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Article

Radiologic assessment of arthroscopic correction of humpback deformity in scaphoid fracture non-union

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Abstract. *Background:* Scaphoid non-unions management has two main goals: to achieve bone healing and to restore the normal bone configurations with correction of any deformity. The purpose of the study was to evaluate the degree of correction of humpback deformity arthroscopically in scaphoid fracture non-unions. *Methods:* This was a prospective single-center study of twenty patients presented to Alexandria Main University Hospital with non-united fracture scaphoid with humpback deformity in a period from January 2020 to January 2022. The correction of humpback deformity was measured by comparing height to length ratio (H:L ratio), dorsal cortical angle (DCA) and lateral interscaphoid angle (LISA) from sagittal computed tomography images preoperatively and at the final follow-up. *Results:* The average follow-up period was 18.75 months. The surgery was performed between 9 to 26 months from injury. Fixation was performed using Kirchner wires in all cases. Seventeen of the twenty non-unions (85%) achieved radiographic union at a mean of 8.7 weeks. H:L ratio decreased from 0.63° (±0.02) to 0.51° (±0.07) (P= 0.0091), DCA increased from 65.4° (±6.07) to 94.35° (±15.3) (P=0.0011) and LISA decreased from 65.4° (±3.26) to 36.45° (±12.04) (P= 0.0012). *Conclusions:* Humpback deformity can be corrected arthroscopically without using open techniques. The use of Kirshner wires is sufficient and effective method of fixation that keeps the graft in position and maintains the corrected scaphoid height till achieving union.

Keywords: Arthroscopy, scaphoid, nonunion, humpback deformity.

Introduction

As scaphoid mal-union alters the carpal kinematics and may progress to wrist arthritis (1, 2). There are various options for the management of scaphoid non-unions starting from percutaneous fixation which is a simple up to free vascularized bone grafting which is a more complex procedure(3). Reconstruction of collapsed scaphoid non-unions with humpback deformity using the volar approach usually violates wrist joint capsule and its ligamentous structures. This may risk joint stability and may lead to stiffness (4). Although, arthroscopic technique is a minimally invasive surgery, it is a challenging procedure that needs a lot of practice and high experience (5,6). However, it has the advantage of achieving an accurate reduction of articular surface and high success rate regarding union with minimal complications that allows for early rehabilitation and return to function (5,6). The aim of the study was to evaluate the degree of correction of humpback deformity in scaphoid fracture non-unions all arthroscopically without using conventional open techniques.

Methods

The study protocol was approved by our institutional review board. Informed consent was taken from all patients to participate in the study.

Study design

This was a prospective single center study of twenty patients (20 men) presented to Alexandria University Hospital with non-united fracture scaphoid with humpback deformity in a period from January 2020 to January 2022. The average follow-up period was 18.75 months (range 13-24 months). The surgery was performed between 9 to 26 months from injury. Five of patients were smokers. Fixation was performed using Kirchner wires in all cases. We excluded from the study cases with advanced or specific arthritis, proximal pole fractures and those with X-ray and CT signs and of avascular necrosis. All the scaphoid non-unions were having DISI and hump-back deformity. The Degree of hump-back deformity was measured pre-operatively and postoperatively after achieving union by measuring scaphoid height to length ratio, dorsal cortical angle (extra scaphoid angle) and lateral intra-scaphoid angle on the computed tomographic most central longitudinal image for scaphoid on sagittal view.

Union was assessed both clinically and radiologically by absence of tenderness over anatomical snuffbox and by doing X-ray and computed tomography scan before and after removal of K-wires.

Statistical Analysis:

The collected data were coded, tabulated, and statistically analyzed using IBM SPSS statistics software version 24.0, IBM Corp., Chicago, USA, 2013. Descriptive statistics were done for quantitative data as minimum& maximum of the range as well as mean ± SD (standard deviation) for quantitative parametric data, while it was done for qualitative data as number and percentage. The level of significance was taken at P value < 0.050 is highly statistically significant, otherwise is non-significant.

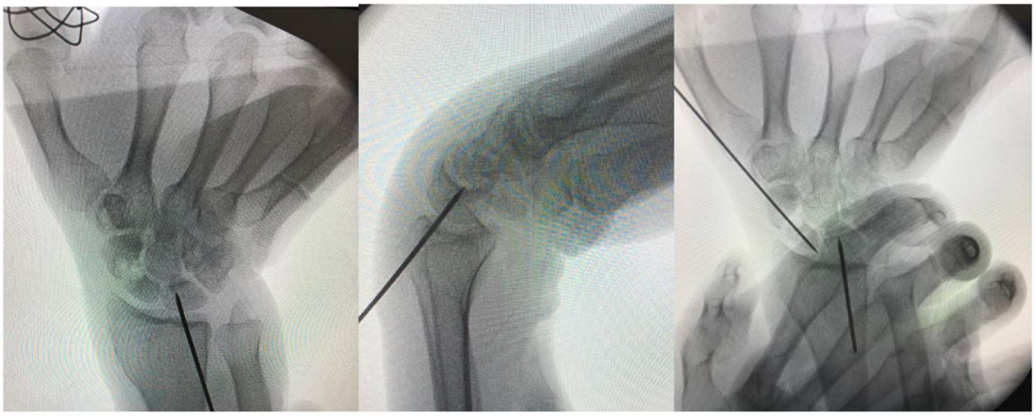
Surgical technique:

