Acta Biomed 2023; Vol. 94, N. 5: e2023194 DOI: 10.23750/abm.v94i5.14646

Review

Scaphoid fracture non-union: a systematic review of the arthroscopic management

Morena Anna Basso[1], Francesco Smeraglia[1], Montserrat Ocampos-Hernandez[2], Giovanni Balato[1], Alessio Bernasconi[1], Fernando Corella-Montoya[2]

[1]Department of Public Health, Division of Orthopaedic Surgery, "Federico II" University, Naples, Italy; [2]Hospital Universitario Infanta Leonor, Madrid, Spain

Abstract. *Background and aim:* There is no consensus regarding the most appropriate treatment of scaphoid nonunion. This systematic review aimed to investigate whether wrist arthroscopy exerts a positive influence on bone union and clinical outcomes. *Methods:* We searched the literature on Medline (PubMed), Web of Science, Embase and Scopus databases using the combined keywords "scaphoid" AND "arthroscopy" AND "pseudoarthrosis" OR "nonunion". Eighteen studies were finally included in our review. The quality of the studies was assessed using the Coleman Methodological Score. *Results:* Our systematic review has shown that arthroscopic management of scaphoid nonunion achieves a high rate of union and satisfactory clinical outcomes with minimal complications. *Conclusions*: There is need to perform randomized controlled trials reporting on the use of arthroscopy. In addition, the different pattern of pseudoarthrosis should be better classified to manage the patients who will benefit after the management. (www.actabiomedica.it)

Key words: scaphoid, non-union, pseudoarthrosis, arthroscopy, bone graft

Introduction

Treatment of scaphoid nonunion is challenging, and its failure rate varies between 25% and 45% (1). This high incidence depends on the intrinsic instability of the scaphoid fracture and the poor vascularization of the scaphoid (2). Many surgical treatments have been proposed, varying in terms of the approach, source, and vascularity of the bone graft, in addition to the choice of the fixation device. Despite the availability of relevant literature, there is no consensus regarding the most appropriate treatment of scaphoid nonunion (3).

Vascularization of the scaphoid is fundamental to healing. Hence, we attempted to minimize surgical exposure to avoid affecting vascularization. Ideally, bone union should be achieved with the least invasiveness. It is also important to differentiate the heterogeneous nature of nonunion to choose the best treatment option. Arthroscopic management of scaphoid nonunion has the theoretical advantage of not interfering with blood supply and preserving carpal ligament proprioception. It was first described by Ho in 1998 (4). Since then, several authors have published radiological and clinical outcomes after arthroscopic treatment; however, to the best of our knowledge, no systematic review has been published.

This systematic review aimed to investigate whether wrist arthroscopy exerts a positive influence on bone union and clinical outcomes. We additionally assessed the methodological quality of the studies published on this topic.

Material and methods

A systematic review of the literature was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses

(PRISMA) (5). The combination of keywords "scaphoid" AND "arthroscopy" AND "pseudoarthrosis" OR "nonunion" was used for the search, with no limits for the year of publication. Medline (PubMed), Web of Science, Embase, and Scopus were accessed on the 25th of January 2022, and articles published in English, Spanish, Italian, and French were identified. Biomechanical studies, studies on animals or cadavers, technical notes, letters to the editor, reviews, case reports, and instructional courses were also excluded. Two authors independently assessed the abstract of each publication. If any study could not be included or excluded based on the abstract, a full-text version of the article was downloaded. If an abstract was not available, the article was excluded from the study. In addition, the reference list of each selected article was manually searched to identify any additional studies missed during the electronic search.

Two investigators assessed each study according to the Coleman Methodological Score (CMS), with scores ranging from 0 to 100 (6). Both investigators performed the CMS assessment twice, with an interval of 10 days, and discussed the scores until consensus was reached when more than a two-point difference was present. Data on demographic features, surgical procedures, diagnostic methods, follow-up periods, type and rate of complications, time of union, and outcome measures were recorded.

