ORIGINAL ARTICLE

Outcome of Arthroscopic Assisted Fracture Scaphoid Fixation

Mohammed H. Amin *, Ibrahim A. I. Hussein, Usama G. Abdalla

Department of Orthopedic Surgery, Faculty of Medicine for Boys, Al-Azhar University, Cairo, Egypt

Abstract

Background: ***Scaphoid fractures represent the most frequent type of carpal fractures, making up nearly 80% of these injuries. The scaphoid plays a critical role in maintaining wrist stability by linking the proximal and distal carpal bones. Damage to this bone has the potential to cause substantial complications, including nonunion, avascular necrosis, and the development of arthritis. These fractures predominantly occur in individuals between the ages of 20 and 40, with a peak around 25 years and an estimated annual incidence of 38 per 100,000 people.***

Methods: ***This study was carried out at Abo Khalifa Emergency Hospital and AL Azhar University Hospitals. Twenty-one patients with displaced scaphoid fractures underwent arthroscopic-assisted reduction and fixation. Demographic data, injury characteristics, and outcomes were collected and analyzed.***

Results: ***The study included 12 males (57%) and 9 females (43%), with a mean age of 34.4 ± 9.5 years (range: 20-50 years). Patients were categorized into three age groups: under 30 years (n = 8), 30-40 years (n = 7), and over 40 years (n = 6). All patients achieved fracture healing within 12 weeks, with a mean time to full union of 10.1 ± 1.4 weeks. Union was observed in 14% of patients by 8 weeks, 24% by 9 weeks, 19% by 10 weeks, 19% by 11 weeks, and 24% by 12 weeks.***

Conclusion: ***Scaphoid fractures can be successfully managed with arthroscopic reduction, offering the advantage of precise fracture realignment while simultaneously allowing for the thorough assessment and treatment of associated soft-tissue injuries within a single procedure.***

Keywords: Arthroscopic; Fracture Scaphoid Fixation; Screw fixation

1. Introduction

Scaphoid fractures are commonly observed, constituting approximately 80% of carpal fractures. The scaphoid is integral to wrist stability, as it connects the proximal and distal rows of carpal bones. Importantly, over two-thirds of the scaphoid's surface is covered in articular cartilage, which is a key consideration in treating these fractures.[1] The scaphoid's main blood supply comes from the palmar and dorsal branches of the radial artery, but the proximal segment of the bone depends on retrograde blood flow, making it particularly vulnerable to complications.[2] Clinically, scaphoid fractures typically present with pain and swelling near the base of the thumb, particularly in the anatomic snuffbox. Patients often experience wrist pain following trauma, although delayed diagnosis is common, as these fractures are frequently missed on initial radiographs. Pain generally worsens with wrist mobility and is often associated with swelling and a diminished range of motion localized to the radial aspect of the wrist.[3] The primary mechanism for scaphoid waist fractures is a fall onto an outstretched hand, with the wrist in hyperextension and subjected to an axial load. A distal scaphoid fracture, the most prevalent type in pediatric cases, may occur due to a direct impact on the scaphoid tubercle, commonly resulting from a fall-related injury.[4]

Accurately diagnosing a scaphoid fracture can be challenging, as no single test can definitively confirm or rule out the condition. However, swelling in the anatomic snuffbox significantly increases suspicion of a fracture.[5] Diagnostic methods for identifying scaphoid fractures include standard radiographs, computed tomography (CT), magnetic resonance imaging (MRI), bone scintigraphy, and ultrasonography.[6]

Accepted 10 February 2025.
Available online 30 April 2025

* Corresponding author at: Orthopedic Surgery, Faculty of Medicine for Boys, Al-Azhar University, Cairo, Egypt.
E-mail address: Hamdy0100625@gamil.com (M. H. Amin).

https://doi.org/10.21608/aimj.2025.446522

The treatment's main purpose is to ensure successful fracture healing and restore full functional capacity while minimizing the risk of complications such as malunion or nonunion. Therapeutic strategies encompass functional treatment, immobilization of the fracture and surrounding joints with a cast, and surgical intervention.[6]. Arthroscopic fixation is a viable option for treating acute nondisplaced scaphoid fractures, as well as acute displaced fractures that are amenable to reduction. Optimal visualization of the reduction process is achieved by positioning the arthroscope within the midcarpal space. This technique can also be employed for the arthroscopic evaluation of selected scaphoid nonunions.[7]

The aim of this study was to assess the clinical and radiological outcomes for arthroscopically-assisted fracture scaphoid screw fixation of displaced waist fractures.

