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ORIGINAL ARTICLE

Comparative Study Between Herbert Screws and Kirschner Wires in Fixation of Scaphoid Waist Fracture Nonunion

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Abstract

Background: Scaphoid nonunions are challenging to treat due to the bone's unique shape, the specifics of the fracture's orientation and kind, and the unique vascular arrangement of the scaphoid's blood supply.

Aim and objective: To evaluate the relative utility of Herbert screw versus Kirschner wires (K-wires) in the management of scaphoid waist fracture nonunion using nonvascularized bone graft regarding efficacy, functional outcome, operative time, and complication.

Patients and methods: This research was performed in the Orthopedic Surgery Department at Al-Azhar University with scaphoid waist nonunion fracture, throughout the period of January 2022–December 2022. A total of 20 cases with scaphoid waist nonunion fracture were treated with corticocancellous iliac bone graft with internal fixation by Herbert screw or multiple K-wires. We continued to check up with our cases for a minimum of 6 months. Clinical (pain –Rom-Power grip strength), radiographs. Modified Mayo's wrist score and the disabilities of the arm, shoulder and hand (DASH) score were the main clinical outcome indicators.

Results: All fractures united in a mean of 7 ± 2 months in Herbert screw groups and 6 ± 3.6 months in the K-wire group. More than three-fourths of the participants (80 %) did not acquire complications. 10 % of the participants suffer from Pin tract infection. 10 % suffer from malnutrition. The overall clinical and functional outcomes, as stated by the scoring system of Mayo, showed that 8 (40 %) cases had excellent results, 6 (30 %) had good results, 4 (20 %) had satisfactory results, and 2 (10 %) had poor results.

Conclusion: Internal fixation by K-wires versus Herbert screw by bone graft was a good option for the treatment of scaphoid waist nonunion fractures. We prefer using K-wires because of shorter operative time, lesser cost, and Simpler to use than the Herbert screw.

Keywords: Herbert screw, Kirschner wires, Nonunion, Scaphoid waist, Scaphoid

1. Introduction

Non-union of the scaphoid typically develops in young boys following an undetected injury or following conservative therapy has failed. Failure to get medical counsel and treatment following a minor injury or a missed diagnosis are common causes of scaphoid nonunions, as are inadequate immobilization and an insufficient period of mobilization.^{1,2} Acute scaphoid fractures are linked with carpal instability, and nonunion of the scaphoid

waist or proximal pole can result from factors such as delayed diagnosis, insufficient initial therapy, proximal fracture placement, and concomitant carpal instability.³

Despite several researches comparing various fixation strategies, screw varieties, bone grafts, and operative approaches, the best way to treat scaphoid nonunion is still up for debate. Operation for scaphoid nonunion aims to treat carpal instability by reuniting the fracture and restoring carpal alignment.^{4,5}

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Despite the fact that several writers from different parts of the world have written about their success with internal fixation of scaphoid nonunion, no single procedure has been universally accepted as the 'best'. Open reduction and screw repair of the scaphoid fracture was initially recommended by Mc Laughlin ⁶. In 1984, Herbert and Fisher ⁷ outlined the Herbert screw fixation. In 1984, Fernandez ⁸ proposed a technique for fixation utilizing a volar wedge bone graft fastened with Kirschner wires (K-wires), and in 1990, he published his outcomes utilizing the 2.7mm lagscrew. ⁹ Our study aimed to evaluate the relative utility of Herbert screw versus K-wires in the management of scaphoid waist fracture nonunion using nonvascularized bone graft regarding efficacy, functional outcome, operative time, and complication.

2. Patients and methods

Prospective research on scaphoid waist nonunion fractures was conducted throughout the period of January 2022–December 2022 by the orthopedic surgery department at Al-Azhar University Hospitals. Each case provided informed written permission in accordance with the standards set out by the Al-Azhar University Ethical Committee. A lack of financial backing.

Inclusion criteria: cases of nonunited scaphoid waist fractures in cases aged 16–50 at 6 months postinjury.