Results

In total, 242 studies were identified after the first search. Thereafter, 31 studies were selected based on the abstract, 13 were excluded after the full text had been read, and 18 publications relevant to the topic were included (Figure 1). All the included studies were published between 2003 and 2022.

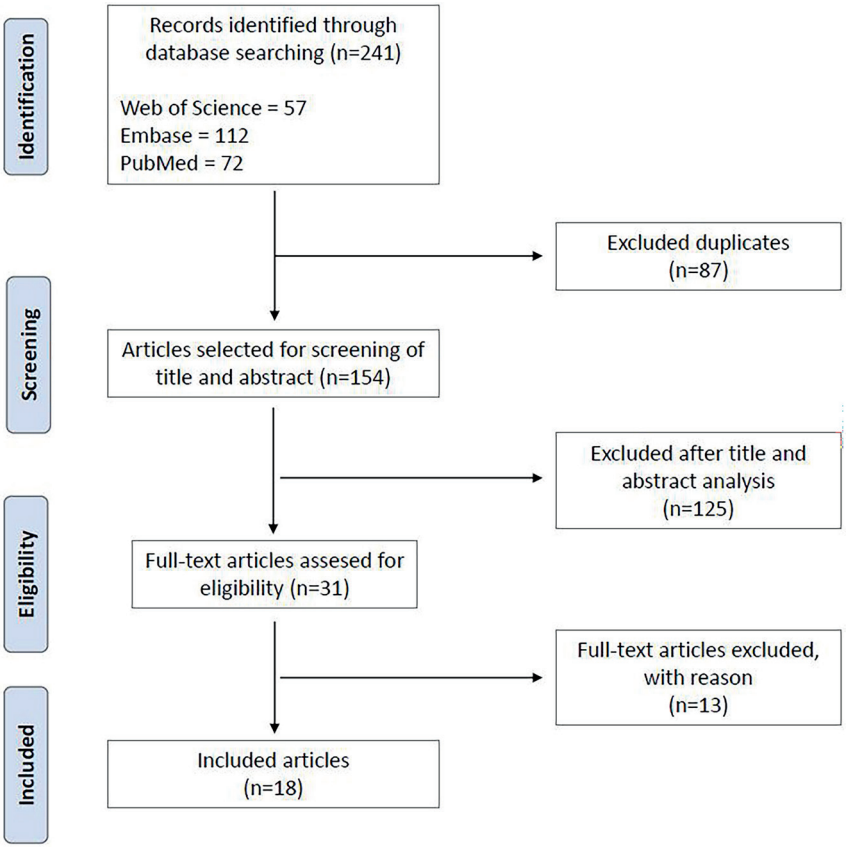

Figure 1. PRISMA flow diagram.

Demographics

Of the 545 total patients, 89% (389) were male and 11% (48) female, and one study (7) did not report sex. The mean age of the patients at the time of treatment was 27.4 years (range, 13-87 years), and one study did not report data on age (7). The mean follow-up time was 25.2 months (range, 3.0-120.0 months), and three studies did not report follow-up data (7-9).

Quality assessment

All the Coleman scores are presented in Table 1. A score of >85 was considered excellent, 70–84 was good, 50–69 was moderate, and <50 was poor. The mean CMS was 71.6 (range 53-85).

All the studies were retrospective, except one (10).

Inclusion and exclusion criteria

Avascular necrosis of the scaphoid (AVN) was an exclusion criterion in seven studies (11-17), while humpback deformity (HD) was an absolute exclusion criterion in two studies and relative (not corrigible or intrascaphoid angle of <45°) in three studies (13, 15, 18). A scaphoid nonunion advanced collapse (SNAC) wrist grade of >II was the exclusion criterion in ten studies (7, 10, 11, 14, 16-21). Other exclusion criteria included grades I-III PSA according to the Slade and Dodds (2006) classification (17).

Pseudoarthrosis classification

Slade and Dodds (2006) (22) classification was used in six studies (13, 17, 18, 20, 23, 24). Wang et al. (21) and Cognet et al. (10) used the Schemberg classification (25).

