What is the Optimal Treatment of Atrophic Scaphoid Non-Union?

Abstract

Aim: To evaluate the efficacy of the treatment method of autogenous iliac wing or radius bone graft and fixation with screw applied to cases of scaphoid non-union. Material and Method: A retrospective evaluation was made of 89 cases between 2000 and 2014. Postoperative measurements were taken of both wrists' movement with a goniometer and muscle strength was assessed with a dynamometer. Fractures were evaluated radiologically according to the Herbert-Fisher System and the functional results according to the Her bert-Fisher Classification System and the Mayo Clinic Modified Wrist Scoring System. The data were input to the SPSS system and evaluated with the Shapiro-Wilk test. Results: Non-union were on the right side in 47 and the left side in 42 cases. The fracture was seen to be in the waist in 60 cases (67.5%), in the proximal third in 27 cases (30.3%) and in the distal third in two cases (2.2%). The mean follow-up period was 16.4 months (range, 5-72 months). Definitive findings of union were observed in 71 cases. The mean time to union was 14.9 weeks (range, 8-40 weeks). Discussion: The grafting procedure applied is an invasive technique but if it is considered that there are negative effects of open surgery on the feeding of the scaphoid bone, then in the treatment of scaphoid non-union which is atrophic non-union, ultimately autogenous bone grafting and screw fixation is a safe and successful method and because of the pain created by an iliac wing graft, radius distal bone graft can be considered more appropriate.

Keywords

Scaphoid; Non-Union; Surgical Treatment; Autografting

Özett

Amaç: Skafoid kaynamamalarında vida ile tespit yapılan olgularda iliski kemik otogrefti ya da radius otogrefti kullanımının etkinliğini araştırmak.

Gereç ve Yöntem: Ocak 2000-Ocak 2014 yılları arasında skafoid kaynamaması nedeni ile opere edilen 89 hasta retrospektif olarak değerlendirildi. Postoperatif ölçümler el bileği hem fleksiyonda hem de ekstansiyonda iken yapıldı, ulnar ve radial deviasyon dereceleri gonyometre ile, kas gücü ise dinamometre ile ölçüldü. Kırıklar radyolojik olarak Herbert-Fisher sistemine göre, fonksiyonel sonuçlar ise Herbert-Fisher sınıflandırması ve Mayo klinik modifiye el bileği skorlama sistemine göre değerlendirildi. Bulgular: 89 skafoid kaynamama vakasının 47’si sağ, 42’si ise sol el bileği yerleşmişti ve bunların 52’si dominanterdi. Kırık oluşmasından cerrahiye kadar geçen süre ortalama 17.8 aydı (3-300). Kırıkların 60’ı (67.5%) bel bölgesinde, 27’si (30.3%) skafoidin proksimal 1/3’ünde, 2’si (2.2%) ise distal 1/3’ündeydi. 54 hastada (60.6%) iliac kana harc, 35 hastada (39.4%) radius distal grefti kullanıldı. Ortalama takip süresi 16.4 aydı (5-72). 71 hastada kaynama görüldü. Kaynama süresi ortallama 14.9 haftaydı (8-40). Ortalama skafotan aç operasyon öncesi 74.3º, 62º – 87º ve operasyon sonrası 43.8º (51º–72º) idi. Kuvvet operasyon güç operasyon sonrası ortalamada 35.7 kg idi (15-63). Tartışma: Otogreft alımı invaziv bir yöntemdir fakat kemik otogrefti sonucunda oluşan ağrı nedeniyle skafoid kaynamamalarının tedaviinde otogreftleme ile birlikte vida fiksasyonu güvenli ve başarılı bir yöntemdir. İliak kana harc sonrası kaynamların genellikle sigmoid bir hale gelmesi ve bunun onarılmaması negatif yönde etkilediği göz önünde bulundurulursa atrofik skafoid kaynamamalarının tedaviinde otogreftleme ile birlikte vida fiksasyonu güvenli ve başarılı bir yöntemdir. Iliski kana harcının genişleme eğilimi ve bu durumda iliski kaynamalarının daha uygun olduğu düşünülebilir.