Exclusion criteria: age less than 16 and more than 50 years and wrist arteritis.

Every one of our cases went through a comprehensive history review as well as a detailed general and local clinical assessment (pain, rom, power grip strength) and locking for any other deformity in upper limbs. Affected scaphoid anteroposterior, lateral and scaphoid radiograph views then computed tomography scan. Modified the disabilities of the arm, shoulder and hand (DASH) and modified Mayo score was done. Twenty cases who presented with nonunion fractures of the scaphoid waist were split evenly among two groups: Fixation was performed on group with K-wire group, while fixation was performed on group using Herbert screws (Herbert group). In the end, 20 cases (divided into two groups of 10 each) were examined (the K-wire group and the Herbert group).

2.1. Surgical procedures Matti-Russe grafting technique for scaphoid nonunion

The scaphoid is exposed through a radiopalmar incision between the flexor carpi radialis (FCR)

tendon and the radial artery. A longitudinal incision is made along the radial border of the FCR tendon from the scaphoid tubercle proximally. The scaphoid is exposed by dissecting radial to the FCR sheath and retracting the tendon ulnarly. The bone is curetted by hand to create a trough for the bone graft. All avascular cancellous bone is excavated from the proximal fragment. Reduction is accomplished using K-wires as joysticks. A cortico-cancellous bone graft is obtained from the anterior iliac crest or the distal radius and fashioned to fit within the trough. Osteotomes of various sizes can be used to measure the depth, width, and length of the trapezoidal defect of the scaphoid, and the graft is sculpted to the correct dimensions using a saw and osteotomes after insertion of the bone graft, which was cancellous or cortico-cancellous fixation was done using Herbert screw in 10 cases and tow K-wires for each case in the remaining 10 cases in our study, using 2 mm mini-fragment Herbert screw and 0.045 inches K-wires [Fig. 1](#).

Postoperative protocol: Patients are kept for a day observation period and then discharged. Patients were followed weekly for 1 month then monthly until a minimum of 6 months with clinical (pain, rom, poer grip strength) and radiological assessment.

3. Results

Table 1.

A total of 20 cases were enrolled in the research, 10 individuals were put through internal fixation using Herbert screw in 10 patients, whilst 10 patients were received K-wires as a method of internal fixation. The mean age was 26.6 ± 5 , and 30.1 ± 6 in Herbert screw group, and K-wires group, respectively. Among of them, 13 patients were smoker [Table 2](#).

Regarding the hand dominance, seven patients in the Herbert screw group were right handed while the three patients were left handed. However, in the K-wire group, 6 of the cases were right-handed and 4 were left-handed. Fractures were discovered to be caused by forced hyperextension during axial stress. Most trauma was caused by a fall on an outstretched hand (FOOSH), however five individuals had injuries while participating in sports, and 1 was involved in a motorbike accident [Table 3](#).

There was no substantial variance among the two groups concerning the delay in the treatment where it was 7 ± 2 months in Herbert screw groups and 6 ± 3.6 months in K-wire group. Regarding the duration immobilization, the Herbert screw group was associated with shorter duration (1.5 ± 0.3



Fig. 1. (a–i) Shows steps of internal fixation of scaphoid waist nonunion fracture using iliac graft fixed by k wires.

Table 1. Patients demographic characteristics.

Variable	Herbert screw group (n = 10) Mean (SD)/N (%)	Kirschner wires group (n = 10) Mean (SD)/N (%)	P- value
Age	26.6 ± 5	30.1 ± 6	0.07
Sex (m/f)	8/2	9/1	0.19
Smoking	6	7	0.94

months) than the K-wire group (2 ± 0.7 months) (P = 0.05). Having the time to union, the Herbert group consumed 5 ± 1.1 months while the K-wire group consumed 4 ± 0.7 months. No significant difference detected between the two groups with respect to the time to union, rate of union, deformity correction, pain analysis, range of motion, grip strength, and complications Fig. 2, Table 4.

