture using kershiner wires versus screw fixation regarding: radiological and functional outcome.

## 2. Patients and methods

Type of study: A prospective research

Sample size: Thirty cases (15 in each group) operated at Al Azhar University Hospitals (El Hussein Hospital and Sayed Galal Hospital).

Study Period: Till completion of the study with regular follow-up for an average of 6 months.

Inclusion criteria: Age between 18 and 45 years old, scaphoid waist fracture, closed fracture, and non-displaced fracture.

Exclusion criteria: Patients younger than 18 years old and older than 45 years old, proximal or distal pole fractures, open fractures, comminuted fractures, and displaced fractures

Ethical Considerations

Consent was taken from every patient in the study. Ethical issues of patient's names were taken in consideration.

Operative technique

**Herbert Screw Technique (Percutaneous Fixation):** The Herbert screw technique involves preparing the upper limb in a sterile field, placing the wrist in hyperextension and ulnar deviation with thumb traction to assist fracture reduction. The central axis of the scaphoid is identified fluoroscopically in both lateral and frontal planes and marked on the skin. A 1.1-millimeter guidewire is introduced percutaneously along the scaphoid's mid-axis, angled 45° dorsally and medially, ensuring central placement. A small skin incision is made, and blunt dissection is performed to the scaphoid's distal pole. Screw length is measured, selecting a screw four millimeters shorter than the actual depth. The wire is then advanced further to maintain position during reaming. A cannulated drill is inserted over the wire, stopping short of the far cortex, followed by insertion of a self-tapping Herbert screw, which compresses the fracture upon final turns. The screw is buried beneath the surface, and its position is confirmed under fluoroscopy.

**K-Wire Technique (Closed Reduction &**

**Percutaneous Pinning):** In the K-wire technique, the wrist is also placed in hyperextension and ulnar deviation under sterile conditions to aid fracture reduction, allowing better access to the scaphoid tubercle and displacement from the radial styloid. The central axis of the scaphoid is identified under fluoroscopy in both AP and lateral views and marked on the skin to guide wire entry. A 1.2-millimeter percutaneous wire is introduced along the scaphoid's axis, maintaining a 45° dorsal and medial angle. Once correctly placed, a second 1.2-mm wire is inserted parallel and slightly lateral to the first, followed by a third parallel wire inserted slightly medial to the first, all maintaining equal lengths. Final fixation is confirmed by moving the wrist under fluoroscopy to ensure proper wire positioning.

Method of clinical and functional assessment

Early postoperative:

According to the cases of Herbert screw:

Wound care, investigation for capillary circulation, and hand edema. Wrist motion has been permitted as tolerated, but full finger range of motion has not been attained immediately. Supplementary K-wires utilized for the fixation of the distal radius have been eliminated at six weeks.

According to cases of K-wires:

Skin around wires should be monitored until wires are removed, and investigation for capillary circulation and hand edema should be conducted. Wrist motion has been permitted as tolerated, but full finger range of motion has not been attained immediately.

Radiological evaluation

According to the cases of Herbert screw:

X-rays after surgery have been investigated for compression of fracture location, screw positioning, e.g., clearance of the scaphotrapezial joint from the screw head, and ensuring that leading threads don't penetrate the dorsal cortex into radioscaphoid articulation, direction of screw, and its association with the fracture plane, and evaluation of the appropriate treatment of related injuries. Serial radiological investigations are conducted at four and six weeks, followed by weekly evaluations until union is achieved.

According to cases of K-wires:

X-rays after surgery have been investigated for fracture location, with no rotation or displacement, the position of wires, e.g., clearance of the scaphotrapezial joint from the wires and its distal part not penetrating the dorsal cortex into radioscaphoid articulation, direction of wires and its association with the fracture plane, and evaluation of the appropriate treatment of related injuries. Serial radiological investigations are conducted at six and eight weeks, followed by weekly evaluations until union is achieved.

Assessment of union:

Absence of fracture location tenderness and the presence of trabeculae crossing the fracture location in plain X-ray and computed tomography, utilized if needed, indicate union.

Late postoperative:

Radiological examination: For the screw at six months, monitor for evaluation of screw position, carpal alignment, and proof of complications such as nonunion or arthritis. For k wires at six months, monitor for evaluation of carpal alignment and proof of complications such as nonunion or arthritis.