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Introduction
Scaphoid bone fractures are the second most common wrist trauma after distal radius fractures. Of the carpal bone fractures, they are the most frequently seen fractures [1,2]. Due to biological, mechanical and blood supply properties, the healing of scaphoid bone fractures is difficult [3]. When there are no signs of union despite 3 and 6 months of treatment in scaphoid bone fractures, it is classified respectively as delayed union and non-union [4].

Many different surgical techniques have been described in the treatment of scaphoid non-unions [5]. Bone grafting, internal fixation with various fixation materials, and vascularised bone grafts with combinations of bone grafting and internal fixation methods are applied in surgical treatment [6]. The aim of all these methods is to achieve a pain-free, functional wrist by removing the problem in the scaphoid bone, which plays a significant role in the stabilisation of the wrist and all wrist movements, and to prevent potential loss of working days [7].

In this paper an evaluation is made of cases of scaphoid non-union treated with autogenous iliac wing or radius bone graft and screw fixation.

Material and Method
The study included 89 cases who were diagnosed with scaphoid non-union and treated with autogenous iliac wing or radius distal bone grafting and screw fixation and had sufficient follow-up at two different clinics between January 2000 and January 2014. Approval for the study was granted by the Local Ethics Committee.

Postoperatively, both wrists were measured with a goniometer for flexion, extension and the degree of radial and ulnar deviation. With the patient in a sitting position, the elbow in 90° flexion and the forearm in a neutral position, the muscle strength of both wrists was measured with a hand dynamometer (Hydraulic Hand Dynamometer, Model SH5001, Saehan Corporation, Masan, Korea). The mean value of 3 measurements was used in the evaluation. Radiological evaluation was made using standard anteroposterior and lateral wrist radiographs. Computed tomography (CT), magnetic resonance imaging (MRI) and scintigraphy were not routinely used.

The fractures were classified radiologically according to the Herbert-Fisher system and the results were evaluated according to the Herbert-Fisher Classification System and the Mayo Clinic Modified Wrist Scoring System. The reason for using two systems in the evaluation of the results was that radiological evaluation cannot be made with the Mayo Clinic Modified Wrist Scoring System.

Statistical analysis
Statistical analysis were made using SPSS v. 15.0 (SPSS Inc., Chicago, IL, USA) software and conformity to normal distribution was evaluated with the Shapiro-Wilk test.

Results
The 89 cases of non-union comprised 81 males and seven females with a mean age of 30.2 years (range, 15-61 years). The non-union was on the right side in 47 and the left side in 42 cases and the dominant hand in 52 cases. The mechanism of the fracture was a sports injury in 43 cases (48.3%), a fall in 38 (42.6%), and a traffic accident in eight (9.1%).

The fracture was seen to be in the waist of the scaphoid in 60 cases (67.5%), in the proximal third in 27 cases (30.3%), and in the distal third in two cases (2.2%). All the cases were consistent with Herbert-Fisher Type D2 (sclerotic non-union pseudarthrosis) (Fig. 1). The fixation material was Acutrak screw in 60 cases (67.4%) and Herbert screw in 29 cases (32.6%). In 54 cases (60.6%) iliac wing graft was taken and in 35 cases (39.4%) radius distal graft was taken. The form of graft used was spongy in 46 cases (51.6%) and corticospongious in 43 cases (48.4%). The mean time from fracture to surgery was 17.8 months (range, 3-300 months).

Clinical and radiological follow-up examinations were made every 3-4 weeks until union was achieved. The time to union was accepted as the period until the first radiograph was obtained on which the fracture line was seen to have disappeared and a trabecular appearance was observed in the location of the fracture line. Definitive findings of union were observed in 71 cases. The mean time to union was 14.9 weeks (range, 8-40 weeks). The mean period of fixation was 6.4 weeks (range, 4-12 weeks), and the mean follow-up period was 16.4 months (range, 5-72 months) (Fig. 2).

Postoperatively compared to the contralateral healthy hand, >10% function loss was observed in the wrist movements. The
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Scapholunate angle was mean 74.3° (range, 62° - 87°) preoperatively and 43.8° (range, 31°-72°) postoperatively. Grip strength postoperatively was mean 35.7 kg (range, 15-63 kg).