Surgical procedure

The fixation methods and sources of the grafts are summarized in Tables 2 and 3. Two papers were excluded from Table 2 because it was not possible to differentiate screw and K-wires (13, 18), and three papers were excluded from graft sources (19-21) because the authors used both sources of graft.

Table 1. General features of the studies.

Article	Year	*n*	Type of study	Coleman Methodological Score (CMS)
Slade JF 3rd et al.	2003	15	Retrospective case series	65
Slade JF 3rd et al.	2008	108	Retrospective case series	65
Chu et al.	2011	15	Retrospective case series	71
Kim et al.	2015	36	Retrospective case series	80
Kang et al.	2016	33	Retrospective case series	82
Kang et al.	2016	46	Retrospective case series	85
Cognet et al.	2017	23	Prospective study	65
Delgado-Serrano et al.	2017	13	Retrospective case series	70
Oh et al.	2018	28	Retrospective comparative study	83
Lee at al	2018	27	Retrospective case series	63
Liu et al	2019	25	Retrospective case series	65
Gvozdenovic et al.	2019	8	Retrospective comparative study	53
Cifras et al.	2019	11	Retrospective case series	68
Hsiung et al.	2021	42	Retrospective case series	85
Wang et al.	2021	21	Retrospective case series	81
Waitayawinyu et al.	2021	22	Retrospective case series	74
Lamon et al.	2021	42	Retrospective case series	81
Ecker et al.	2022	30	Retrospective case series	54

Table 2. Surgical data and primary outcomes.

Article	Year	*n*	Fixation method	Source of graft	Union rate	Union time weeks (range)
Slade JF 3rd et al.	2003	15	Screw	No graft	15 (100%)	14 (6-34)
Slade JF 3rd et al.	2008	108	Screw	82 distal radius	96%	22
Chu et al.	2011	15	Screw	Bone graft substitute	14 (93.5%)	15,4 (10-24)
Kim et al.	2015	36	Screw	16 (44%) iliac crest	31 (86%)	11 (8-18)
Kang et al.	2016	33	Screw or K-wires	Iliac crest	32 (97%)	8 to 10
Kang et al.	2016	46	Screw or K-wires	Iliac crest	43 (93%)	8 to 10
Cognet et al.	2017	23	Screw or K-wires	Distal radius	23 (100%)	16 (12-48)
Delgado-Serrano et al.	2017	13	Screw	Iliac crest or distal radius	13 (100%)	7 (4-10)
Oh et al.	2018	28	Screw	Iliac crest	27 (96.4%)	NR
Lee at al	2018	27	K-wires	Distal radius	26 (96%)	10 (7-14)
Liu et al	2019	25	Screw or K-wires	Iliac crest or distal radius	25 (100%)	12 (6-26)
Gvozdenovic et al.	2019	8	Screw	Distal radius	7 (87.5%)	10,5 (7-24)
Cifras et al.	2019	11	Screw	Distal radius	11 (100%)	9,1
Hsiung et al.	2021	42	Screw	Distal radius	38 (92.6%)	NR
Wang et al.	2021	21	S-L screw	8 iliac crest/13 distal radius	19 (90.4%)	16,3 (10-28)
Waitayawinyu et al.	2021	22	Screw	Olecranon	22 (100%)	15,3
Lamon et al.	2021	42	K-wires	Distal radius	37 (88%)	12 (8-32)
Ecker et al.	2022	30	K-wires	Iliac crest	29 (96.6%)	12

Table 3. Patients clustered in fixation method and graft source.

		Number of patients	Union rate %
Method of fixation	Screw	350	326/350 (93%)
	K-wire	116	109/116 (94%)
Source of the graft	Distal radius	183	142/183 (78%)
	Iliac crest	153	146/153 (95%)
	Olecranon	22	22 (100%)
	None	52	36/52 (69%)
Slade and Dodds classification	I	-	
	II	5	
	III	22	
	IV	110	
	V	42	
	VI	16	

Complications

Two studies reported minor complications (18, 26): four patients experienced neuroapraxia of the radial sensory nerve, and three patients experienced superficial wound infection.