Clinical evaluation: All patients were evaluated after 6 months for wrist flexion, extension, radial deviation, and Ulnar deviation. All of them were evaluated using a goniometer, grip strength, and the ability to perform complete circumduction. The grip strength of the affected side was assessed and compared to that of the non-affected side through the utilization of the Jamar dynamometer. The Mayo modified wrist score has been utilized to assess the functional result.

### 3. Results

Table 1 demonstrates a statistically insignificant variance has been observed among the K-Wires and Screw Fixation groups regarding age, BMI, gender distribution, or injury side.

Table 1. Demographic data in study groups

| PARAMETER   | CATEGORY     | K-<br>WIRES<br>(N=15) | SCREW<br>FIXATION<br>(N=15) | P-<br>VALUE | SIGNIFICANCE |
|-------------|--------------|-----------------------|-----------------------------|-------------|--------------|
| AGE (YEARS) | Mean ± SD    | 27.33 ± 4.58          | 28.53 ± 6.47                | 0.562       | NS           |
|             | Median (IQR) | 29.00 (23.00-30.50)   | 27.00 (23.00-35.50)         |             |              |
| BMI (KG/M2) | Mean ± SD    | 24.07 ± 1.63          | 23.85 ± 1.27                | 0.683       | NS           |
|             | Median (IQR) | 24.30 (22.70-24.80)   | 24.30 (22.95-24.95)         |             |              |
| GENDER      | Male         | 11 (73.3%)            | 10 (66.7%)                  | 1.000       | NS           |
|             | Female       | 4 (26.7%)             | 5 (33.3%)                   |             |              |
| INJURY SIDE | Right        | 12 (80.0%)            | 12 (80.0%)                  | 1.000       | NS           |
|             | Left         | 3 (20.0%)             | 3 (20.0%)                   |             |              |

IQR: Interquartile Range, BMI: Body Mass Index, NS: Not Significant, SD: Standard Deviation

Table 2 shows a statistically insignificant variance has been observed among the K-Wires and Screw Fixation groups in terms of injury characteristics. The mechanism of injury, time from injury to operation, and radiographic displacement were comparable across both groups, with all p-values indicating non-significance.

Table 2. Injury Characteristics in study groups

| PARAMETER           | CATEGORY       | K-<br>WIRES<br>(N=15) | SCREW<br>FIXATION<br>(N=15) | P-<br>VALUE | SIGNIFICANCE |
|---------------------|----------------|-----------------------|-----------------------------|-------------|--------------|
| MECHANISM OF INJURY | FOOSH          | 9 (60.0%)             | 8 (53.3%)                   | 0.739       | NS           |
|                     | Direct Trauma  | 3 (20.0%)             | 2 (13.3%)                   |             |              |
|                     | Motor accident | 2 (13.3%)             | 2 (13.3%)                   |             |              |
|                     |                |                       |                             |             |              |

|                                        |              |                  |                  |       |    |
|----------------------------------------|--------------|------------------|------------------|-------|----|
| TIME FROM INJURY TO SURGERY (DAYS)     | Mean ± SD    | 1.00 ± 0.76      | 1.00 ± 0.74      | 0.630 | NS |
|                                        | Median (IQR) | 6.00 (5.50-6.50) | 6.00 (6.00-7.00) |       |    |
| X-RAY FINDINGS: MEAN DISPLACEMENT (MM) | Mean ± SD    | 1.12 ± 0.16      | 1.09 ± 0.18      | 0.672 | NS |
|                                        | Median (IQR) | 1.10 (1.05-1.20) | 1.10 (1.00-1.25) |       |    |

FOOSH: Fall on Outstretched Hand

Table 3 indicates a statistically insignificant variance has been observed among the K-Wires and Screw Fixation groups in terms of surgical time or length of hospital stay.

Table 3. Surgical Data in study groups

| PARAMETER               | CATEGORY     | K-<br>WIRES<br>(N=15) | SCREW<br>FIXATION<br>(N=15) | P-<br>VALUE | SIGNIFICANCE |
|-------------------------|--------------|-----------------------|-----------------------------|-------------|--------------|
| SURGICAL TIME (MINUTES) | Mean ± SD    | 43.67 ± 5.50          | 41.67 ± 4.08                | 0.268       | NS           |
|                         | Median (IQR) | 40.00 (40.00-47.50)   | 40.00 (40.00-42.50)         |             |              |
| HOSPITAL STAY (DAYS)    | Mean ± SD    | 1.07 ± 0.26           | 1.00 ± 0.00                 | 0.326       | NS           |
|                         | Median (IQR) | 1.00 (1.00-1.00)      | 1.00 (1.00-1.00)            |             |              |

HS: Highly Significant

Table 4 shows statistically significant differences in postoperative recovery between the K-Wires and Screw Fixation groups. Patients in the Screw Fixation group achieved radiological union more quickly (p = 0.009) and returned to work or sports significantly earlier (p < 0.001) compared to those in the K-Wires group.

