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*RESEARCH ARTICLE*

# SCAPHOID EXCISION AND FOUR CORNER FUSION IN TREATMENT OF SCAPHOLUNATE DISSOCIATION

**Dr. Mustafa Elsagair[1] and Dr. Khaled Elderbag[2]**

1. Aljazeera Orthopedic Hospital.
2. Misurata Medical Centre.

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***Abstract***



## Introduction:-

Osteoarthritis (OA) of the wrist is one of the most common conditions encountered by hand surgeons and is characterized by degeneration of cartilage and hypertrophic bone changes. These abnormalities result in altered wrist kinematics, which can lead to debilitating pain, swelling, and loss of motion as the involved joints degenerate. Factors such as increasing age, female gender, obesity, and genetics are also believed to contribute to the development of hand or wrist OA.

Scapholunate advanced collapse (SLAC) is a frequently encountered form of wrist OA that typically ensues from scapholunate ligament injury. In fact, SLAC is the most common etiology of wrist OA, accounting for approximately 55% of all individuals with wrist arthritis

The radiolunate joint is typically preserved in that it has minimal or more commonly no arthritis; hence, the surgical treatment for SLAC and SNAC wrists is a capitolunate or 4corner fusion, or a proximal row carpectomy.

Injuries to the scapholunate joint are the most common cause of carpal instability. „ An isolated injury to the scapholunate ligament may progress to abnormal joint mechanics and degenerative cartilage changes.

Treatment for scapholunate instability is aimed at arresting the degenerative process by restoring ligament continuity and normalising carpal kinematics. „ Early arthroscopic diagnosis of scapholunate injury is mandatory for establishing the prognosis of the injury, as a proper ligament repair is recommended within four to six weeks after trauma.

Capito-lunate-triquetral-hamate, or ‘‘four corner’’, arthrodesis is an accepted salvage operation for scapholunate advanced collapse (SLAC) and scaphoid nonunion advanced collapse (SNAC) and carpal instability and related conditions of the wrist

**Classification of SLAC Based on Radiological Findings**

Through Using static and dynamic radiographs, the injuries can be categorized into four groups: predynamic instability/occult, dynamic instability, static scapholunate dissociation, and SLAC.

**Corresponding Author:- Dr. Mustafa Elsagair**
Address:- Aljazeera Orthopedic Hospital.

| Group | Description |
|---|---|
| Predynamic instability | Radiographs do not reveal injury but physical exam is positive for pain with wrist use |
| Dynamic instability | Radiographs will reveal the injury under stressed or dynamic loading |
| Static scapholunate dissociation | Plain radiographs will show scaphoid displacement without stressed or dynamic loading |
| Scapholunate advanced collapse | Radiographs show static scapholunate dissociation with arthritic changes at the wrist |

In radiographs, a PA view is used to determine the size of the space between the scaphoid and the lunate. A gap greater than 3mm is considered to be pathologic, although there is research demonstrating that in normal wrists, the average is 3.7mm. For this reason, it is important to compare the size of the gap in the involved wrist to the patient's uninvolved side. In addition to the PA view, the lateral view shows the scapholunate angle. The normal angle should be 30-60°, and if the angle is over 70°, it is considered a positive scapholunate dissociation.

For dynamic instability, SL dissociation is noted radiologically with SL angle > 60° and SL gap > 3 mm on clenched-fist or ulnar-deviation radiographs.It often takes three to 12 months after trauma before dynamic instability develops and SL dissociation is noted radiologically. For this development and progression to occur, an additional tear or gradual, continuous elongation of the secondary ligament stabilisers of the SL ligament is needed.

SLAC has its own spectrum based on the progression of arthritis. In the first stage, arthritic changes begin at the radial styloid. In the second stage, the arthritic changes progress to the radioscaphoid joint. In the third stage, arthritic changes are evident at the capitolunate joint.

In the fourth stage there is evidence of arthritis throughout the radiocarpal and midcarpal joints.

Treatment of scapholunate advanced collapse is difficult and not always predictable. Nonoperative treatment can include NSAIDS, wrist splints, and possible corticosteroid injections for mild disease.