2. Patients and methods

This interventional prospective study was conducted on patients presenting with scaphoid fractures at the outpatient clinic and emergency department of the orthopedic surgery unit at Al-Azhar University Hospitals and Abo Khalifa Emergency Hospital, in accordance with specific inclusion and exclusion criteria. Upon securing approval from the Institutional Ethical Committee of the Faculty of Medicine at Al-Azhar University, and obtaining informed consent from each patient.

Inclusion criteria:

Age 20-50.

Both genders.

Recent injury

Isolated fracture of the scaphoid

Exclusion criteria:

Open fractures

Old fractures

Fracture dislocation.

Pathological fracture

Operative Technique:

The patient is positioned prone on the table, with a pillow positioned beneath the abdomen to enhance comfort.

The fluoroscopy unit should be aligned in a direct posteroanterior orientation.

After identifying the appropriate spinal level, angling the X-ray beam caudally by 20–30° will provide a clearer visualization of the joint, commonly referred to as the “Scotty-Dog” view.

Patient preparation: the arm resting on the arm board with an attached tourniquet. A standard traction tour is used during an arthroscopic procedure

Injection of saline. Injection of saline to distract the joint

First phase arthroscopic checking

Second phase manipulation and reduction. Manipulation and reduction of thumb movement and arthroscopic section.

Third fixation by Kwire & screw insertion.

In the fourth and final phase, traction is reapplied to the hand for an arthroscopic assessment to evaluate the precision of the reduction. This assessment is conducted via the midcarpal portal, with the option to make additional rotations of the screw if necessary to ensure optimal compression and precise intraosseous positioning through the radiocarpal portal.

Fifth phase : screw fluoroscopy checking.

Skin closure

Method of evaluation:

Radiological

X-ray (every 3 weeks)

CT (3 months postoperative)

Functional (modified Mayo wrist score)

Pain was scored

Wrist Range of Motion

Grip strength

Post-operative follow-up & rehabilitation:

At the initial postoperative visit, the therapist fabricates a custom removable volar splint to maintain the wrist and hand in an optimal functional alignment. During this period, the patient begins moderate strengthening activities alongside active range-of-motion exercises. Postoperative radiographs are obtained biweekly. To evaluate fracture consolidation, a CT scan of the scaphoid, with 1-mm cuts in both posteroanterior and lateral planes, is conducted between 4 and 6 weeks post-surgery. The scan is repeated at four-week intervals until complete fracture healing is confirmed.

Statistical analysis:

Gathered data will be processed using SPSS version 21 (SPSS Inc., Chicago, IL, USA). Quantitative data will be expressed as means ± SD, while qualitative data will be expressed as numbers and percentages (%). Student's t-test will be used to test the significance of the difference for quantitative variables, and Chi-Square will be used as a test of the significance of the difference for qualitative variables. A probability value (p-value) < 0.05 will be considered statistically significant.

3. Results

A total of 21 patients, presenting with displaced scaphoid fractures undergoing arthroscopic-assisted reduction and fixation, were enrolled in our study. The basic demographic, Table 1 summarizes data of study subjects, including age, gender, side of injury, dominant hand, mechanism of injury, fracture pattern, time between injury and operation, and follow-up duration.