Table 4. Postoperative Recovery in study groups

| PARAMETER                             | CATEGORY     | K-<br>WIRES<br>(N=15) | SCREW<br>FIXATION<br>(N=15) | P-<br>VALUE | SIGNIFICANCE |
|---------------------------------------|--------------|-----------------------|-----------------------------|-------------|--------------|
| TIME TO RADIOLOGICAL UNION (WEEKS)    | Mean ± SD    | 4.73 ± 0.80           | 4.07 ± 0.46                 | 0.009       | HS           |
|                                       | Median (IQR) | 5.00 (4.00-5.00)      | 4.00 (4.00-4.00)            |             |              |
| TIME TO RETURN TO WORK/SPORTS (WEEKS) | Mean ± SD    | 7.20 ± 0.86           | 3.40 ± 0.51                 | <0.001      | HS           |
|                                       | Median (IQR) | 7.00 (6.50-8.00)      | 3.00 (3.00-4.00)            |             |              |

Table 5 reveals significant differences in several functional outcomes among the K-Wires and Screw Fixation groups. The Screw Fixation group demonstrated higher functional scores on the Mayo Modified Wrist Score (p = 0.04), experienced less pain as measured by the VAS scale (p-value equal to 0.001), and showed greater grip strength compared to the K-Wires group (p-value equal to 0.003). However, an insignificant variance has been observed in wrist range of motion between the two groups (p = 0.522).

Table 5. Functional Outcomes in study groups

| PARAMETER                                   | CATEGORY     | K-<br>WIRES<br>(N=15) | SCREW<br>FIXATION<br>(N=15) | P-<br>VALUE | SIGNIFICANCE |
|---------------------------------------------|--------------|-----------------------|-----------------------------|-------------|--------------|
| FUNCTIONAL SCORE: MAYO MODIFIED WRIST SCORE | Mean ± SD    | 84.13 ± 5.26          | 86.07 ± 5.28                | 0.04        | HS           |
|                                             | Median (IQR) | 84.00 (81.50-87.00)   | 86.00 (82.50-89.50)         |             |              |
| PAIN SCORE (VAS SCALE)                      | Mean ± SD    | 5.20 ± 0.77           | 4.20 ± 0.77                 | 0.001       | HS           |
|                                             | Median (IQR) | 5.00 (5.00-6.00)      | 4.00 (4.00-5.00)            |             |              |

|                                                  |               |                        |                        |             |    |
|--------------------------------------------------|---------------|------------------------|------------------------|-------------|----|
| GRIP STRENGTH<br>(% OF<br>CONTRALATERAL<br>HAND) | Mean $\pm$ SD | 34.07 $\pm$ 2.02       | 36.67 $\pm$ 2.41       | $\pm$ 0.003 | HS |
|                                                  | Median (IQR)  | 34.00 (32.50-35.00)    | 36.00 (35.00-38.50)    |             |    |
| WRIST RANGE OF<br>MOTION<br>(DEGREES)            | Mean $\pm$ SD | 127.00 $\pm$ 6.60      | 128.33 $\pm$ 4.45      | $\pm$ 0.522 | NS |
|                                                  | Median (IQR)  | 124.00 (123.00-130.50) | 128.00 (126.00-130.00) |             |    |

VAS: Visual Analog Scale

Table 6 indicates a statistically insignificant variance has been observed among the K-Wires and Screw Fixation groups in terms of Infection Rate, Hardware Complications and Reoperation Rate

Table 6. Complications in study groups

| PARAMETER                 | CATEGORY | K-<br>WIRES<br>(N=15) | SCREW<br>FIXATION<br>(N=15) | P-<br>VALUE | SIGNIFICANCE |
|---------------------------|----------|-----------------------|-----------------------------|-------------|--------------|
| INFECTION<br>RATE         | n (%)    | 3<br>(20.0%)          | 0 (0.0%)                    | 0.224       | NS           |
| HARDWARE<br>COMPLICATIONS | n (%)    | 1<br>(6.7%)           | 1 (6.7%)                    | 1.000       | NS           |
| REOPERATION<br>RATE       | n (%)    | 1<br>(6.7%)           | 0 (0.0%)                    | 1.000       | NS           |

Table 7 shows a statistically significant variance has been observed among the K-Wires and Screw Fixation groups based on the Mayo score outcomes. The Screw Fixation group had a much greater proportion of excellent outcomes, while the K-Wires group had more fair and good outcomes.