Stage I SLAC wrist Radial styloidectomy and scaphoid stabilization procedures PIN and AIN denervation

Stage II SLAC wrist Proximal row carpectomy (PRC) is indicated to treat Stage II (but not Stage III) SLAC wrist. Note that a PRC procedure is contraindicated in Stage III deformity given that this implies an element of capitolunate arthritis, and patients inevitably report inferior outcomes in this clinical scenario

Stage III SLAC wrist Scaphoid excision and four corner fusion Produces reliable, positive outcomes in patients suffering from debilitating Stage II or Stage III SLAC wrist deformity Outcomes are equivalent in the long-term when comparing this procedure to a PRC in Stage II SLAC wrist deformity

Wrist fusion Indicated in the setting of Stage III SLAC wrist or pancarpal arthritis Wrist fusion procedures result in positive outcomes with respect to pain relief, but wrist motion is compromised compared to scaphoid excision/four corner fusion (the latter demonstrates preserved wrist motion following surgical reconstruction via the lunate/distal radius articulation at the lunate fossa)

The first report about an intercarpal fusion dates back to 1924, when Thornton described a fusion between scaphoid, lunate, capitate, and hamate. During the1950s and 1960s, intercarpal arthrodesis was described by several authors for the treatment of different pathologies.

In the past, excised scaphoid has been replaced with a silicon implant1,21Y23 until the mid1980s when silicone synovitis and other disadvantages were described.24,25 Others have tried to reconstruct the scaphoid at the same time as the fusion26 or replace the scaphoid with an extensor carpi radialis longus tendon ‘‘anchovy’’ graft.8

The purpose of this study was to evaluate the clinical outcome, union rate, and complications of a consecutive series of scaphoid excision and four-corner arthrodeses performed by a three surgeon using distal radius bone graft Herbert screws or K-wires or cannulated Synthes screws or Flower plate fixation. Mean duration of follow-up was 16 months

## Materials and Methods:-

The total number of patient included in this study 15 patients diagnosed as SLAC type 3 ,4

( Scapholunate advanced carpal collapse) who underwent scaphoid excision and 4-corner fusion , the surgical intervention and follow up done in misurata medical Centre and Aljazeera orthopedic hospital in misurata – Libya between February 2014 and December 2019. All the surgeries were performed by the same team of 3 hand surgeons, following the same approach .

We excluded from the study: (1) any patient who was submitted to a wrist arthrodesis different from 4-corner fusion (eg, total wrist arthrodesis or scaphocapitate arthrodesis),

The indications for 4-corner fusion were all traumatic: SlAC type 3 (n = 10) and SLAC type 4 (n = 5) wrists. (2) any patient who was submitted to 4-corner fusion by using any different techniques or hardware (eg, 4-corner fusion performed using plates, K-wires, or screws )

**Surgical Technique**

A dorsal midline incision aligned with the third metacarpal is made and the extensor retinaculum is opened , The third compartment is released and transposed radially and the fourth compartment is elevated and retracted ulnarly, exposing a segment of the posterior interosseous nerve, which is excised.

The capsulotomy is performed and, after scaphoidectomy , the cartilage of the bone surfaces between lunate, triquetrum, capitates, and hamate is removed. This step is achieved by using a combination of curettes and perostium elevator .

Under C Arm X ray guidance, an imaginary line is drawn as a parameter, passing between the fourth and fifth metacarpal bones distally and the capitate and triquetrum proximally. We had observed that this line crosses the hamate and lunate exactly in their centers, dividing them equally in normal wrist radiographs, provided that an appropriate posteroanterior (PA) incidence has been obtained Subsequently, with the aid of retractors and K-wires as joysticks, we orient ourselves to keep the 4 bones in arthrodesis position). We correct the position of the lunate, often in dorsal intercalated segment instability, to neutral or slightly volar intercalated segment instability.

This is usually done with the aid of the K-wires inserted into the dorsal lunate and capitate, acting as joysticks. In difficult cases, we consider the release of the dorsal capsule from the triquetrum and temporary fixation of the bones. In these cases, K-wires are used: They are inserted from the distal to the proximal row without crossing the radiocarpal joint. Then we insert 2 crossed Kirschner guide wires: the first one following the virtual line that enters between the fourth and fifth metacarpal bones and passes from the hamate to the lunate. The position of the first guide wire is checked by performing fluoroscopy to assure that it crosses the center of the bones in the lateral incidence. The second guide wire is passed perpendicular to the former, transecting the capitate and triquetrum.