Union time and union rate

Radiography was used as the only radiological examination to assess bone union in one study (23). Five studies used a CT integration in dubious cases (11, 15, 19, 21, 16), and CT scans were used in twelve studies (7-10, 12-14, 16-18, 20, 24). The union times and union rates are summarized in Table 2.

Clinical outcomes

Clinical outcomes, both objective and subjective, are presented in Table 4.

Table 4. Clinical outcomes.

Article	VAS		ROM		Grip strength		DASH/Quick DASH		PRWE		MMWS	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Slade JF 3rd et al.	-	-	-	49 ext 61 flex 19 rad dev 25 uln dev	-	-	-	-	-	-	-	12 excellent 3 good
Slade JF 3rd et al.	-	-	-	-	-	-	-	-	-	-	-	-
Chu et al.	-	-	-	-	-	90.1%	-	-	-	-	-	92.5
Kim et al.	-	-	57 ext 64 flex 19 rad dev 37 uln dev	65 ext 60 flex 19 rad dev 36 uln dev	56	78	44	13	51	23	-	9 excellent 17 good 2 fair
Kang et al.	4.5	0.6	F-E 100	F-E 109	35	50	25	4	-	-	56	89
Kang et al.	4.3	0.6	F-E 103	F-E 108.5	33.9	48	23.8	3.6	-	-	57.4	89.2
Cognet et al.	6.5	1.5	F-E 122	F-E 119	32	41	-	-	-	-	-	-
Delgado-Serrano et al.	6.8	0.7	66.3 ext 71.9 flex 11.9 rad dev 21.5 uln dev	84.4 ext 81.7 flex 13.3 rad dev 25.5 uln dev	-	-	36	8	-	-	-	-
Oh et al.	4.8	0.6	F-E 99.8 R-U dev 37.5	F-E 108 R-U dev 43.6	67.6	81.4	26.3	5.6	-	-	55	17 excellent 8 good 3 fair
Lee at al	6.4	1.6	167	178	32.7	37.1	-	-	-	-	60.2	83.4
Liu et al	-	-	-	F-E 90% of controlateral	-	-	-	-	-	4	-	96
Gvozdenovic et al.	-	-	-	-	-	-	-	-	-	-	-	-
Cifras et al.	-	-	60 ext 55 flex 12 rad dev 16 uln dev	84 ext 78 flex 18 rad dev 22 uln dev	-	-	40	11	-	-	-	-
Hsiung et al.	5.89	0.2	-	64.5 ext 81.5 flex 11.5 rad dev 47.5 uln dev	-	71,9	21.3	1.6	-	-	71.1	94
Wang et al.	4.6	2.1	62.3 ext 54.5 flex, 15.7 rad dev 27.6 uln dev	71.7 ext 67.4 flex 19.1 rad dev 27.5 uln dev	9.6	24.7	52.4	21.4	-	-	-	-
Waitayawinyu et al.	5	1.09	F-E 99.45	F-E 106.5	32.68	46.41	29.53	5.3	-	-	58.4	90.68
Lamon et al.	3.8	0.1		61 ext 64 flex 27 rad dev 31 uln dev		39	40	11	52	11		
Ecker et al.	-	-	-	-	-	-	-	-	-	-	-	-

Radiological outcomes

The postoperative scapholunate angle (SLA) was calculated in eight studies (11, 12, 14, 16, 19, 21, 24, 26), and the intrascaphoid angle was calculated in five studies (11, 12, 14, 16, 24).

Discussion

Our systematic review showed that arthroscopic bone grafting and internal fixation are reliable and safe techniques for the treatment of scaphoid pseudoarthrosis. The average quality of the studies included in the present investigation was good, with an average CMS of 71.1 points (Table 1). The longest follow-up was 38 months (14), with an average follow-up of 22.2 months, a period long enough to assess functional outcomes, but not to assess the occurrence of post-traumatic degenerative changes and their impact on function.

