Original Article

Use of pronator quadratus pedicle vascularized bone graft with headless compression screw in nonunion scaphoid fractures

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Objective: To evaluate the effectiveness of the vascularized muscle pedicle bone graft technique for achieving healing in nonunion scaphoid fracture cases.

Methodology: This prospective study was conducted from 2017 to 2019 and inckuded 25 patients with scaphoid fractures with nonunion evaluated radiological. The procedure was done under general anesthesia in which a pedicle vascularize pronator quadrats vascularized graft taken from the radius was placed at the site of nonunion and fixed with a headless compression screw with a guide wire. Patients were assessed both clinically and radiologically every four weeks for 25 weeks

Results: Out of 25 patients, 19 (76%) were males and 6 (24%) were females. Eight (32%) had fracture of the proximal pole of the scaphoid whereas 17 (68%) had fracture of the waist of the scaphoid. The mean duration of the bony union was 12.4±2.3 weeks. The mean grip strength increased by 28% after the union, while the mean preoperative VAS score (which was 45.3±5.2 initially) decreased to a mean of 20.3±7.9 after the bony union.

Conclusion: The use of a headless screw along with a vascularized pedicle pronator quadratus graft provided high chances of the union in scaphoid fractures. (Rawal Med J 202;46:102-105).

Keywords: Fractures, pronator grafts, scaphoid fracture.

INTRODUCTION

Among the carpal bones, the most commonly fractured is the scaphoid bone and 5-30% of cases it is associated with nonunion.[1-4] The most common reason for high rates of nonunion in these fractures is that scaphoid lacks periosteal covering, due to which the healing and callus formation is delayed.[4] This makes the proximal pole of the scaphoid entirely dependent on the intraosseous blood flow starting from the distal pole, this being the main cause of avascular necrosis of its proximal pole.[5] Other factors associated with nonunion include late immobilization due to delay in diagnosing, displacement of fragments, and greater than 15-degree angulation of fragments.[4,6]

There are multiple treatment modalities used for the management of nonunion. Usually, it involves the combination of bone graft and internal fixation. There is a high rate of failure of bone grafts, the reason being the disturbed vascularity, slow formation of callus, or lack of stability.[7-9] However, if a vascularized bone graft is used, the rate of callus formation is high. This vascularized bone graft technique was first given by Zaidemberg et al. but due to sufficient chances of bone loss, the authors do not recommend these.

To counter these, Kawai and Yamamoto introduced the pronator quadratus pedicle vascularized bone graft technique which is easy to perform and less time-consuming.[10,11] The indications for using this pedicle bone graft are scaphoid nonunion, lunatomalacia, and osteonecrosis of the scaphoid. Pedicle bone graft has been associated with improved blood flow, improved osteocyte preservation, and accelerated healing rate.[12] This study aimed to evaluate the effectiveness of the vascularized muscle pedicle bone graft technique for achieving healing in nonunion scaphoid fracture cases.

METHODOLOGY

This prospective study was conducted at Department of Orthopedic Surgery, Dr. K. M. Ruth Phau Civil hospital, Karachi, Pakistan from January

2017 to January 2019. During this duration, a total of 25 patients presented with scaphoid fractures with nonunion (defined as failed bony healing after at least five months of injury). Exclusion criteria included patients with avascular necrosis of the proximal pole of scaphoid, carpal collapse, and instability of carpals according to MRI. We took approval from the Ethical Review Committee of the university and written informed consent was taken from all participants. All patients underwent an anteroposterior, poster anterior, lateral, and oblique view X-rays of the wrist joint. An MRI scan was done in all patients to confirm nonunion.[14]

General anesthesia was given to all patients. The graft was placed transversely at the site of nonunion, longitudinal to the axis of the bone and the tourniquet was deflated to ensure adequate blood supply. The sutures were opened at 14 days and a Spica cast was applied covering the wrist and thumb to ensure complete immobilization. The duration of the plaster cast was three weeks. After the removal of the cast, physiotherapy was advised to all patients and kept in wrist splint for 4 weeks.

Patients were followed for 25 weeks and assessed every four weeks. Preoperative and postoperative pain was analyzed by VAS (Visual analog scale) with 0 being the lowest and 100 being the highest. Clinical assessment included a range of motion assessment, grip strength, and pain on tapping the joint. The radiologic assessment included a poster anterior, lateral, and oblique view X-rays of the wrist.

Statistical Analysis: Statistical analysis was performed using SPSS version 20. $P<0.05$ was considered significant.

