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Nonunion of the scaphoid in children: a review of literature

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Abstract:

Fractures of the carpal scaphoid are not common in children. When they occur the fractures are usually located in the distal pole but they have also been sustained through the waist. Resultant scaphoid non-unions have been reported. Their optional treatment remains controversial. Most fractures of the scaphoid in the immature skeleton heal with immobilization. Other options may be included bone grafting with K-wire fixation, without osteosynthesis and Herbert screw fixation with or without bone grafting. I believe that open reduction and internal fixation with Herbert screw using bone grafting is a reliable option that obtains excellent results. Here, I document a review of literature. In this review, there are not figures and outcomes.

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Introduction

The scaphoid is the most commonly fractured carpal bone, accounting for approximately of 60 % of carpal fractures and 11% of all hand fractures often misdiagnosed as a simple wrist sprain, scaphoid fractures may go on malunion or non union. Patients with one of these problems will almost always present later because of persistent wrist pain. Malunion and non union are especially challenging conditions to treat successfully and, if untreated, they usually produce abnormal carpal kinematics that can lead to wrist arthrosis. Thus early diagnosis and vigilant care of an acute scaphoid fracture was warranted.

Fractures of scaphoid are very uncommon in children, accounting for 0,5 % of all hand upper limb fractures and 3% all hand and wrist fractures in children [1]. Resultant scaphoid

nonunions have been reported [1-9], but because of rarely of the lesion, experience is imitated, and therefore their optimal treatment remains controversial [2,10,11-35].

Mechanism of injury

Scaphoid fractures usually result from a fall. Most commonly the patient lands on the hand with the wrist in extension and radial deviation [36-38]. Other mechanism of injury can cause a scaphoid fracture [38-39]. The exact mechanism of failure is a subject of debate. Some have suggested that the scaphoid fails secondary to excessive compression along its concave medial articulation with the capitate, whereas others believe that the scaphoid fails secondary to excessive tension [39-41]. Weber and Chao created scaphoid fractures in cadavers with the wrist in only 95° to 100° of dorsiflexion and a load applied to the radial portion of the palm [37].

Diagnosis

Patients with a scaphoid fracture most often present with “wrist pain”. They almost always have tenderness and a fullness in the anatomic snuffbox. Axial compression of the thumb, which compresses the scaphoid, usually elicits pain [42]. Sometimes there is discomfort just with percussion of the tip of an abducted thumb. Forced ulnar deviation of a pronated wrist can also elicit pain. Pain and tenderness in the anatomic snuffbox should warrant studies to rule out a scaphoid fracture. Even if initial radiographs reveal negative findings, the wrist should be immobilized in a wrist splint or short arm thumb Spica cast and the radiographs should be repeated in one to two weeks [43]. If a fracture is not seen on the repeat x-rays and a scaphoid fracture is still suspected, a CT scan, a magnetic resonance imaging scan, or a bone scan should be done [44-47]. Computed tomography scanning is fast, convenient, and the most sensitive and specific of the studies; bone scanning is the least sensitive and specific [48,49].

Treatment

Available treatment options may include cast immobilization [1,9,12], bone grafting with k wire fixation [3,10,13] without osteosynthesis [5,8] and Herbert screw fixation with or without bone grafting [2,4,5,7,13,14]. A limited number of case series [4,5,13,14] have addressed the results of treatment of scaphoid non unions in the immature skeleton with Herbert screw and bone graft. In some studies [13,14] however, patients were treated in a uniform manner with Herbert screw fixation and there is no separate mention in the results of the outcomes of this approach; furthermore, one study [14] had a minimum follow-up period of three months. Two studies [4,5] coming from a single center have investigated the results of the screw fixation and bone graft in only 5 and 9 patients, respectively. Scaphoid fractures are rare in children because of the appreciable amount of cartilage present in the scaphoid (giving a cushioning effect) [11,18] during development. Most are undisplaced, and can be

managed successfully with immobilization [1,5,11,19]. As in adults, the scaphoid is the most commonly fractured carpal bone in the children with a peak incidence of about 15 years [6,23]. In the immature skeleton, most scaphoid fractures involve the distal third of the bone, and therefore non-unions are rare [4,8-10,12,13,23]. Most of non-unions involve the waist of the bone [3,4,9,10,12-14], which was the case in all patients of this series.