Nonunion classifications are not widely used. The Slade and Dodds classification (22) is the most frequently adopted but was still used only in 31% of the studies (6/19); in their study, the authors proposed a treatment algorithm based on X-rays, magnetic resonance imaging (MRI), computed tomography (CT) scans, and arthroscopic findings that correlate with the healing potential of the nonunion. In our review, the Slade and Dodds classification (22) influenced the treatment in only one study (17), which excluded grades I-III. To apply the most appropriate surgical treatment, it is crucial to identify different forms of pseudarthrosis. Healing is influenced by the fracture site (e.g., proximal pole) and bone stock (27). The impact of carpal deformity is debated; several studies have shown worse clinical outcomes in patients with DISI deformity (28, 29), whereas others have shown good clinical outcomes (30, 31). However, the DISI deformity can be corrected arthroscopically using the Linscheid maneuver (21). Three studies (12, 14, 16) showed that arthroscopic techniques restored suboptimal radiological angles, despite acceptable results. Our review showed that both AVN and humpback deformities can be successfully treated arthroscopically.

Cannulated screws were the most popular fixation method (75%, 350/466 patients), followed by K-wires (25%; 116/466 patients); however, the two fixation methods did not show any difference in terms of union rate (93% vs. 94%). In their systematic review of open treatment for scaphoid nonunion, Pinder et al. (3) reported union rates of 88% and 92% for screws and k-wires, respectively. The average union rate in our review was 13.6 weeks (Table 2), which is the same as that reported by Pinder et al. (3).

Cancellous bone grafts have advantages and disadvantages. While yhey have faster remodeling than tricortical bone grafts, they have less structural strength. One systematic review (32) reported faster bone union using cancellous bone grafts. Different sources of graft were used, with the most common being the distal radius and iliac crest, used in 44% and 37% of the patients, respectively. We observed (Table 3) a better union rate in the group of patients who used iliac crest (95%), compared with distal radius (78%). Grafting from olecranon resulted in the best union rate (100%), but it was only used in 0.5% of the patients.

It was not possible to compare the clinical results of our review with other systematic reviews regarding open treatment because the most recent reviews focused on the union rate and not on the clinical outcomes. We believe that there is a need for a systematic review that reports the clinical outcomes of open techniques, and we believe that the lower morbidity of the arthroscopic technique could have a positive influence on the range of motion.

In conclusion, this systematic review has shown that arthroscopic management of scaphoid nonunion achieves a high rate of union and satisfactory clinical outcomes with minimal complications. The methodological quality of the studies evaluated using the Coleman score was rated as good. However, no clear conclusion can be drawn regarding the source of the graft and type of fixation with the current evidence. Furthermore, there is no extended, generally accepted arthroscopic classification that orients the best way of treatment; therefore, future studies should focus on this issue, defining the type of nonunion and the best method of arthroscopic management.

Ethics Committee: For this systematic review our institutions didn't require ethical approval

Conflict of Interest: Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article

Authors Contribution: All authors contributed to the study conception and design. Material preparation and data collection were performed by Francesco Smeraglia, Fernando Corella-Montoya and Morena Anna Basso. Data analysis was performed by Francesco Smeraglia and Fernando Corella-Montoya. The first draft of the manuscript was written by Francesco Smeraglia and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