The K-wires are always aligned to the center of the bones and crossed at a 90° angle. Efforts are made to achieve the perfect PA incidence on Xray , by using the distal radioulnar joint (DRUJ) for direction before inserting the guide wires.

After finding the suitable position of the guide wires on X Ray PA and lateral incidences, we internal fixation inplants , inserted from distal to proximal, Herbert screws ( 5 cases), k.wire fixation in (2 cases), and cannulated Synthes screws (3 cases). Flower plate (5 cases)

The joystick wires are removed and the passive range of motion is recorded, to see if there is any kind of hardware impingement. Only after that the remaining space between the bones is packed with harvesting cancellous bone graft (taken from iliac crest), and the wound closure is initiated (capsule, retinaculum, and skin). Whenever we believed that the bone graft from the scaphoid was of poor quality, opaque, or not bleeding, bone graft from the distal radius was used instead.



The wrist is immobilized in a slightly extended position by using a splint, which is replaced by a below-elbow cast 1 week after surgery. The cast is retained until the consolidation is confirmed in plain radiographs, when mobilization is allowed under hand therapist supervision. If consolidation has not been obtained after 8 weeks, the cast is changed to a removable splint.

## Result:-

The study group consisted of 15 patients, 12 men and 3 women, of mean age 37.5 years(range 25-50).. Herbert screws were used in 5 cases, k.wire fixation in 2 cases, and cannulated Synthes screws in 3 cases. Flower plate in 5 cases Mean duration of follow-up was 16 months

The cast was removed at a mean of 30 days after surgery. By the end of follow-up, fusion was achieved in 12/15 wrists. The average time to radiographic fusion was 80 days. There were no differences in rate of fusion by previous operative procedure, smoking history, or postoperative intake of acetylsalicylic acid or nonsteroidal anti-inflammatory drugs(table 1) .

At the last follow-up, 8 patients reported no pain, 3 mild pain, and 2 moderate pain. 2 severe pain .

There was a significant and expected decrease in extension after surgery, with no significant change in flexion, pronation, or supination. The most common postoperative complication was back-out of the lunocapitate screw, in( Table 2 ). — Clinical characteristics of 15 patients (15 wrists) undergoing four-corner arthrodesis

**Characteristics of . pts.**

| | |
|---|---|
| Sex | |
| Male | 12 |
| Female | 3 |
| Hand dominance | |
| Right | 10 |
| Left | 5 |
| Diagnosis | |
| SLAC type 3 | 11 |
| SLAC type 4 | 4 |
| Prior wrist surgery | |
| YES | 2 |
| NO | 13 |
| Smoking history | |
| YES | 8 |
| NO | 7 |
| Chronic ASA/NSAID use | |
| YES | 12 |
| NO | 3 |

**Table 2:-** Preoperative and postoperative range of motion in 15 patients treated with four-corner arthrodesis.

| **Preoperative(degrees of** | **Postoperative motion),(degrees of motion),** | |
|---|---|---|
| Extension | 34 ± 17 | **25 ± 15** |
| Flexion | 34 ± 18 | **35 ± 13** |
| Pronation | 83 ± 5 | **85 ± 18** |
| Supination | 83 ± 5 | **85 ± 18** |

*The decrease in postoperative extension was statistically significant.

Three patients. In two of them, fusion was not achieved. Management in these cases consisted of removal of the screws with mild residual pain,. The third patient underwent screw removal with wrist arthrodesis... Other complications were carpal tunnel syndrome, dysesthesia of the dorsal branch of the ulnar nerve, and dysesthesia of the superficial radial nerve, in one patient each.

Ninety-six postoperative series of three x-rays obtained throughout the follow-up were available for review. Nineteen series were excluded from analysis because they were obtained with the patient in a cast and therefore considered unreliable for determining bony fusion. For three patients, only x rays taken at the last follow-up (, 12 months, and 2 years) were available ; all demonstrated bony fusion.