Furthermore, because of the rarity of this injury, there is controversy regarding optimal treatment [2,10,11] and treatment options include cast immobilization [1,9,12], bone grafting, without osteosynthesis^{5,8}, and Herbert screw fixation or without bone grafting [3,4,9,10,12-14]. There is one of the largest case series that presents successful treatment of established scaphoid non-union of the immature skeleton treated in a uniform approach using Herbert screw and bone graft. There was absence of complications. Similar results have been reported in other published series using the same technique [4,5]. In a study of 5 patients⁴ with a mean follow-up period of 3 years, Herbert screw fixation and bone graft were successfully used, giving excellent clinical and radiographic results. Another study [5] with a mean follow-up period of 3 years compared the results of 9 patients treated with Herbert screw fixation with 4 patients [4] treated with the Matti-Russe procedure; excellent results were obtained by both methods. The length of time for postoperative immobilization, however, was significantly less in the Herbert screw group than in the Matti-Russe group, and therefore the investigators recommended the Herbert screw and bone graft approach. Excellent results have also been reported with k-wire fixation in 2 [13] and 11 [10] patients and bone grafting in 4 [5,11], and 6 [13] patients. These data show that there is a good prognosis regarding this injury in children.

There have been concerns regarding the use of the Herbert screw in children because of the lower amount of the bone stock available and the greater proportion of cartilage present that



could lead to loss of the effectiveness and disturbance of growth [11]. This is similar to a previous study of 9 patients [5]. The use of a Herbert screw provides several advantages, including strong internal fixation with compression at the fracture site, prevention of scaphoid collapse, reduction of the time of external immobilization before definite union has occurred. Children have a superior healing potential over adults [11] and might not benefit from the last advantage because union occurs earlier. The duration of immobilization for the patients is described in several studies [4,5,13] reporting results using techniques [3,13] involving bone grafting without fixation. In children, scaphoid fractures may be missed for several possible reasons: 1. the presence of a large proportion of cartilage may mask a fracture; 2. clinical symptoms may be subtle, and the physician may focus on the distal radius region, where trauma is more frequent than in the carpus [11]; and 3. the interpretation of radiographs of the immature wrist is challenging [19].

This brings up the important issue of recommending surgery in asymptomatic patients. Several studies [24-26] of the natural history in scaphoid nonunions of the adult population without carpal collapse have shown that the progress to radiocarpal arthritis is almost certain in all patients within 10 years. The natural history of scaphoid non-union in the immature skeleton is unknown. The altered biomechanics of the wrist after scaphoid non-union that in the adult produce the well-known patterns of scaphoid non-union advanced collapse have never been shown in children [23]. I agree with others [23] that it cannot be determined to what extent a scaphoid non-union should be managed in the immature skeleton. Regarding the choice of treatment, I agree with others [10] that an initial treatment of long-term immobilization may have to be prolonged in case of failure and that it does not provide a solution to the potential problem of scaphoid non-union that could potentially lead to degenerative conditions of the wrist. Although this assumption may be reasonable, there have been 2 case reports [27] of spontaneous

remodeling of a scaphoid malunion associated with a dorsal intercalated segment instability, which were attributed to the potential of the immature bone to remodel.

There are some study limitations that have to be considered: one clear limitation is the relatively short-follow up period, which is comparable with those of other studies [4,5]. Magnetic resonance Imaging, however, is recommended for non-unions when there is a high suspicion of avascular necrosis of the proximal fragment [28]. CT scan evaluation is sufficient to clearly show that all non-unions involve the scaphoid wrist; in addition, AVN of scaphoid in the paediatric population is possible but has never been reported for scaphoid waist non-unions. To my knowledge, there has been reported only 6 reports of proximal pole of the scaphoid in skeletally immature patients in the English-language literature [1,19,29], and only half of those [29] were complicated by AVN of the proximal pole.