Regarding the pain score, the preoperative assessment of the Herbert screw group revealed four patients with mild pain with vigorous activities, three patients with moderate pain with vigorous activities, and three patients with mild pain with activities of daily living. After operation, the score

Table 2. Type of hand dominance and mood of trauma

Variable	Herbert screw group (n = 10) N (%)	Kirschner wires group (n = 10) N (%)	P- value
Rt hand	7 (70 %)	6 (80 %)	0.31
Lt hand	3 (30 %)	4 (20 %)	0.6
FOOSH	8 (80 %)	6 (60 %)	0.31
Athletic activity	2 (20 %)	3 (30 %)	0.6
Motorcycle accident	0	1 (10 %)	0.73

Table 3. The time of treatment and outcome appear.

Variable	Herbert screw group (n = 10) mean (SD)	Kirschner wires group (n = 10) mean (SD)	P- value
Delay in treatment (months)	7 ± 2	6 ± 1.6	0.45
Immobilization (months)	1.5 ± 0.3	2 ± 0.7	0.05
Time to union (months)	5 ± 1.1	4 ± 0.7	0.06

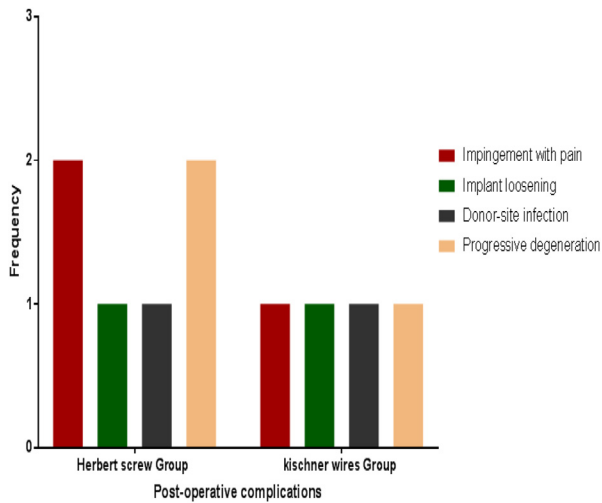


Fig. 2. Postoperative complications in each group.

improved to get seven patients without pain, two patients with mild pain with vigorous activities, and one patient with moderate pain with vigorous activities. On the other hand, the preoperative assessment of the K-wires group revealed three patients with mild pain with vigorous activities, one patient with pain only with weather changes, four patients with moderate pain with vigorous activities, and two patients with mild pain with activities of daily living. Interestingly, the postoperative score improved to get nine patients without pain and one patient with mild pain with vigorous activities.

There was a substantial variance among the two groups concerning the pain score [Table 5](#).

According to the range of motion, the preoperative assessment of the Herbert screw group revealed three patients with 75–99 % of normal motion, five patients with 50%–74 % of normal motion, and two patients with 25–49 % of normal motion. After operation, the score improved to get seven patients with 100 % of normal motion and three patients with 75–99 % of normal motion. On the other hand, the preoperative assessment of the K-wires group revealed three patients with 75–99 % of normal motion, six patients with 50–74 % of normal motion, and one patient with 25–49 % of normal motion. Interestingly, the postoperative score improved to get nine patients with 100 % of normal motion and one patient with 75–99 % of normal motion. There was a substantial variance amongst the two groups regarding the pain score.

3.1. Case presentation 1

A 27 years-old male patient who sustained a hyper-extension injury in the wrist (during football playing) he had his scaphoid fractured and it was managed initially by cast immobilization for 6 weeks and removed without radiography assessment. Patient had prolonged wrist complaint after this incident. The nonunion was of the rt scaphoid waist fracture. The case had bone graft from iliac crest

Table 4. Comparison between the two groups regarding pre and postoperative pain score.