References

1. Schiund F, Haentjens P, Van Innis F, Vander Meren C, Garcia Elias M, Sennwald G. Prognostic factors in the treatment of carpal scaphoid non-unions. J Hand Surg Am 1999 Jul;24(4):761-76. doi: 10.1053/jhsu.1999.0761.
2. Gelberman RH, Menon J. The vascularity of the scaphoid bone. J Hand Surg Am 1980 Sep;5:508–513. doi: 10.1016/s0363-5023(80)80087-6.
3. Pinder RM, Brkljac M, Rix L, Muir L, Brewster M. Treatment of Scaphoid Nonunion: A Systematic Review of the Existing Evidence. J Hand Surg Am 2015 Sep;40:1797-1805.e3. doi: 10.1016/j.jhsa.2015.05.003.
4. Wong WC, Ho PC. Arthroscopic Management of Scaphoid Nonunion. Hand Clin 2019 Aug;35:295-313. doi: 10.1016/j.hcl.2019.03.003.
5. Liberati A, Altman DJ, Tetzlaff J, et al. The PRISMA statement for reporting systematic reviews and meta- analyses of studies that evaluate healthcare interventions: explanation and elaboration. BMJ 2009 Jul 21;339: b2700. doi: 10.1136/bmj.b2700.
6. Coleman BD, Khan KM, Maffulli N et al. Studies of surgical outcome after patellar tendinopathy: clinical signifi- cance of methodological deficiencies and guidelines for future studies. Victorian Institute of Sport Tendon Study Group. Scan J Med Sci Sports 2000;10: 2–11. doi: 10.1034/j.1600-0838.2000.010001002.x.
7. Slade JF 3rd, Gillon T. Retrospective review of 234 scaphoid fractures and nonunions treated with arthroscopy for union and complications. Scand J Surg 2008;97:280-9. doi: 10.1177/145749690809700402.
8. Slade JF 3rd, Geissler WB, Gutow AP, Merrell GA. Percutaneous internal fixation of selected scaphoid nonunions with an arthroscopically assisted dorsal approach. J Bone Joint Surg Am 2003;85-A Suppl 4:20-32. doi: 10.2106/00004623-200300004-00003.
9. Ecker J, Shahbaz L, Kohli S, Breidhal W, Andrijich C. Arthroscopic bone graft and internal fixation of non-union of the proximal pole of the scaphoid: surgical technique and outcomes. J Wrist Surg 2022 Jan 20; 04:279-374. doi: 10.1055/s-012-54202.
10. Cognet JM, Louis P, Martinache X, Schernberg F. Arthroscopic grafting of scaphoid nonunion - surgical technique and preliminary findings from 23 cases. Hand Surg Rehabil 2017 Feb;36:17-23. doi: 10.1016/j.hansur.2016.11.002.
11. Chu PJ, Shih JT. Arthroscopically assisted use of injectable bone graft substitutes for management of scaphoid nonunions. Arthroscopy 2011 Jan;27:31-7. doi: 10.1016/j.arthro.2010.05.015.
12. Kim JP, Seo JB, Yoo JY, Lee JY. Arthroscopic management of chronic unstable scaphoid nonunions: effects on restoration of carpal alignment and recovery of wrist function. Arthroscopy 2015 Mar;31:460-9. doi: 10.1016/j.arthro.2014.08.035.
13. Kang HJ, Chun YM, Koh IH, Park JH, Choi YR. Is arthroscopic bone graft and fixation for scaphoid nonunions effective? Clin Orthop Relat Res 2016 Jan;474:204-12. doi: 10.1007/s11999-015-4495-3.
14. 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 2018 Oct;34:2810-2818. doi: 10.1016/j.arthro.2018.04.024.
15. Gvozdenovic R, Joergensen RW, Joerring S, Jensen CH. Arthroscopically assisted bone grafting reduces union time of scaphoid nonunions compared to percutaneous screw fixation alone. J Wrist Surg 2020 Feb;9:13-18. doi: 10.1055/s-0039-1693146.
16. Cifras JL, Azocar C, Sanhueza M, Cavalla P, Liendo R. Arthroscopic treatment for scaphoid pseudoarthrosis with humpback: surgical technique and case series. Rev Chil Orthop Traumatol 2019;60:47-57. doi: 10.1055/s-0039-1698416.
17. Waitayawinyu T, Lertcheewanan W, Boonyasirikool C, Niempoog S. Arthroscopic treatment of scaphoid nonunion with olecranon bone graft and screw fixation leads to union and improved outcomes. Arthroscopy 2022 Mar;38:761-772. doi: 10.1016/j.arthro.2021.09.018.
18. Kang HJ, Chun YM, Oh WT, Koh IH, Lee SY, Choi YR. The effect of debridement of coexisting partial ligament injuries on outcomes following arthroscopic osteosynthesis for minimally displaced scaphoid nonunions. J Hand Surg Am 2016 Jun;41:e135-42. doi: 10.1016/j.jhsa.2016.04.007.
19. Delgado-Serrano PJ, Jiménez-Jiménez I, Nikolaev M, Figueredo-Ojeda FA, Rozas-López MG. Arthroscopic reconstruction for unstable scaphoid non-union. Rev Esp Cir Ortop Traumatol 2017 Jul-Aug;61:216-223. doi: 10.1016/j.recot.2017.03.002.