Conclusion

I believe that open reduction and internal fixation with a Herbert screw using bone grafting is a reliable option that obtains excellent results.

References

1. Christodoulou AG, Colton CL. 1986. Scaphoid fractures in children. *J Pediatr Orthop.* 6: 37-39. Ref.: <https://pubmed.ncbi.nlm.nih.gov/3941178/> DOI: <https://doi.org/10.1097/01241398-198601000-00008>
2. Littlefield WG, Friedman RL, Urbaniak JR. 1995. Bilateral non-union of the carpal scaphoid in a child. A case report. *J Bone Joint Surg.* 77: 124-126. Ref.: <https://pubmed.ncbi.nlm.nih.gov/7822344/> DOI: <https://doi.org/10.2106/00004623-199501000-00015>
3. Maxted MJ, Owen R. 1982. Two cases of non-union of carpal scaphoid fractures in children. *Injury.* 13: 441-443. Ref.: <https://pubmed.ncbi.nlm.nih.gov/7085063/>



- DOI: [https://doi.org/10.1016/0020-1383\(82\)90103-6](https://doi.org/10.1016/0020-1383(82)90103-6)
4. Mintzer CM, Waters PM, Simmons BP. 1995. Nonunion of the scaphoid in children treated By Herbert screw fixation and bone grafting. A case report of five cases. *J Bone J Surg.* 77: 98-100. Ref.: <https://pubmed.ncbi.nlm.nih.gov/7822406/>
 5. Mintzer CM, Waters PM. 1999. Surgical treatment of pediatric scaphoid fractures non-unions. *J Pediatr Orthop.* 19: 236-239. Ref.: <https://pubmed.ncbi.nlm.nih.gov/10088696/>
DOI: <https://doi.org/10.1097/00004694-199903000-00020>
 6. Mussbichler H. 1961. Injuries of the carpal scaphoid in children. *Acta Radiol.* 56: 361-368. Ref.: <https://pubmed.ncbi.nlm.nih.gov/14477567/>
DOI: <https://doi.org/10.3109/00016926109172830>
 7. Onuba O, Ireland J. 1983. Two cases of non-union of fractures of the scaphoid in children. *Injury.* 15: 109-112. Ref.: <https://pubmed.ncbi.nlm.nih.gov/6629483/>
DOI: [https://doi.org/10.1016/0020-1383\(83\)90036-0](https://doi.org/10.1016/0020-1383(83)90036-0)
 8. Southcott R, Rosman MA. 1977. Non-union of carpal scaphoid in children. *J Bone J Surg.* 59: 20-23. Ref.: <https://pubmed.ncbi.nlm.nih.gov/321463/>
DOI: <https://doi.org/10.1302/0301-620x.59b1.321463>
 9. Wilson-MacDonald J. 1987. Delayed union of the distal scaphoid in a child. *J Hand Surg.* 12: 520-522. Ref.: <https://pubmed.ncbi.nlm.nih.gov/3611646/>
DOI: [https://doi.org/10.1016/s0363-5023\(87\)80199-5](https://doi.org/10.1016/s0363-5023(87)80199-5)