24, 12 (57%) patients were males, while 9 (43%) patients were females. The male-to-female ratio was 1.3:1. The mean age at the time of the study was 34.4 ± 9.5 years, ranging between 20 and 50 years. As shown in Figure 25, patients were classified into three age categories: less than 30 years (n = 8), between 30 and 40 (n = 7), and more than 40 years old (n = 6).26, the right side was involved in 14 (67%) patients, and the left side was involved in 7 (33%) patients. In 13 (62%) patients, the dominant side was affected by the injury. Regarding the mechanism of injury, 13 (62%) patients suffered from a fall on the ground, five (24%) patients fell from height, and three (14%) patients had a road traffic accident. Regarding the pattern of scaphoid fracture, 15 (71%) patients had simple fracture patterns, whereas six (29%) patients showed a comminuted pattern. The mean interval between the injury and operation was 5.7 ± 1.4 days, ranging between 3 and 7 days. The follow-up duration had a mean value of 34.3 ± 4.3 weeks, ranging from 28 to 40 weeks.

Intraoperative Data, Table 2 summarizes the operative data, including surgical time, and associated ligament and cartilage injuries as demonstrated by wrist arthroscopy intraoperatively.

The mean operating time was 49.6 ± 5.8 minutes, ranging from 40 to 60 minutes., Four (19%) patients had isolated scaphoid fractures without associated ligament or cartilage injuries. Eleven (52%) had isolated ligament or cartilage injury, including one (5%) patient with scapholunate ligament injury, four (19%) with lunotriquetral ligament injury, two (10%) with injury of the triangular fibrocartilage complex, and four (19%) with cartilage injury. Six (29%) patients had combined injuries, including one (5%) with SL and LT injuries, and five (24%) with TFCC and LT injuries.

Radiological Outcomes, Table 3 summarizes the postoperative radiological outcomes, including union time and scapholunate angle.

All patients achieved fracture healing by 12 weeks. The mean time to full union was 10.1 ± 1.4 weeks, ranging from 8 to 12 weeks. As shown in Figure 31, three (14%) achieved union by 8 weeks, five (24%) achieved union by 9 weeks, four (19%) achieved union by 10 weeks, four (19%) achieved union by 11 weeks, and five (24%) achieved union by 12 weeks. the mean scapholunate angle at last follow-up was 48 ± 9.9 degrees, ranging from 33 to 62. The mean angle on the normal side was 47.1 ± 10.3 degrees, ranging from 30 to 60. Normal and injured sides were comparable regarding scapholunate angle (P = .095).

Functional Outcomes, Table 4 summarizes the functional outcomes at last follow-up, including VAS for pain, Mayo wrist score, wrist ranges of motion, and grip strength.

The mean VAS for wrist pain was 2.6 ± 1.1, ranging from 1 to 4 points. Regarding the Mayo wrist score, the average score was 85 ± 5.2 points, ranging from 75 to 93. Seven (33.3%) patients had excellent scores, 12 (57%) patients had good scores, two (9.5%) had fair scores, and none had poor scores. The average grip strength was 80 ± 11% of the normal side, ranging from 60 to 100%.

In all, the overall complication rate was 14%. As shown in Table 5, two (9.5%) patients developed superficial infection that resolved with conservative treatment. Only one (4.7%) patient developed posttraumatic osteoarthritic changes. No cases of non-union or malunion were reported.

Table 1. Basic Demographic Data (N = 21)

	NO.	%	MEAN ± SD	MEDIAN (IQR)	RANGE
GENDER			-	-	-
MALE	12	57.1			
FEMALE	9	42.9			
AGE, YR	-	-	34.4 ± 9.5	32 (16)	20 – 50
SIDE			-	-	-
RIGHT	14	66.7			
LEFT	7	33.3			
DOMINANT HAND	13	61.9	-	-	-
INJURY MECHANISM			-	-	-
FOG	13	61.9			
FFH	5	23.8			
RTA	3	14.3			
FRACTURE PATTERN			-	-	-
SIMPLE	15	71.4			
COMMINUTED	6	28.6			
TIME TO FIXATION, D	-	-	5.7 ± 1.4	6 (2)	3 – 7
FOLLOW-UP, WK	-	-	34.3 ± 4.3	34 (9)	28 – 40

Table 2. Intraoperative Data (N = 21)