Pain category	Herbert screw group (n = 10) N (%)		Kirschner wires group (n = 10) N (%)		P- value
	Preoperative	Postoperative	Preoperative	Postoperative	
No Pain	0	7 (70 %)	0	9 (90 %)	0.03
Mild pain with vigorous activities	4 (40 %)	2 (20 %)	3 (30 %)	1 (10 %)	
Pain only with weather changes	0	0	1 (10 %)	0	
Moderate pain with vigorous activities	3 (30 %)	1 (10 %)	4 (40 %)	0	
Mild pain with activities of daily living	3 (30 %)	0	2 (20 %)	0	
Moderate pain with activities of daily living	0	0	0	0	
Pain at rest	0	0	0	0	

Table 5. Comparison between the two groups regarding pre and postoperative range of motion.

Range of motion category	Herbert screw group (n = 10) N (%)		Kirschner wires group (n = 10) N (%)		P- value
	Preoperative	Postoperative	Preoperative	Postoperative	
100 % percentage of normal	0	7 (70 %)	0	9 (90 %)	0.04
75–99 % percentage of normal	3 (30 %)	3 (30 %)	3 (30 %)	1 (10 %)	
50–74 % percentage of normal	5 (50 %)	0	6 (60 %)	0	
25–49 % percentage of normal	2 (20 %)	0	1 (10 %)	0	
0–24 % percentage of normal	0	0	0	0	



Fig. 3. Showing scaphoid waist nonunion fracture in antro-posterior (B) and scaphoid (A) radiography views.

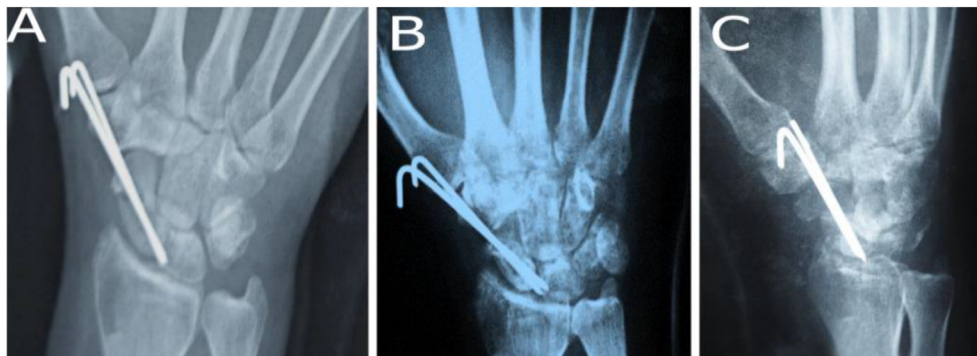


Fig. 4. PA radiograph early after the grafting procedure, (B and C) radiograph 10 weeks after the grafting procedure.

with fixation with K-wires, immobilized for 2 months in below elbow cast and after which physiotherapy, ROM and grip strengthening exercises was started. Complete union and full loading achieved at 12 weeks. His postoperative Mayo score improved from fair to excellent 1 A: preoperative radiography anteroposterior (AP) and lateral wrist

views and postreduction computed tomography scan cuts [Figs. 3 and 4](#).

3.2. Case presentation 2

Following falling off his bike, a 22-year-old right-hand student in excellent condition fractured his left



Fig. 5. Showing scaphoid waist nonunion fracture in antro-posterior (B) and scaphoid (A) radiography views.



Fig. 6. AP and lat radiograph 2 months after the grafting procedure. AP, anteroposterior.

scaphoid waist. In the beginning, he sought care at a facility outside of ours, where he had 6 months of cast immobilization. An early diagnosis of a scaphoid fracture at the waist led to the application of a short-arm thumb spica splint, which was later removed. One restriction prevented them from lifting large things. The case denied using cigarettes and had no relevant medical history (Figs. 5 and 6).