 10. Duteille F, Dautel G. 2004. Non-union fractures of the scaphoid and carpal bones in children: surgical treatment. *J Pediatr Orthop B.* 13: 34-38. Ref.: <https://pubmed.ncbi.nlm.nih.gov/15091257/>
DOI: <https://doi.org/10.1097/00009957-200401000-00007>
 11. Garcia-Mata S. 2002. Carpal scaphoid fracture non-union in children. *J Pediatr Orthop.* 22: 448-451. Ref.: <https://pubmed.ncbi.nlm.nih.gov/12131439/>
 12. DeBoeck H, Van Wellen P, Haentjens P. 1991. Non-union of a carpal scaphoid fracture in a child. *J Orthop Trauma.* 5: 370-372. Ref.: <https://pubmed.ncbi.nlm.nih.gov/1941322/>
DOI: <https://doi.org/10.1097/00005131-199109000-00018>
 13. Henderson B, Letts M. 2003. Operative management of pediatric scaphoid non-union. *J Pediatr Orthop.* 23: 216-221. Ref.: <https://pubmed.ncbi.nlm.nih.gov/12724610/>
 14. Toh S, Miura H, Arai K, et al. 2003. Scaphoid fractures in children: problems and treatment. *J Pediatr Orthop.* 23: 216-221. Ref.: <https://pubmed.ncbi.nlm.nih.gov/12604954/>
 15. Fernandez DL. 1984. A technique for anterior wedge shaped grafts for scaphoid non-unions with carpal instability. *J Hand Surg.* 9: 733-737. Ref.: <https://pubmed.ncbi.nlm.nih.gov/6386956/>
DOI: [https://doi.org/10.1016/s0363-5023\(84\)80025-8](https://doi.org/10.1016/s0363-5023(84)80025-8)
 16. Trumble T, Nyland W. 2001. Scaphoid nonunions. Pitfalls, and pearls. *Hand Clin.* 17: 611-624. Ref.: <https://pubmed.ncbi.nlm.nih.gov/11775472/>
 17. Cooney WP, Bussey R, Dobyns JH, et al. 1987. Difficult wrist fractures. Perilunate fracture-dislocations of the wrist. *Clin Orthop.* 214: 136-147. Ref.: <https://pubmed.ncbi.nlm.nih.gov/3791735/>
 18. D' Arienzo M (2002) Scaphoid fractures in children. *J Hand Surg.* 27: 424-426. Ref.: <https://pubmed.ncbi.nlm.nih.gov/12367553/>
DOI: <https://doi.org/10.1054/jhsb.2002.0820>
 19. Vahvanen V, Westerlung M. 1980. Fractures of the carpal scaphoid in children. A clinical and raentgenological study of 108 cases. *Acta Orthop Scand.* 51: 909-913. Ref.: <https://pubmed.ncbi.nlm.nih.gov/7211295/>
DOI: <https://doi.org/10.3109/17453678008990893>
 20. Beatty E, Light TR, Belsole RJ, et al. 1990. Wrist and hand skeletal injury in children. *Hand Clin.* 6: 723-738. Ref.: <https://pubmed.ncbi.nlm.nih.gov/2269682/>
 21. Greene MH, Hadied AM, LaMont RL. 1984. Scaphoid fractures in children. *J Hand Surg.* 9: 56-541. Ref.:



- <https://pubmed.ncbi.nlm.nih.gov/6747238/>
DOI: [https://doi.org/10.1016/s0363-5023\(84\)80106-9](https://doi.org/10.1016/s0363-5023(84)80106-9)
22. Grundy M. 1969. Fractures of the carpal scaphoid in children: A series of eight cases. *Br J Surg.* 56: 523-524. Ref.: <https://pubmed.ncbi.nlm.nih.gov/5794969/>
DOI: <https://doi.org/10.1002/bjs.1800560713>
23. Graham TJ, O' Brien ET. 1996. Fractures and dislocations of the hand and carpus in children. In: Rockwood CA; Wilkins KE, Beaty JH, eds. *Fractures in children*, 4th ed. Philadelphia: Lippincott-Raven. 323-447.
24. Lindstrom G, Nystrom A. 1992. A natural history of scaphoid non-union with special reference to asymptomatic cases. *J Hand Surg.* 17: 697-700. Ref.: <https://pubmed.ncbi.nlm.nih.gov/1484258/>
DOI: [https://doi.org/10.1016/0266-7681\(92\)90204-f](https://doi.org/10.1016/0266-7681(92)90204-f)
25. Mack GR, Bosse MJ, Gelberman RH, et al. 1984. The natural history of scaphoid non-union. *J Bone J Surg.* 66: 504-509. Ref.: <https://pubmed.ncbi.nlm.nih.gov/6707028/>
26. Roby LK, Stinson J, Belsky MR. 1985. The natural history of scaphoid non-union. A review of fifty-five cases. *J Bone J Surg.* 67: 428-435. Ref.: <https://pubmed.ncbi.nlm.nih.gov/3972868/>
27. Suzuki K, Herbert TI. 1993. Spontaneous correction of dorsal intercalated segment instability deformity with scaphoid malunion in the skeletally immature. *J Hand Surg.* 18: 1012-1015. Ref.: <https://pubmed.ncbi.nlm.nih.gov/8294732/>
DOI: [https://doi.org/10.1016/0363-5023\(93\)90393-h](https://doi.org/10.1016/0363-5023(93)90393-h)
28. Fernandez DI, Eggl S. 2001. Scaphoid non-union and malunions. How to correct deformity. *Hand Clin.* 17: 631-646. Ref.: <https://pubmed.ncbi.nlm.nih.gov/11775474/>
29. Waters PM, Stewart SL. 2002. Surgical treatment of non-union and avascular necrosis of the proximal part of the scaphoid in adolescents. *J Bone J Surgery.* 84: 915-920. Ref.: <https://pubmed.ncbi.nlm.nih.gov/12063324/>
DOI: <https://doi.org/10.2106/00004623-200206000-00004>
30. Hove LM. 1999. Epidemiology of scaphoid fractures in Bergen, Norway. *Scand J Plast Reconstr Surg Hand Surg.* 33: 423-426. Ref.: <https://pubmed.ncbi.nlm.nih.gov/10614752/>
DOI: <https://doi.org/10.1080/02844319950159145>
31. Sherman SB, Greenspan A, Norman A. 1983. Osteonecrosis of the distal pole of the carpal scaphoid following fracture- a rare complication. *Skeletal Radiol.* 9: 189-191. Ref.: <https://pubmed.ncbi.nlm.nih.gov/6844937/>
DOI: <https://doi.org/10.1007/bf00352552>
32. Amalio PC, Berquist TH, Smith DK, et al. 1989. Scaphoid malunion. *J Hand Surg.* 14: 679-687. Ref.: <https://pubmed.ncbi.nlm.nih.gov/2787817/>
DOI: [https://doi.org/10.1016/0363-5023\(89\)90191-3](https://doi.org/10.1016/0363-5023(89)90191-3)
33. Lindstrom G, Nystrom A. 1992. Natural history of scaphoid non-union, with special reference to asymptomatic cases. *J Hand Surgery.* 17: 697-700. Ref.: <https://pubmed.ncbi.nlm.nih.gov/1484258/>
DOI: [https://doi.org/10.1016/0266-7681\(92\)90204-f](https://doi.org/10.1016/0266-7681(92)90204-f)
34. Langhoff O, Andersen JL. 1988. Consequences of late immobilization of scaphoid fractures. *J Hand Surgery.* 13: 77-79. Ref.: <https://pubmed.ncbi.nlm.nih.gov/3361213/>
DOI: [https://doi.org/10.1016/0266-7681\(88\)90058-7](https://doi.org/10.1016/0266-7681(88)90058-7)
35. Verdán C, Narakas A. 1968. Fractures and pseudoarthrosis of the scaphoid. *Surg Clin North Am.* 48: 1083-1095. Ref.: <https://pubmed.ncbi.nlm.nih.gov/5683792/>
DOI: [https://doi.org/10.1016/s0039-6109\(16\)38637-6](https://doi.org/10.1016/s0039-6109(16)38637-6)
36. Frykman G. 1967. Fracture of the distal radius including sequelae-shoulder-hand-finger syndrome, disturbance in the distal radio-ulnar joint and impairment of the nerve function. A clinical and experimental study. *Acta Orthop Scand Suppl.* 108: 3. Ref.: <https://pubmed.ncbi.nlm.nih.gov/4175195/>
DOI: <https://doi.org/10.3109/ort.1967.38.suppl-108.01>
37. Weber ER, Chao EY. 1978. An experimental approach to the mechanism of scaphoid waist