	NO.	%	MEAN ± SD	MEDIAN (IQR)	RANGE
OPERATING TIME, M	-	-	49.6 ± 5.8	48 (11)	40 – 60
ASSOCIATED INJURIES			-	-	-
NONE	4	19			
SL LIGAMENT	1	4.8			
LT LIGAMENT	4	19			
TFCC	2	9.5			
CARTILAGE INJURY	4	19			
SL + LT	1	4.8			
TFCC + LT	5	23.8			

Table 3. Radiological Outcomes (N = 21)

	MEAN	SD	MIN	MAX
UNION TIME, WEEKS	10.1	1.4	8	12
SCAPHOLUNATE ANGLE				
INJURED SIDE	48.0	9.9	33	62
NORMAL SIDE	47.1	10.3	30	60
P VALUE		.095		

Table 4. Functional Outcomes (N = 21)

	MEAN	SD	MIN	MAX
VAS FOR PAIN	2.6	1.1	1	4
MAYO WRIST SCORE	85	5.2	75	93
GRIP STRENGTH				
% NORMAL SIDE	80	11	60	100
WRIST FLEXION	77	5.6	68	88
% NORMAL SIDE	91	5.9	83	100
WRIST EXTENSION	69	9.1	58	87
% NORMAL SIDE	86	7.1	77	99
WRIST ULNAR DEVIATION	29	4.6	22	40
% NORMAL SIDE	85	8.7	71	98
WRIST RADIAL DEVIATION	14	2.5	10	19
% NORMAL SIDE	84	9.8	67	98

Table 5. Postoperative Complications (N = 21)

	FREQUENCY	PERCENTAGE
COMPLICATIONS		
NONE	18	85
SUPERFICIAL INFECTION	2	10
POSTTRAUMATIC OA	1	5

Case Presentation:

Case 1:

42 years old male, farmer, presented with fracture left scaphoid waist with angulation deformity due to falling on outstretched hand.plain x-ray was done. Postero anterior and scaphoid view.

Figure 1. Plain x-ray A.P and lateral view

Figure 2. Intra operative wrist arthroscope

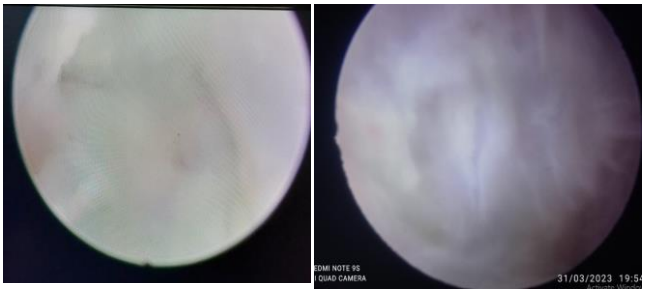

Figure 3. Intra articular arthroscopic view shows fracture line scaphoid

Figure 4. C – arm image intra operative after Herbert insertion

Figure 5. Plain x-ray A.P and laterl view post operative

Figure 6. Plain x-ray A.P and laterl view 3 monthts follow up

Figure 7. Hand appearance and ROM 3 months post-operative.

4. Discussion

The utilization of arthroscopic assistance offers significant advantages, including enhanced precision in implant placement and more reliable outcomes. In particular, arthroscopy facilitates the optimal positioning of the guidewire. In cases of comminuted fractures, arthroscopy holds particular significance as it enables thorough assessment of fracture reduction quality through direct visualization, even with small skin incisions, allowing for precise evaluation of the fracture alignment. Additionally, arthroscopy allows for the evaluation of fixation stability, as a screw that appears to have a good purchase may still fail to adequately secure a comminuted fragment. [8]

In our study, the male-to-female ratio was 1.3:1, with males comprising 57% of the patient population and females accounting for 43%. The average age was 34.4 ± 9.5 years. Patients were grouped into three categories: under 30 years (n = 8), 30–40 years (n = 7), and over 40 years (n = 6). Similarly, Shih et al.[12] conducted a study with the objective of visualizing the fracture to confirm its alignment and reduction, as well as to evaluate any concurrent ligamentous injuries. Their research included 15 acute cases, comprising 13 male and 2 female patients.