Table 7. Outcome based on mayo score in study groups

| PARAMETER | CATEGORY  | K-<br>WIRES<br>(N=15) | SCREW<br>FIXATION<br>(N=15) | P-<br>VALUE | SIGNIFICANCE |
|-----------|-----------|-----------------------|-----------------------------|-------------|--------------|
| OUTCOME   | Fair      | 3<br>(20.0%)          | 1 (6.7%)                    | .001        | HS           |
|           | Good      | 10<br>(66.7%)         | 2 (13.3%)                   |             |              |
|           | Excellent | 2<br>(13.3%)          | 12 (80.0%)                  |             |              |

### Cases presentation

#### Case (1)

A male patient aged 39 years old works as construction worker fall on outstretched hand. He has left scaphoid fracture and he is right handed. his fracture has been categorized as B2 (total waist fracture) based on Herbert classification. Percutaneous Herbert screw has been inserted five days following the injury. The case has been immobilized for three weeks and the fracture united six weeks later. Full power has been restored following six weeks and there was no restriction on movement. Functional result at final follow-up was good based on MMS score.

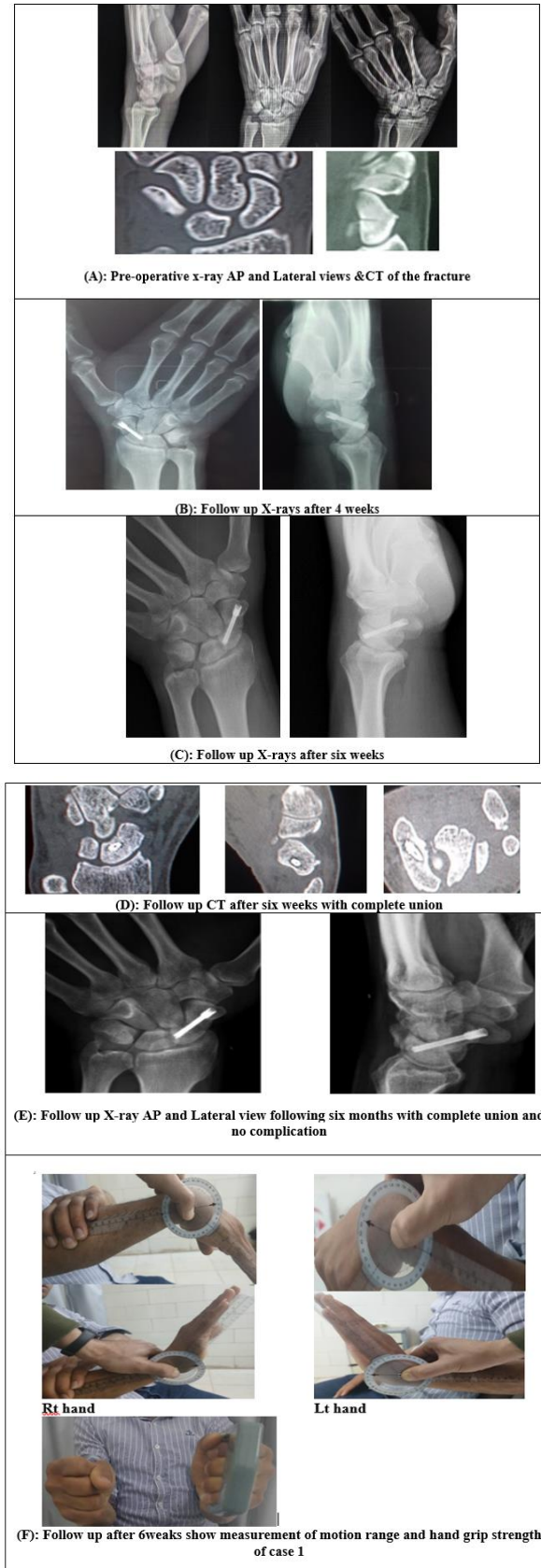


Figure 1. shows photos of case 1

#### Case (2)

A male patient aged 32 years old works as lawyer fall on outstretched hand. He has left scaphoid fracture and he is right handed. his

fracture has been categorized as B2 (total waist fracture) based on Herbert classification. Percutaneous K wires has been inserted five days following the injury. The case has been immobilized for nine weeks and the fracture united nine weeks later. Full power has been restored following eleven weeks and there was no restriction on movement. Functional result at final follow-up was good based on MMS score.