**Mayo wrist score**

A clinician completed scoring system used to evaluate the level of disability in the wrist, assessing pain, functional status (able to work), range of motion an d grip strength.

| Pain | Points | | |
|---|---|---|---|
| | 25 | No pain | 0 |
| | 20 | Mild, occasional | 1–4 |
| | 15 | Moderate, tolerable | 5–7 |
| | 0 | Severe to intolerable | 8–10 |
| **Functional Status** | **Points** | | |
| | 25 | Return to regular employment | |
| | 20 | Restricted employment | |
| | 15 | Able to work, unemployed | |
| | 0 | Unable to work, pain | |
| **Range of Motion** | **Total Motion** | **Percentage of Normal (%)** | |
| 25 | ≥ 20° | 90–100 | |
| 20 | 100°–119° | 80–89 | |
| 15 | 90°–99° | 70–79 | |
| 10 | 60°–89° | 50–69 | |
| 5 | 30°–59° | 25–49 | |
| 0 | 0°–29° | 0–24 | |
| **Grip Strength** | | **Percentage of Normal (%)** | |
| 25 | | 90–100 | |
| 15 | | 75–89 | |
| 10 | | 50–74 | |
| 5 | | 25–49 | |
| 0 | | 0–24 | |

Excelent 100 -90 Good 89 – 80
Fair 60 – 79 Poor less than 60

**Preoperative Mayo wrist score**

| Patient state | pain | Functional movement | Range of strength | Grip | **The total of the case** |
|---|---|---|---|---|---|
| 1 | 0 | 0 | 5 | 5 | 11 |
| 2 | 0 | 15 | 5 | 5 | 52 |
| 3 | 15 | 0 | 5 | 15 | 52 |
| 4 | 0 | 15 | 15 | 5 | 52 |
| 5 | 15 | 15 | 5 | 0 | 52 |
| 6 | 0 | 0 | 5 | 0 | 2 |
| 7 | 0 | 0 | 5 | 15 | 51 |
| 8 | 0 | 0 | 15 | 0 | 12 |
| 9 | 15 | 0 | 5 | 5 | 52 |
| 10 | 0 | 0 | 0 | 15 | 12 |
| 11 | 15 | 15 | 15 | 15 | 01 |
| 12 | 0 | 15 | 5 | 25 | 52 |
| 13 | 15 | 15 | 15 | 5 | 21 |

| | | | | | |
|---|---|---|---|---|---|
| 14 | 15 | 0 | 15 | 5 | 52 |
| 15 | 15 | 0 | 5 | 15 | 52 |
| total | | | | | 56.00 |

**Post-operative mayo wrist sc )re**

| Patient | pain | Functional state | Range of movement | Grip strength | The total of the case |
|---|---|---|---|---|---|
| **1** | **15** | **25** | **15** | **25** | **01** |
| **2** | **15** | **15** | **15** | **25** | **01** |
| **3** | **15** | **15** | **15** | **15** | **01** |
| **4** | **15** | **15** | **15** | **25** | **01** |
| **5** | **25** | **15** | **5** | **25** | **01** |
| **6** | **5** | **15** | **25** | **15** | **01** |
| **7** | **0** | **0** | **15** | **15** | **51** |
| **8** | **15** | **15** | **15** | **25** | **01** |
| **9** | **15** | **25** | **5** | **25** | **01** |
| **10** | **15** | **0** | **5** | **15** | **52** |
| **11** | **25** | **15** | **25** | **25** | **61** |
| **12** | **15** | **15** | **15** | **25** | **01** |
| **13** | **15** | **25** | **25** | **15** | **01** |
| **14** | **15** | **15** | **15** | **20** | **01** |
| **15** | **15** | **15** | **25** | **15** | **01** |
| total | | | | | **00** |

## Discussion:-

The management of a degenerative wrist due to scapholunate collapse remains a challenging choice between several surgical options. Wrist denervation can only be used selectively and prosthetic joint replacement is still controversial in non-rheumatoid wrists.

Total wrist arthrodesis provides predictable pain relief at the cost of a complete loss of motion and shock absorption. Moreover, the complication rate of this procedure is relatively high (Clayton and Ferlic, 1984; Clendenin and Green, 1981). Therefore, motionpreserving procedures, such as four-corner arthrodesis and proximal row carpectomy, are preferred as they also offer good pain relief, but with preservation of some motion.

Among different salvage procedures, excision of the scaphoid and four-corner arthrodesis, although technically demanding, results in greater patient satisfaction and good to excellent relief of pain, especially in younger patients and working men. The present study was conducted to assess the functional outcome of 20 patients with stage II or III SNAC/SLAC wrists treated with excision of the scaphoid and four-corner arthrodesis.