Our findings are consistent with those reported by Shih et al.[9], who documented an average patient age of 29.2 years, with the age range extending from 19 to 48 years.

To investigate the prevalence of ligamentous and other injuries related to scaphoid fractures after arthroscopically assisted reduction and percutaneous fixation, Caloia et al.[10] conducted a study involving 8 patients with stable fractures and 16 with unstable fractures. The participants' mean age was 32 ± 14 years, with ages ranging from 17 to 75 years.

In our findings, 14 patients (67%) had injuries on the right side, while 7 patients (33%) were affected on the left side. Additionally, the injury impacted the dominant side in 13 patients (62%).

Regarding the mechanism of injury, 13 (62%) patients suffered from a fall on the ground, five (24%) patients fell from height, and three (14%) patients had a road traffic accident. We found that regarding the pattern of scaphoid fracture, 15 (71%) patients had simple fracture patterns, whereas six (29%) patients showed a comminuted pattern.

Arroyo-Berezowsky et al.[11] determined that falls were the most prevalent mechanism of injury, accounting for 33.56%, followed by blunt trauma at 22.57%. Hyperextension accounted for 7.83% of injuries, and 6.96% were due to striking an object with a fist. Fractures.

In our study, the average time from injury to surgery was 5.7 days (SD 1.4). The average follow-up duration was 34.3 weeks (SD 4.3).

Our results are corroborated by Prabhakar et al.[12], who found through ROC analysis that a fracture volume less than 38% and a duration exceeding 31 days from injury to surgery were linked with an increased risk of nonunion. They further concluded that the probability of nonunion was heightened when treatment was initiated more than 31 days post-injury and when the fracture volume constituted less than 38% of the total scaphoid volume.

In this study, operative data, including associated ligament and cartilage injuries, were demonstrated by wrist arthroscopy intraoperatively.

Farr S. et al.[13] documented that their study encountered no intra-operative complications associated with the arthroscopic procedures, such as breakage of the arthroscope. Similarly, there were no instances of neurovascular issues, damage to cartilage or ligaments, infections, or complications arising from traction and arm positioning, findings that align with those of our own research.

In our current study, the mean operating time was 49.6 ± 5.8 minutes, ranging from 40 to 60 minutes. Four (19%) patients had isolated scaphoid fractures without associated ligament or cartilage injuries. Eleven (52%) had isolated ligament or cartilage injury, including one (5%) patient with scapholunate ligament injury, four (19%) with lunotriquetral ligament injury, two (10%) with injury of the triangular fibrocartilage complex, and four (19%) with cartilage injury. Six (29%) patients had combined injuries, including one (5%) with SL and LT injuries, and five (24%) with TFCC and LT injuries.

Farr S.[13] reported that out of 34 examined wrists, 28 exhibited a tear in the TFCC, representing 82.4%. Additionally, 26 of these wrists (76.5%) displayed other pathologies beyond TFCC tears. Subsequently, 14 arthroscopic TFCC

resections, two arthroscopic TFCC repairs, and seven open resection arthroplasties were conducted. Notably, no complications associated with the arthroscopic procedures occurred either during or after the operations.

Our study showed that all patients achieved fracture healing by 12 weeks. The mean time to full union was 10.1 ± 1.4 weeks, ranging from 8 to 12 weeks. Three (14%) achieved union by 8 weeks, five (24%) achieved union by 9 weeks, four (19%) achieved union by 10 weeks, four (19%) achieved union by 11 weeks, and five (24%) achieved union by 12 weeks.

In contrast to the study by Marzouki et al.[14], which reported a 95% union rate (20/21) after percutaneous fluoroscopy-guided retrograde pinning of the scaphoid with an average union time of 13 weeks (12–14) and one case of nonunion, our findings showed a shorter mean union time of 10.1 ± 1.4 weeks.

In our study, the mean scapholunate angle at the last follow-up was 48 ± 9.9 degrees, with the normal side showing a mean angle of 47.1 ± 10.3 degrees. Scapholunate angles of the normal and injured sides were comparable.