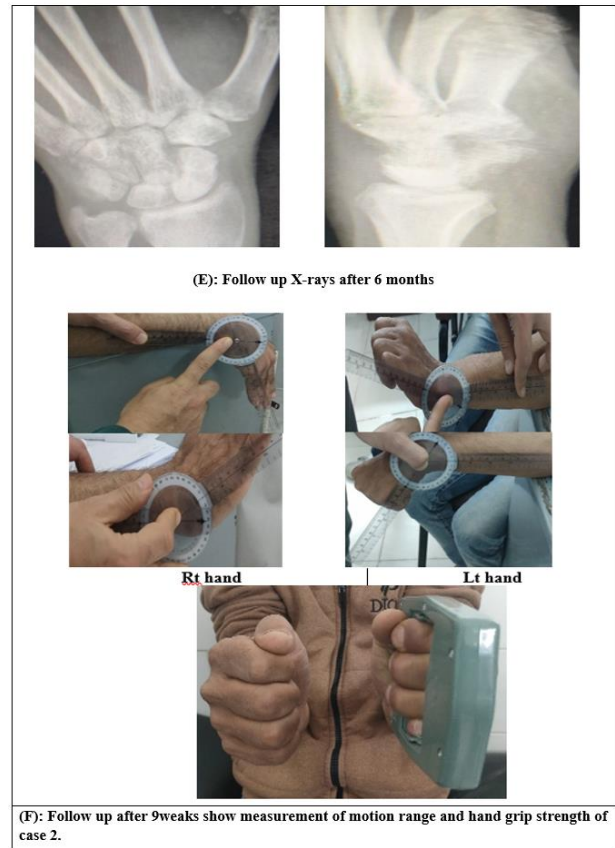


Figure 2. case 2

#### 4. Discussion

According to demographic data, in terms of age, both groups were comparable, with mean values of  $27.33 \pm 4.58$  years in the K-Wires group and  $28.53 \pm 6.47$  years in the Screw Fixation group (p-value equal to 0.562). Regarding BMI, an insignificant variance has been observed among groups, with mean values of  $24.07 \pm 1.63$  kg/m<sup>2</sup> and  $23.85 \pm 1.27$  kg/m<sup>2</sup>, respectively.

In agreement, Al-Qattan,<sup>8</sup> study included 40 males received closed reduction and K-wire fixation and their mean age was 34 years, ranged from 22 to 46 years.

According to injury characteristics, in terms of mechanism of injury, a fall on an outstretched hand (FOOSH) was the most frequent cause in both groups, occurring in 60.0% of K-Wires cases and 53.3% of Screw Fixation cases.

Regarding direct trauma, it was slightly more common in the K-Wires group (20.0%) in comparison with the Screw Fixation group (13.3%). Motor accidents contributed equally to both groups (13.3% each), while sports injuries were more frequent in the Screw Fixation group (20.0%) in comparison with the K-Wires group (6.7%).

Regarding time from injury to surgery, both groups had nearly identical durations, with mean values of  $6.00 \pm 0.76$  days and  $6.13 \pm 0.74$  days, respectively.

In line with us, Hegazy et al.,<sup>9</sup> study showed no differences among the K-wire group and Herbert group with respect to time elapsed from initial injury to operation.

Regarding hospital stay, both groups had comparable durations, with a mean of  $1.00 \pm 0.00$  days for K-Wires and  $1.07 \pm 0.26$  days for Screw Fixation, showing no significant difference.

According to surgical data, in terms of surgical time, the mean duration was slightly longer in the K-Wires group ( $43.67 \pm 5.50$  minutes) compared to the Screw Fixation group ( $41.67 \pm 4.08$  minutes); however, this variance was statistically insignificant (p-value equal to 0.268).

Costa et al.,<sup>10</sup> stated that the operative time for the Kirschner wire fixation was shorter compared to locking plate, with a median variance of thirty-one minutes (ninety-five percent confidence interval twenty-eight to thirty-five minutes; Mann-Whitney test P-value below 0.001).