- fractures. *J Hand Surg.* 3: 142-148. Ref.: <https://pubmed.ncbi.nlm.nih.gov/556476/>
DOI: [https://doi.org/10.1016/s0363-5023\(78\)80062-8](https://doi.org/10.1016/s0363-5023(78)80062-8)
38. Mayfield JK. 1980. Mechanism of carpal injuries. *Clin Orthop Relat Res.* 149: 45-54. Ref.: <https://pubmed.ncbi.nlm.nih.gov/7408319/>
39. Leinsheid RL, Weber ER. 1998. Scaphoid fractures and non-union. In: Cooney WP, Leinsheid RL, Dobyns JH, editors. *The wrist: diagnosis and operative treatment.* St Louis: Mosby. 385-430.
40. Cobey MC, White RK. 1946. An operation for non-union of fractures of the carpal navicular. *J Bone Joint Surg.* 28: 757-764. Ref.: <https://pubmed.ncbi.nlm.nih.gov/21003185/>
41. Todd AH. 1921. Fractures of the carpal scaphoid. *Br J Surg.* 9: 7-26.
42. Powell JM, Lloyd GJ, Rintoul RF. 1988. New Clinical test for fracture of the scaphoid. *Can J Surg.* 31: 237-238. Ref.: <https://pubmed.ncbi.nlm.nih.gov/3390770/>
43. Sjolín SU, Andersen JC. 1988. Clinical fracture of the carpal scaphoid-supportive bandage or plaster cast immobilization? *J Hand Surg.* 13: 75-76.
44. Temple CL, Bennett JD, Garvin GJ, et al. 2005. Comparison of sagittal computed tomography and plain radiography in a scaphoid fracture model. *J Hand Surg.* 30: 534-542. Ref.: <https://pubmed.ncbi.nlm.nih.gov/15925164/>
DOI: <https://doi.org/10.1016/j.jhsa.2005.01.001>
45. Breederveld RS, Tuinebreijer WE. 2004. Investigation of computed tomographic scan concurrent criterion validity in doubtful scaphoid fracture of the wrist. *J Trauma* 57: 851-854. Ref.: <https://pubmed.ncbi.nlm.nih.gov/15514541/>
DOI: <https://doi.org/10.1097/01.ta.0000124278.29127.42>
46. Kumar S, O' Connor A, Despois M, et al. 2005. Use of early magnetic resonance imaging in the diagnosis of occult scaphoid fractures: the CAST Study (Camberra Area Scaphoid Trial). *NZ Med J.* 118: 1296. Ref.: <https://pubmed.ncbi.nlm.nih.gov/15711629/>
47. Brooks S, Cicuttini FM, Lim S, et al. 2005. Cost effectiveness of adding magnetic resonance imaging to the usual management of suspected scaphoid fractures. *Br J Sports Med.* 39: 75-79. Ref.: <https://pubmed.ncbi.nlm.nih.gov/15665201/>
DOI: <https://doi.org/10.1136/bjsm.2003.007435>
48. Bain GI. 1999. Clinical utilisation of computed tomography of the scaphoid. *Hand Surg.* 4: 3-9. Ref.: <https://pubmed.ncbi.nlm.nih.gov/11089151/>
DOI: <https://doi.org/10.1142/s0218810499000198>
49. Sanders WE. 1988. Evaluation of the humpback scaphoid by computed tomography in the longitudinal axial plane of the scaphoid. *J Hand Surg.* 13: 182-187. Ref.: <https://pubmed.ncbi.nlm.nih.gov/3351239/>
DOI: [https://doi.org/10.1016/s0363-5023\(88\)80045-5](https://doi.org/10.1016/s0363-5023(88)80045-5)