Oh WT[15] carried out a detailed study comparing the outcomes of managing acute scaphoid fractures with arthroscopic-assisted reduction and fixation versus open reduction and fixation. The trial included 20 patients, divided into two cohorts: 11 in Group A (arthroscopically assisted) and 9 in Group O (open). The lunotriquetral distance, radiolunate angle, and scapholunate angle were essential metrics. The results indicated comparable outcomes in both groups, with Group A reporting values of 47.2°, 1.7°, and 2.0 mm, while Group O recorded values of 48.8°, 5.6°, and 2.1 mm.

BOE et al.[16] reported that only 27% of patients with malunited scaphoid fractures showing more than 45° of lateral intrascaphoid angulation achieved clinically satisfactory results.

We observed the mean VAS for wrist pain was 2.6 ± 1.1, ranging from 1 to 4 points. Regarding the Mayo wrist score, the average score was 85 ± 5.2 points, ranging from 75 to 93. Seven (33.3%) patients had excellent scores, 12 (57%) patients had good scores, two (9.5%) had fair scores, and none had poor scores. The average grip strength was 80 ± 11% of the normal side, ranging from 60 to 100%.

Oh WT [15] reported that the mean grip strength was 81.1% of the contralateral side in Group A and 80.9% in Group O, with no significant difference observed between the groups (P = .594). However, the average Mayo wrist score was significantly higher in Group A (85.5) compared to Group O (79.4), with a P-value of .026.

Our study showed that the mean wrist flexion was 77 ± 5.6 degrees (Range, 68 – 88), representing 91 ± 5.9% of the normal side. The mean wrist extension was 69 ± 9.1 degrees (Range, 58 – 87), representing 86 ± 7.1% of the normal side. The mean wrist ulnar deviation was 29 ± 4.6 degrees (Range, 22 – 40), representing 85 ± 2.5% of the normal side. The mean wrist radial deviation was 14 ± 2.5 degrees (Range, 10 – 19), representing 84 ± 9.8% of the normal side.

Caloia et al.[10] identified problems in their research, including one instance of partial necrosis at the proximal pole of the scaphoid and two instances in which patients exhibited decreased wrist flexion and grip strength, both of which improved after hardware removal. Fifteen of the twenty-four patients with acute scaphoid fractures were found to have concomitant ligamentous and/or chondral injuries.

In a cohort of 20 patients, Oh WT[19] evaluated the clinical and radiological outcomes, union rates, and complications associated with arthroscopic-assisted reduction and fixation versus open reduction and fixation. The patients were categorized into two groups: 11 in Group A (arthroscopically assisted) and 9 in Group O (open). The study revealed that the average flexion-extension arc in Group A was significantly greater than in Group O, measuring 125.0° compared to 105.6° (P = 0.028).

In our study, the overall complication rate was 14%, with two patients (9.5%) developing superficial infections that were resolved with conservative treatment. One patient (4.7%) developed posttraumatic osteoarthritis, but no cases of nonunion or malunion were observed.

Ahsan ZS et al.[17] examined complications related to wrist arthroscopy and identified various issues, including nerve and tendon injuries, tendon sheath fistulae, arterial damage, cyst formation, carpal tunnel syndrome, de Quervain's tenosynovitis, persistent mobility loss, hematomas, equipment-related burns, and localized infections.

Finally, we don't ignore that this study has a number of limitations that we acknowledge. As it has a small number of patients. The inability to differentiate treatment options based on the fracture pattern also limited our study. A future study with a large sample size and long-term follow-up would provide a better evaluation of arthroscopic-assisted fixation for acute scaphoid fractures. Future prospective controlled studies would be needed to draw firm conclusions.

4. Conclusion

Our research concludes that arthroscopic-assisted fixation for acute scaphoid fractures yields superior functional and radiological results, since this technique facilitates adequate fracture

reduction and the evaluation and treatment of soft-tissue injuries.

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

Funding

No Funds : Yes

Conflicts of interest

There are no conflicts of interest.