20. Liu B, Wu F, Ng CY. Wrist arthroscopy for the treatment of scaphoid delayed or nonunions and judging the need for bone grafting. J Hand Surg Eur 2019 Jul;44:594-599. doi: 10.1177/1753193419841253.
21. Wang JP, Huang HK, Shih JT. Arthroscopic-assisted reduction, bone grafting and screw fixation across the scapholunate joint for proximal pole scaphoid nonunion. BMC Musculoskelet Disord 2020 Dec 10;21:834. doi: 10.1186/s12891-020-03850-w.
22. Slade JF, Dodds SD. Minimally invasive management of scaphoid nonunions. Clin Orthop Relat Res 2006 Apr;445:108-119. doi: 10.1097/01.blo.0000205886.66081.9d.
23. Lee YK, Choi KW, Woo SH, Ho PC, Lee M. The clinical result of arthroscopic bone grafting and percutaneous K-wires fixation for management of scaphoid nonunions. Medicine (Baltimore) 2018 Mar;97:e9987. doi: 10.1097/MD.0000000000009987.
24. Lamon B, Ardouin L, Bellemère P, Dautel G, Athlani L. Arthroscopic bone grafting for scaphoid nonunion: a retrospective study of 42 cases. J Hand Surg Asian Pac Vol 2021 Dec;26:545-554. doi: 10.1142/S242483552150051X.
25. Schernberg F. Fractures récentes du scaphoïde (moins de trois semaines) [Recent scaphoid fractures (within the first three weeks)]. Chir Main 2005 Jun- Aug;24(3-4):117-31. doi: 10.1016/j.main.2005.05.001.
26. Hsiung W, Huang HK, Wang JP, Chang MC, Huang YC. Arthroscopic realignment and osteosynthesis of unstable scaphoid nonunion with cancellous bone graft from the ipsilateral radius. Int Orthop 2021 Jan;45:191-197. doi: 10.1007/s00264-020-04840-2.
27. Augat P, Margevicius K, Simon J, Wolf S, Suger G, Claes L. Local tissues properties in bone healing: influence of size and stability of the osteotomy gap. J Orthop Res 1998 Jul;16:475-481. doi: 10.1002/jor.1100160413.
28. Mathoulin CL, Arianni M. Treatment of the scaphoid humpback deformity – is correction of the dorsal intercalated segment instability deformity critical? J Hand Surg Eur 2018 Jan;43:13-23. doi: 10.1177/1753193417739526.
29. Amadio PC, Berquist TH, Smith DK, Ilstrup DM, Cooney WP3rd, Linsheid RL. Scaphoid malunion. J Hand Surg Am 1989 Jul;14:679-87. doi: 10.1016/0363-5023(89)90191-3.
30. Nakamura R, Imaeda T, Miura Y. Scaphoid non malunion. J Bone Joint Surg Br 1991;73:134-7. doi: 10.1302/0301-620X.73B1.1991749.
31. Fernandez DL, Martin CJ, Gonzalez-Del Pino J. Scaphoid malunion: the significate of rotational malalignment. J Hand Surg Br 1998 Dec;23:771-5. doi: 10.1016/s0266-7681(98)80094-6.
32. Sayegh ET, Strauch RJ. Graft choice in the management of unstable scaphoid nonunion: a systematic review. J Hand Surg Am 2014 Aug;39:1500-6. doi: 10.1016/j.jhsa.2014.05.009.

Correspondence:
Received: 26 April 2023
Accepted: 26 May 2023
Morena Anna Basso, MD
Department of Orthopaedic Surgery, "Federico II" University
Via S. Pansini 5, bd. 12, 80131
Naples, Italy
E-mail: morenaanna.mb@gmail.com