According to the Herbert-Fisher classification, the results were found to be excellent or good in 79% and poor in 21%; the Mayo Score was determined as mean 78.1 (range, 40-100).

No vascular or nerve complications developed during surgery. No scar tissue that limited joint movement developed in any patient. No major or minor complication was encountered in the graft donor site. In three patients, the screw was determined to be in an inappropriate position on the postoperative radiographs and in one patient, wound site infection was observed on postoperative day three. These patients were informed and second surgery was necessary. No problems developed in the follow-up period of any of these four patients.

Of the 18 cases where union was not observed, the fracture was in the proximal in 12 cases, in the scaphoid bone waist in five, and in the distal in one. Screw loosening was observed in one of the 18 cases and the screw was seen not to have passed the non-union line in two cases. Avascular necrosis was observed in the proximal fragment in two cases during follow-up and in both cases the screw was removed and the proximal fragment was excised. In three patients with persistent pain, a radical styloectomy was applied.

Apart from these 18 cases, union was achieved in all other cases and outcomes were evaluated as successful. In one case where union was achieved, the screw was observed to have advanced to the lunatum. Non-union in the distal region is not frequently observed and two cases were operated on for distal region non-union.

Discussion
Scaphoid fractures are seen in the young, active population at a mean age of approximately 25 years at the rate of 13-43 per 100,000 per year [1,2]. Difficulty in determining the fracture line on direct radiographs taken early, fractures that remain untreated, or delay of treatment may result in non-union because of the biological, mechanical and vascular properties of the bone. These situations can cause post-traumatic arthritis and the development of carpal instability in patients [4].

For success in cases of scaphoid non-union, even if treatment is applied later in cases of non-treatment or delayed treatment, effective treatment must be applied before the permanent complication develops of a wrist with painful and limited movement because of the delay. Union in the scaphoid bone only is not sufficient; restoring bone anatomy and obtaining functional recovery must be considered essential [7].

Scaphoid non-unions display the general features of atrophic (vascular) non-union. The treatment principles of atrophic non-unions are cleaning the scar tissue, decortication and bone graft, and stable fixation for fracture healing [8]. These treatment principles are equally valid for scaphoid non-union as for atrophic non-union.

In scaphoid non-unions there are advantages to placing grafts in the spaces between fragments after cleaning and smoothing the surfaces. When autogenous bone grafts are successfully applied, fracture stability is increased, fracture healing is accelerated, and the period of immobilisation is shortened [9,10]. Spongy bone graft provides a larger contact surface and more rapid union due to cellularity and vascularity. Cortical graft provides protection and restoration of the scaphoid bone length because of the dense structure and prevents carpal instability from a united but smaller scaphoid bone. Berris et al. [11] reported that corticospinous grafts were more effective than spongy grafts in reducing deformity and obtaining initial stabilisation. Rates of union with bone graft were reported as 61-93% by Russe and as 75-100% by Fernandez [12,13]. Even though filling bone defects with autogenous bone grafts is seen as the gold standard, there are risks. The development of fracture, vascular, and nerve damage, infection, haematoma, and chronic pain have been reported in 6-25% of cases [14,15]. In the current series, bone restoration was achieved using corticospinous graft in cases that had lost scaphoid height and spongy grafts in those that had not, and no complications developed in any patient in the donor site.

Various studies have been made on the subject of graft donor site. Many studies have compared the sites that were used in this study as donor sites—the iliac wing and the distal radius. A study based on postoperative pain reported that the clinical scores were better when the distal radius was used as the donor site rather than the iliac wing [16]. Aguilella and Garcia [17] stated that the anterolateral corner of the distal radius metaphysis could be used as a donor site and provided some advantages compared to other methods. These advantages include providing good quality bone graft, reaching the donor site with the same incision used for scaphoid surgery, no requirement for general anaesthesia, and less morbidity compared to the use of the iliac wing. In the current series, negative effects were observed in patient satisfaction and mobilisation due to pain in cases where iliac graft was used. Complaints of much greater postoperative pain in the wrist have been reported with the use of iliac wing.