According to postoperative recovery in study cases, in terms of time to radiological union, the K-Wires group had a significantly longer duration ( $4.73 \pm 0.80$  weeks) compared to the Screw Fixation group ( $4.07 \pm 0.46$  weeks), with a highly significant difference (p=0.009).

In agreement, a meta-analysis of Merrell et al.<sup>11</sup> showed that thirty-six papers documented that bone graft with screw fixation attained ninety-four percent union, and Kirschner wires attained seventy-seven percent union with the average period to union as twenty weeks.

According to functional outcomes in study groups, in terms of the Mayo Modified Wrist Score, the Screw Fixation group showed a significantly higher functional score ( $86.07 \pm 5.28$ ) compared to the K-Wires group ( $84.13 \pm 5.26$ ), with a significant difference (p=0.04).

Similarly, to k-wires mean, Kazemian et al.,<sup>12</sup> fixed scaphoid fractures thorough a volar approach and three k-wires have been inserted to stabilize the scaphoid to the adjacent bones and found that the mean Mayo wrist score was 81.5.

In disagreement, Souer et al.,<sup>13</sup> study confirmed that, based on the Mayo Modified Wrist Score, the functional outcome was excellent in one case in the screw group, good in two cases (one each group), fair in six patients (three in each group), and poor in nine cases (four screws, five K-wire).

However, Costa et al.,<sup>10</sup> study observed that wrist scores improved in the postoperative period in the two groups, but function at twelve months was still around fifteen percent worse than prior to the injury.

Regarding pain levels, the Screw Fixation group reported significantly lower pain scores

( $4.20 \pm 0.77$ ) compared to the K-Wires group ( $5.20 \pm 0.77$ ), with a highly significant difference (p=0.001).

In terms of grip strength, the Screw Fixation group demonstrated a significantly higher percentage of contralateral hand strength ( $36.67 \pm 2.41\%$ ) compared to the K-Wires group ( $34.07 \pm 2.02\%$ ), with a highly significant difference (p=0.003).

In agreement with us, Souer et al.,<sup>13</sup> stated that the mean grip strength was seventy-four percent in the screw fixation group and sixty-seven percent in K-wire group that of the uninjured arm.

However, Hegazy et al.,<sup>9</sup> study mentioned that both Kirschner wire and screw fixation groups were comparable regarding grip strength and confirmed data and said that both groups were comparable regarding VAS score.

According to complications, in terms of infection rate, three cases (20.0%) were reported in the K-Wires group, while no infections occurred in the Screw Fixation group, though this variance was statistically insignificant (p-value equal to 0.224).

This was in line with Al-Qattan,<sup>8</sup> they showed that the complication rate was greater in Group 1 (closed reduction and percutaneous K-wires) than Group 2 (open reduction and interosseous loop wire fixation) but the variance didn't reach statistical significance (p-value equal to 0.084).

Regarding hardware complications, both groups had an equal incidence of 6.7% (p=1.000), showing no difference.

In agreement with us, Costa et al.,<sup>10</sup> had different results as they showed that there was no proof to propose that rates of any complications varied among study groups, depending on comparing counts in groups.

According to outcome based on Mayo score, in terms of excellent recovery, a higher proportion was observed in the K-Wires group (26.7%) in comparison with the Screw Fixation group (13.3%), though this was statistically insignificant. Regarding good outcomes, the majority of patients in both groups achieved this level, with 60.0% in the K-Wires group and 66.7% in the Screw Fixation group.

Regarding good outcomes, the K-Wires group showed a considerably greater proportion (66.7%) than the Screw Fixation group (13.3%). Conversely, excellent outcomes were significantly more frequent in the Screw Fixation group (80.0%) in comparison with the K-Wires group (13.3%). A greatly significant variance has been found among the groups (p-value equal to 0.001).

In disagreement, Hegazy et al.,<sup>9</sup> study observed insignificant variance among the two groups with respect to deformity correction and clinical results.

#### 4. Conclusion

From our study results, in closed surgery, Kershiner's wire technique takes more time for postoperative recovery and time to return to work or sports than the screw fixation technique. Screw Fixation technique exhibits more functional outcomes, which have more efficacy than K-wires in closed surgery, as it has high contralateral hand strength with low pain and low reoperation rate.

#### Disclosure

The authors have no financial interest to declare in relation to the content of this article.

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All authors have a substantial contribution to the article

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#### Conflicts of interest

There are no conflicts of interest.

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