4. Discussion

Scaphoid nonunion is a problematic consequence that can develop from scaphoid fractures and can be the consequence of missing diagnoses at the time of injury, delayed diagnoses, or unsatisfactory initial nonsurgical or operative care. The removal of sclerotic bone tissue, its substitution of it with an osteo-inductive and osteo-conductive matrix, firm fixation and the re-establishment of vascular supply are the essential components of a successful union.^{10,11} We included 20 patients aged more than 16 years diagnosed with nonunited scaphoid fracture, iliac crest bone graft (ICBG) was standard in all cases, 10 patients were underwent to internal fixation using Herbert screw, whilst ten patients were underwent K-wires as a method of internal fixation. Volar approach used in patients in both groups. Patients underwent to K-wires achieved union rate (90 %) which is superior to cases underwent to Herbert screw (80 %) as a strategy for internal fixation. Regarding postoperative pain two patients of Herbert screw group and one patient of K-wires had unresolved postoperative pain which was investigated by plain radiograph and computed tomography which showing impingement, the suggested cause of impingement is maldirection of Herbert screw or K-wires. According to the modified DASH score, cases who were treated with K-wires fared better than those who were treated with Herbert screw. Multivariate regression research showed that

sex (specifically male participants) was an independent indicator of time to bone repair. Regarding the union rate, many studies were found in the literature to be concomitant with our study. For instance, in a retrospective analysis of 32 cases, Meisel et al.¹² evaluated the viability of K-wire fixation for scaphoid nonunion and found that the combination of K-wire fixation and ICBG resulted in superior union rates in contrast to those seen with other procedures. Despite the fact that a lot of people suffered proximal pole fractures, which tend to heal more slowly.¹³ Retrospective analysis of 151 scaphoid nonunions treated with ICBG and K-wire fixation among 1966 and 1988 found a 97 % union rate and a mean time to union of 17 weeks in the research by Stark et al.¹⁴ However, Christodoulou et al.¹⁵ found that the union rate for the Herbert screw was 77 %, whereas the union rate for the K-wire was just 55 %. Furthermore, in contrast to the Herbert screw and the Arbeitsgemeinschaft für Osteosynthesefragen (AO) 2 mm mini-fragment screw, K-wire performed poorly. When evaluating the efficacy of a therapy for scaphoid nonunion, union rates alone should not be used as the sole criterion. Both the structure and function of the carpus must be restored. Radiological union is necessary for better function,¹⁶ but it does not guarantee a positive outcome. When the K-wires protrude through the skin, they might cause discomfort and necessitate a second surgery to remove them. Despite the difficulty of the required surgical procedure, the absence of a protruding head is the primary benefit of the Herbert screw¹⁶ However, the use of K-wires was associated with skin irritation in three of the 30 instances studied. In a more current meta-analysis, Pinder et al.¹⁷ compared the success rates of several surgical procedures for treating scaphoid nonunions and found that vascularized bone grafts had an estimated union frequency of 92 %, whereas nonvascularized bone

grafts had a success rate of 88 %. While Pinder and colleagues found a 90 % union rate for the K-wires group, we only found an 80 % union rate for the Herbert screws group. Long-term results of non-unions treated with open reduction internal fixation with or without bone graft were investigated by Reigstad et al.,¹⁸ with a mean follow-up duration of 12.2 years. With a sample size of 50 people, they found a union rate of 90 %. These studies are interesting since they compare two ways of fixation using iliac crest bone transplant in both groups. The small size of our sample is one of the weaknesses of our research. Without a more varied sample, it is difficult to draw any firm conclusions on the impact of case variables.¹⁹ We did not assess any functional outcomes either. Direct assessments of functional outcomes were not explored because the cases in our research did not report any functional restrictions, discomfort, or unhappiness with their results.

4.1. Conclusion

Our results bring to light that, effective treatment of scaphoid waist nonunion can be achieved by combining a bone graft taken from the iliac crest with internal fixation using a K-wire and a Herbert's screw. K-wires, on the other hand, may be a viable alternative to the Herbert screw due to its low cost and ease of application, particularly for poor nations. External validity is compromised by the study's single-center design.

Disclosure

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

Authorship

All authors have a substantial contribution to the article.

Conflicts of interest

The authors declared that there were NO conflicts of Interest.

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