The choice of the four-corner arthrodesis technique for management of stage III SNAC wrists is consistent with other studies. For stage II lesions, there is controversy in the literature on the appropriate salvage procedure. Some authors prefer proximal row carpectomy over the four-corner arthrodesis arguing that the latter is technically a more demanding procedure that requires longer postoperative immobilization for bony union and the differences in the resultant functional outcome are not statistically significant.

Excision of scaphoid was performed for all patients in the present study. A cadaveric study was performed and proved that scaphoid excision with four-corner arthrodesis allows significant greater ROM at the wrist compared with scaphoid retention.

Different methods of fixation can be used to secure the arthrodesis including K-wires, staples, screws, and specially designed plates. The chosen method determines the postoperative care rehabilitation program. Also, the average time needed to achieve fusion differs with different methods of fixation. It was estimated that for K wires, approximately 8 to 10 weeks are needed to achieve arthrodesis.

In the present study, K wires were used to secure arthrodesis in all patients. The mean time to achieve fusion was 10 weeks which is similar to other studies. Using the modified Mayo Wrist Scoring Chart for functional assessment of patients both preoperatively and at the last follow-up, good results were obtained in 70% of patients, fair results in 20% and poor results in 10% of patients. This scoring chart depends on two subjective categories [pain and patient satisfaction], and two objective categories [ROM of the wrist and grip strength].

From the results of the present study, it is obvious that both the percentages of wrist ROM and grip strength scores are nearly constant despite differences in the percentages of improvement between each patient. This has a very little impact on the final score and result. On the other hand, pain and patient satisfaction affect the final score and results as noticed that the 6 patients with fair and poor results had mild to moderate pain with activity, and consequently affect the degree of patient satisfaction. No excellent results were obtained in the present study because the scoring system needs 90-100 points to give excellent results which could be achieved only if the recovery of ROM of the wrist or the grip strength or both reaches 100% of normal. This is not expected with a salvage procedure at the wrist.

Other studies report the recovery of wrist ROM to range from 41 % to 78% of normal and the recovery of grip strength to range from 61% to 76% after scaphoid excision and fourcorner arthrodesis. The improvement of the wrist ROM and grip strength in the present study ranged from 75%-79% and 75%- 80% respectively. These results are higher than those reported in the previous mentioned studies. This can be explained by the small number of patients in the present study .

Four patients had redial palsy due to tourniquet and recovery after 3 months with physiotherapy. Solid fusion was achieved in all patients. These results are better than many published studies. This can be explained by the small number of patients with strict adherence to surgical technique, good preparation of graft bed, and relatively long period of postoperative immobilization adopted in the present study. Dorsal impingement of the capitate and radius occurred in two patients and resulted in reduction of the degree of dorsiflexion. However, it did not affect the final total score or the end result. Four patients suffered reflex sympathetic dystrophy, which resolved completely with physiotherapy and active hand exercise, and did not affect the final total score or end result. Two patients suffered superficial wound infection that resolved completely with local measures and antibiotics; also, this did not affect the final total score or end result .

The overall complication rate in the present study [20%] is significantly higher than published in other studies [13.5%]. this is explained again by the small number of patients in the present study. Despite the apparently high rate of complications, they were nonsignificant, resolve completely without further intervention, and did not affect the final score or the end result .

Four corner arthrodesis provides a satisfactory option for palmar midcarpal instability. No clinical study had made note of a significant increase in ulnar-sided wrist pain, as one may expect because of redistribution of load from that normally would be transferred across the radio scaphoid joint .

The study findings also suggested that load across the radio scaphoid joint is preferentially redistributed to the radiolunate joint as compared to the ulnocarpal articulation. This finding may help to explain why the clinical results after scaphoid excision and four-corner fusion and proximal row carpectomy are so comparable, as were reported by Krakauer et al .

## Conclusion:-

In short, result of the present study revealed that, patient satisfaction is high, and the procedure offers well to excellent pain relief. Advances in surgical exposures, fixation techniques, and implants have allowed for rigid fixation that enables for rapid union and the commencement of early range of motion. Failure rates and complication rates are relatively low, and long-term outcomes have been promising

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