Wrist arthroscopy was performed under general anesthesia. the arm was stabilized on arm table using drapes and vertical traction was done using metal finger traps, equalizer system and custom-made traction tower. Traction was done by about 7 kgs. Iliac crest was draped for bone grafting. The arthroscopic surveillance was started through the radiocarpal joint using 2.4 mm scope, the scaphoid fracture usually was not visualized from radiocarpal joint. Midcarpal ulnar and radial portals were done both for viewing and working, respectively (Figure 1).

Figure (1): Portals for wrist arthroscopy

By using 2.9 mmm burr and 2mm shaver the fibrosis of non-union and sclerosis were taken down till appearing punctate bleeding from both ends of fracture.

Then we start to correct the humpback deformity using the Linscheid maneuver under C-arm guidance. The wrist was flexed to correct the extended proximal pole and lunate position provided that scapholunate ligament was intact, then a 1.6 mm radio lunate K-wire is introduced. By doing wrist extension and ulnar deviation and supination the distal pole was extended and reduced and with the proximal pole, then a volar positioned scaphoid 1.2 mm K-wire is introduced from volar to dorsal to hold the scaphoid in corrected position and length. (Figure 2).



(a) **b)**

Figure (2): Linscheid maneuver: AP, Lateral view showing radiolunate wire (a). Volar to dorsal scaphoid 1.2 mm K-wire after restoring scaphoid height and extending distal pole creating more fracture gap to be filled with bone graft (b).

Reintroducing 2.4 mm scope in MCU portal and 2.7 mm sheath loaded with morselized iliac crest bone graft through MCR portal was done. Fine hammering on the trocar inside sheath helps to introduce the graft easily without being stuck. Compression of graft in fracture gap was done by using trocar and dissector then we inject fibrin glue to keep the graft in its place.

Introduction of another two 1.2 mm k-wires is done to maintain stability of scaphoid percutaneously under C-arm guidance (Figure 3).

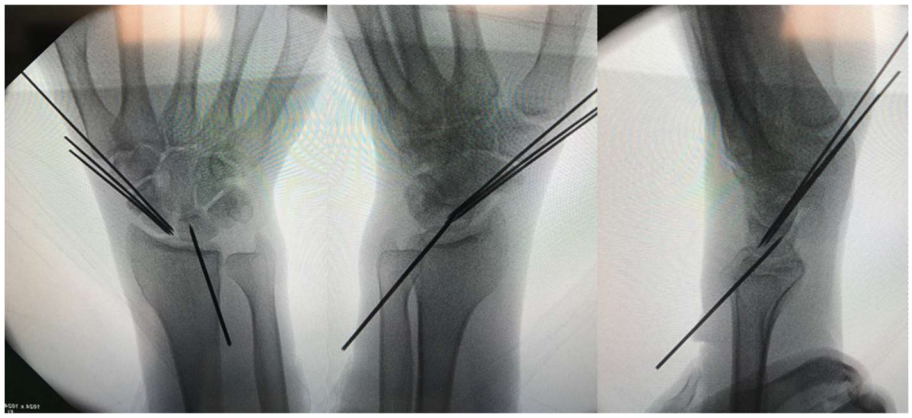


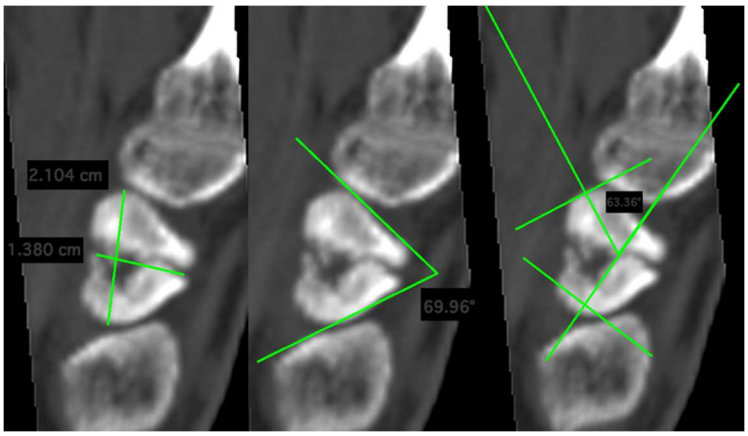
Figure (3): AP, pronation 45°, lateral view after insertion of bone graft and another two K-wires.