References

1. Jorgsholm P, Ossowski D, Thomsen N, Björkman A. Epidemiology of scaphoid fractures and non-unions: A systematic review. Handchirurgie· Mikrochirurgie· Plastische Chirurgie. 2020; 52(05):374-81.
2. Kawamura K and Chung KC. "Treatment of scaphoid fractures and nonunions". Journal of Hand Surgery 33.6 (2008): 988-997.
3. Dinah AF, Vickers RH. Smoking increases failure rate of operation for established non-union of the scaphoid bone. Int Orthop. 2007 Aug;31(4):503-5.
4. Horii, E., Nakamura R, Watanabe K, Tsunoda K., Scaphoid fracture as a "puncher's fracture". J Orthop Trauma, 1994. 8(2): p. 107-10.
5. Parvizi J, Wayman J, Kelly P, Moran CG. Combining the clinical signs improves diagnosis of scaphoid fractures. A prospective study with follow-up. J Hand Surg Br. 1998;23(3):324–7.
6. Rhemrev SJ, Ootes D, Beeres FJ, Meylaerts SA, Schipper IB. Current methods of diagnosis and treatment of scaphoid fractures. Int J Emerg Med. 2011 Feb 4;4:4.
7. Geissler, W.B. Arthroscopic Management of Scaphoid Fractures and Nonunions. In: Geissler, W.B. (eds) Wrist and Elbow Arthroscopy with Selected Open Procedures. Springer, Cham. 2022.
8. Jain S, editor. Managing Difficult Problems in Hand Surgery: Challenges, Complications and Revisions, An Issue of Hand Clinics, E-Book: Managing Difficult Problems in Hand Surgery: Challenges, Complications and Revisions, An Issue of Hand Clinics, E-Book. Elsevier Health Sciences; 2023 Jul 17
9. Shih et al., Chu PJ. Arthroscopically assisted use of injectable bone graft substitutes for management of scaphoid nonunions. Arthrosc J Arthrosc Relat Surg Off Publ Arthrosc Assoc North Am Int Arthros Assoc. 2011;27(1):31–7.
10. Caloia MF, Gallino RN, Caloia H, Rivarola H. Incidence of ligamentous and other injuries associated with scaphoid fractures during arthroscopically assisted reduction and percutaneous fixation. Arthroscopy: The Journal of Arthroscopic & Related Surgery. 2008 Jul 1;24(7):754-9.
11. Arroyo-Berezowsky C, Quinzaños-Fresnedo J. Epidemiology of hand and wrist injuries treated in a reference specialty center over a year. Acta ortopédica mexicana. 2021 Oct;35(5):429-35.
12. Prabhakar P, Wessel L, Nguyen J, Stepan J, Carlson M, Fufa D. Factors associated with scaphoid nonunion following early open reduction and internal fixation. Journal of Wrist Surgery. 2020;9(02):141-9.
13. Farr S, Grill F, Girsch W. Wrist arthroscopy in children and adolescents: a single surgeon experience of thirty-four cases. International orthopaedics. 2012 Jun; 36:1 215-20.
14. A. Marzouki, B. Soumare, A.S. Diarra, K. Lahrach, F. Boutayeb, Surgical treatment by percutaneous anterior screw fixation of scaphoid fractures, Hand Surgery and Rehabilitation, Volume 37, Issue 2,2018,Pages 91-94.
15. Oh WT, Kang HJ, Chun YM, Koh IH, Lee YJ, Choi YR. Retrospective comparative outcomes analysis of arthroscopic versus open bone graft and fixation for unstable scaphoid nonunions. Arthroscopy: The Journal of Arthroscopic & Related Surgery. 2018 Oct 1;34(10):2810-8.
16. Boe CC, Amadio PC, Kakar S. The management of the healed scaphoid malunion: what to do?. Hand Clinics. 2019 Aug 1;35(3):373-9.
17. Ahsan, Z.S. and Yao, J. 'Complications of wrist arthroscopy', Arthroscopy: The Journal of Arthroscopic & Related Surgery, 2012; 28(6), pp. 855–859.