The most important of the factors affecting the rate of union in scaphoid fractures is the fracture location; studies have shown lower rates of union in proximal fractures [18]. In the current study, of the 18 cases that were not successful, 12 were non-union with a proximal location. Inoue et al. [19] described avascular necrosis criteria in the proximal fragment as loss of trabeculation, advanced sclerosis, and deformation in the proximal fragment. Surgery is contra-indicated in these kinds of cases. In the current study, of the 27 cases with proximal location of the fracture, avascular necrosis was observed postoperatively in the proximal fragment in two. In one case, the screw was removed and the proximal fragment was excised and the other case refused surgery.

The development of non-union in scaphoid fractures is more evident in proximal pole fractures in particular, due to less blood supply of proximal scaphoid [20]. In uncomplicated stable non-unions, success rates of bone graft and screw fixation have been reported as 70-90% [21]. With bone graft and screw fixation in proximal scaphoid non-union, Megerle et al. [22] obtained union rates of 61%, Inoue et al. [19] 81% and DeMaagd and Engber [23] 92%. In contrast, again in cases of scaphoid non-union that developed avascular necrosis in the proximal pole, success rates with bone graft and internal fixation have been reported to have only reached 50% [12]. On the other hand, Matsuksi et al. [24]...
obtained 100% union with Herbert screw and grafting in 11 cases of proximal pole non-union and this result was reported to be independent of the vascularity of the proximal fragment. In addition, Gereli et al. [25] reported union in 15 of 17 cases where non-vascularised grafting and Acutrak screw were applied for proximal non-union and in 11 of 12 cases where fixation was made with Herbert screw. Thus it can be seen that with rates varying between 50 and 100% for non-vascularised grafting and screw fixation for scaphoid proximal pole fractures, it is possible to talk of both success and failure. The most important factor affecting this result is whether or not there is avascular necrosis. It is thought that in some of the current series cases there could have been proximal region avascular necrosis which could not be determined on direct radiograph. In addition, the open surgery method can be considered as contributing to the unsuccessful results with the effect of impairing the vascularity in the scaphoid bone proximal region in particular [26,27].

Limitations of this study can be said to be that because it was retrospective, there was no evaluation of differences in the types of cannulated screw applied and no MRI of the proximal fragment in proximal region non-unions.

In conclusion, generally rapid union is obtained with autogenous iliac wing or radius bone graft and screw fixation in the treatment of scaphoid atrophic non-union. This method with the appropriate surgical technique and under scopey guidance is safe and successful. Due to the pain caused in iliac wing grafting, distal radius bone graft can be considered more suitable. Thus, by providing rigid internal fixation, early active movement is possible, the immobilisation period is shortened, and workdays lost are reduced.

Competing interests

The authors declare that they have no competing interests.