All the K-wires are buried under skin. Below elbow plaster cast was applied for all cases except for the TFCC type IB patient above elbow plaster cast was applied for 6 weeks then changed to below elbow cast. Radio lunate wire was removed after 3 weeks. X-ray was done after 6 weeks then 2 months. Computed tomography scan was done to check for union. After achievement of both clinical and radiological union, removal of K-wires was done under local anesthesia (Figure 4).

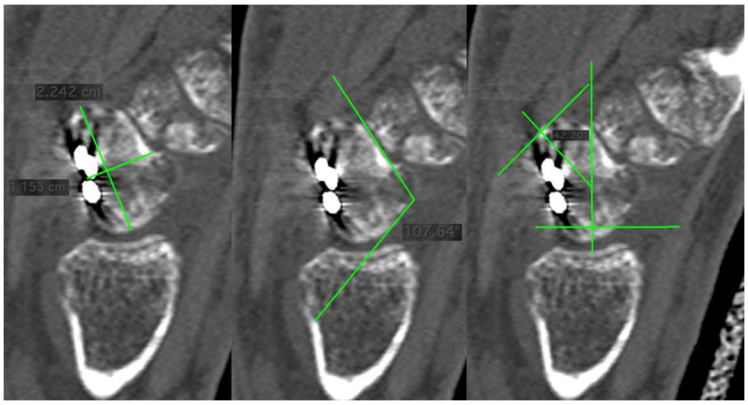
Figure (4): AP, lateral view showing united scaphoid after removal of k-wires

Result

Seventeen of the twenty non-unions (85%) achieved radiographic union at a mean of 8.7 weeks (range, 7-10 weeks). There was significant improvement in H:L ratio, DCA and LISA (Figure 5).



(a)



(b)

Figure (5): Pre-operative (a), post-operative (b) CT sagittal images on scaphoid showing improvement of H:L ratio from 0.65 to 0.51, DCA from 69.9°to 107.6° and LISA from 63.3°to 42.2°.

H:L ratio decreased from 0.63° (±0.02) to 0.51° (±0.07) (P= 0.0091), DCA increased from 65.4° (±6.07) to 94.35° (±15.3) (P=0.0011) and LISA decreased from 65.4° (±3.26) to 36.45° (±12.04) (P= 0.0012). There was no intra or post-operative complications except for non-union in three cases, one of them was managed by conventional open reduction and revision bone grafting and screw fixation and the other two developed scapho-capitate arthritis and undergone three-corner fusion. There was no pin tract infection as the K-wires was buried under the skin.

Discussion

Chen et at achieved union rate 100 % by using multiple K-wires in open technique (7). Lee et al, achieved 96% union with arthroscopic bone grafting and K-wires fixation which is comparable to our study (6).

Regarding scaphoid humpback nonunion deformity, it consists of DISI deformity with dorsal angulation of apex and dorsal translation of the distal fragment with volar shortening (8). Correction of hump-back deformity is critical in scaphoid non-union as deformity disrupts normal kinetics and affect the normal anatomical relation between carpal bones which may progress to arthritis.(8) scaphoid fixation in a hump-back deformed position might predisposes to failure and non-union due to abnormal stresses on both fragments (9).

In our study we emphasized on the importance of correcting humpback deformity. The height-to-length ratio has the best intra- and interobserver reliability over the lateral inter-scaphoid angle and the dorsal cortical angle (10). H:L ratio in this study improved to a mean of 0.51 which is comparable to normal scaphoid H:L ratio (0.597, 0.58) as reported by Bain et al and Guldbrandsen et al, respectively (10,11). Mean post-operative H:L in our study was also comparable to that reported by El-Karef after correction of scaphoid mal-union (from 0.62 to 0.53) (1).

Mean of LISA in our study was comparable to that of normal scaphoid as reported by Guldbrandsen et al (27°) (11). Mean of DCA in our study was much less than that reported by Bain et al and Guldbrandsen et al in normal scaphoid measurements (128°, 139°) and more than reported by ring et al (69°) (10-12). This difference in DCA measurements between different study groups may be due to lack of intra, inter-observer reliability for DCA and LISA as reported by Bain et al (10).

Conclusion

The use of Kirshner wires is sufficient and effective method of fixation that keeps the graft in position. Scaphoid humpback deformity can be corrected arthroscopically with good union rate.

Limitations

Points of limitations in our study include the small number of patients and the CT scans to measure scaphoid humpback deformity and its correction post-operatively as well as union were calculated by two hand surgeons who were not blind to the surgery done. However, all unions were confirmed by later radiographs for at least 1 year follow-up.

Authorship

All authors state that this manuscript has been read and approved by all the authors, the requirements for authorship as stated earlier in this document have been met and each author believes that the manuscript represents honest work.

Conflicting interests

We, the authors declare that there were no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Informed consent

Written informed consent was obtained from all subjects before the study.

Ethical approval

For this study was obtained from The Ethics Committee of Faculty of Medicine Alexandria University.

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