References

1. Gürbüz Y, Kayalar M, Bal E, Toros T, Kıcık L, Sıpın TN. Comparison of dorsal and volar percutaneous screw fixation methods in acute Type B scaphoid fractures. Acta Orthop Traumatol Turc 2012;46(5):339-45.
2. Hove LM. Epidemiology of scaphoid fractures in Bergen, Norway. Scand J Plast Reconstr Surg Hand Surg 1999;33:423-6.
3. Tuncay İ, Doğan A, Alpaslan S. Comparison between fixation with Herbert screws and Kirschner wires in the treatment of scaphoid pseudoarthrosis. Acta Orthop Traumatol Turc 2002;36:17-21.
4. King A, Sokıcısı S, Parmaksozgıl AS, Gıl M, Kabutoğlu BS. Comparison of surgical and functional outcomes in the surgical treatment of scaphoid non-unions. Acta Orthop Traumatol Turc 2011;45(6):399-405.
5. Amadio PC, Taleisnik J. Fractures of the carpal bones. In: Green DP, Hotchkiss RN, Pederson WC, editors. Green’s operative surgery. Philadelphia: Churchill-Livingstone; 1999:809-56.
6. Kabak Ş, Bakır N, Türk Y, Şahin V, Karakaş ES. Treatment Result of Scaphoid Fractures. Turkish J Hand Surg and Microsurg 1995;2:3-59-65.
7. Tomak Y, Karaçobanlıoğlu N, Tylko K, Diri B, Babak N, Andac A. Skaphoid nonunionların ilk kemik grefisi ve Herbert vida rıksasyonu ile tedavisi. O.M.U. Tip Dergisi 1999;16(1):17-28.
8. Taylor JC. Delayed Union and Nonunion of Fractures. In: Crenshaw AH, editor. Campbell’s Operative Orthopaedics. Toronto: Mosby Year-Book Inc; 1991:1287-345.
9. Leung KS, Shyn WY, Tsang HK, Chiu KH, Leung PC, Hung LK. An effective treatment of comminuted fractures of the distal radius. J Hand Surg 1990;15:11-7.
10. Cooney WP, Berger RA. Treatment of complex fractures of the distal radius: Combined use of internal fixation and external fixation and arthroscopic reduction. Hand Clin 1993;9:605-12.
11. Bents AE, Soucacos PN, Xenakis T. Scaphoid Nonunion Treated with Bone Graft and Herbert Screw. Acta Orthop Scand 1997;68:60-4.
12. Merrell GA, Wolfe SW. Slade JF. Treatment of scaphoid nonunions: qualitative meta-analysis of the literature. J Hand Surg 2002;27:685-91.
13. Steinmann SP, Bishop AT, Berger RA. Use of the 1,2 intercompartmental supraretinacular artery as a vascularized pedicle bone graft for difficult scaphoid nonunion. J Hand Surg 2002;27:391-401.
14. Summers BN, Eiseinstein SM. Donor site pain from the ilium: A complication of lumbar spine fusion. J Bone Joint Surg 1989;71:677-80.
15. Younger EM, Chapman MW. Morbidity at bone graft donor sites. J Orthop Trauma 1989;3:192-5.
16. Gang B, Goyal T, Kotwal PP, Sankineai SR, tripod SY. Local distal radius bone graft versus iliac crest bone graft for scaphoid nonunion: a comparative study. Musculoskelet Surg 2013;97:109-14.
17. Aguillella L, Garcia-Elías M. The Anterolateral Corner of the Radial Metaphysis as a Source of Bone Graft for the Treatment of Scaphoid Nonunion. J Hand Surg 2012;37A:1258-62.
18. Ritter K, Giachino AA. The treatment of pseudoarthrosis of the scaphoid by bone grafting and three methods of internal fixation. Can J Surg 2000;43:118-24.
19. Inoue G, Shionoya K, Kuwashata Y. Ununited proximal pole scaphoid fractures. Treatment with a Herbert screw in 16 cases followed for 0.5-8 years. Acta Orthop Scand 1997;68:124-7.
20. Slade JF, Dodds SD. Minimally invasive management of scaphoid nonunions. Clin Orthop Relat Res 2006;445:108-19.
21. Cooney WP, Dobyns JH, Linscheid RL. Nonunion of the scaphoid: analysis of the results from bone grafting. J Hand Surg 1980;5:343-54.
22. Megerle K, Keutgen X, Müller M, Germann G, Sauemberr M. Treatment of scaphoid nonunions of the proximal third with conventional bone grafting and mini-Herbert screw: an analytical clinical and radiological results. J Hand Surg 2008;33E:179-85.
23. DeMaagd RL, Engber WD. Retrograde Herbert screw fixation for treatment of proximal pole scaphoid nonunions. J Hand Surg 1981;14:996-1003.
24. Matsuki H, Ishikawa J, Iwassaki N, Uchiyama S, Minami A, Kato H. Nonvascularized bone graft with Herbert-type screw fixation pole scaphoid nonunion. J Orthop Sci 2011;16:749-55.
25. Gereli A, Nalbantoğlu U, Sener IU, Kocaçöblü B, Türkmen M. Comparison of headless screws used in the treatment of proximal nonunion of scaphoid bone. International Orthopaedics 2011;35:1031-5.
26. Saint-Cyr M, Oni G, Wong C, Sen MK, Lajoie AS, Gupta A. Dorsal percutaneous cannulated screw fixation for delayed union and nonunion of the scaphoid. Plast Reconstr Surg 2011;128:467-73.
27. Pişkin A, Çıralık A, Erdoğan M, Göçer H, Şener M. Is non-vascularized auto-grafting in the proximal scaphoid nonunions ineffective? Eklem Hastalik Cerrahisi 2014;25(1):21-5.