RESULTS

Out of 25 patients, 76% were males whereas the rest were females. The mean age was 38.2±14.5 years. The most common mode of injury was a road traffic accident (72%, n=18) (Table 1). Mean duration from injury to surgery was 15.2 months. Mean duration of bony union evident on plain radiographs was 12.4±2.3 weeks. Patients were called to follow-up after every four weeks. Eight patients (32%) had a fracture of the proximal pole of the scaphoid whereas 17 (68%) had a fracture of the waist of the scaphoid. Of 25 patients, 22 achieved union early whereas three had a late union at 16, 17, and 18 weeks with a mean duration of 12.4±2.3 weeks. Nothing was done in patients with the late bony union.

Table 1. Demographic and injury characteristics of patients.

	Number	(%)
Gender		
Male	19	76.0
Female	6	24.0
Side of fracture		
Right	18	28.0
Left	7	72.0
Site of fracture		
Waist of scaphoid	17	68.0
Proximal pole of the scaphoid	8	32.0
Mode of injury		
Uncertain	3	12.0
Road traffic accident	18	72.0
Fall from a height on hyperextended hand	4	16.0

Table 2. Comparison of preoperative and postoperative characteristics.

	Preoperative	Postoperative	p-Value
Mean grip strength	67.16 ± 6.388	95.08 ± 4.812	<0.001
Mean dorsiflexion in degrees	51.40 ± 3.958	60.24 ± 2.087	<0.001
Mean palmar-flexion in degrees	51.72 ± 3.285	58.40 ± 3.109	<0.001
Mean radial deviation in degrees	7.48 ± 1.046	11.72 ± 1.021	<0.001
Mean ulnar deviation in degrees	22.00 ± 1.155	28.76 ± 1.200	<0.001
Mean Visual analogue score	45.3 ± 5.2	20.3 ± 7.9	0.002

Mean values of grip strength, wrist joint movements, and visual analogue score, both before and after intervention are given in Table 2. On every follow-up, along with radiographs, a clinical assessment was done which involved an assessment

of pain, range of motion, and grip strength. The pain resolved in all patients except one until the last follow-up, and that too had some relief.

DISCUSSION

Chronic scaphoid nonunion can lead to degenerative arthritis. Due to the ability of scaphoid bone to join the distal and proximal carpal bones, conditions with chronic scaphoid nonunion can lead to scaphoid nonunion advanced collapse.[2] Kumar et al in their study used the pronator quadrates graft in 17 patients. Their study subjects reached bony consolidation at an average of 9.8 weeks.[12] Lee et al in their study used pronator quadratus pedicled vascular graft along with headless compression screw in 27 patients. Their study subjects received bony consolidation in an average of 11.5 weeks.[8]

Obada et al had six patients with nonunion scaphoid fractures who were managed with pronator quadrates vascularized pedicle bone graft and Herbert Screwer wires of Kirshner wires. Bony consolidation was seen on an average of 9.8 weeks.[15]

Goel et al performed pronator quadratus vascularized pedicle bone graft in 11 cases of scaphoid fractures with nonunion. They concluded that this management modality offered excellent results. However, one of their patients developed scaphoid nonunion with advanced collapse and wrist arthritis and in that patient, another surgery was performed which involved proximal row corpectomy.[16]

Charan et al conducted a study in which using vascularized bone for the union of scaphoid fractures. Of 17 subjects, 20 achieved union. Of the three which did not, two were associated with proximal pole absorption.[17] Pinder et al conducted a meta-analysis on the management of nonunion of the scaphoid bone and concluded that vascularized bone graft leads to the union in 92% of cases whereas non-vascularized bone grafts lead to the union in 88% of cases.[18]

Percutaneous Herbert screw fixation in acute fractures and open reduction and internal fixation with Herbert screw and bone grafting in cases of the nonunion resulted in 88.46% union.[19] Another study used Herbert screw fixation along with bone graft and all (n=21) patients achieved union.[20] On the other hand, in the results of a study done in 2015, patients with the use of screws were associated with early mobility as compared to those with the use of K-wires.[18]

Limitations of this study included the financial constraints, due to which computed tomography scan was not performed throughout and MRI was not performed postoperatively. Secondly, we had a very small study population with limited follow-up duration.

CONCLUSION

Use of a headless screw along with a vascularized pedicle pronator quadratus graft provides high chances of the union in scaphoid fractures. More studies comparing the use of different types of screws or K-wire along with pedicle pronator quadratus graft are required to further support our findings.

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REFERENCES

1. Wolfe S, Pederson W, Kozin SH. Green's Operative Hand Surgery. Churchill Livingstone; 2010.
2. Kawamura K, Chung KC. Treatment of scaphoid fractures and nonunions. J Hand Surg Am 2008;33:988-97.
3. Rhemrev SJ, Ootes D, Beeres FJ, Meylaerts SA, Schipper IB. Current methods of diagnosis and treatment of scaphoid fractures. Int J Emerg Med 2011;4:4.
4. Gupta V, Rijal L, Jawed A. Managing scaphoid fractures. How we do it? J Clin Orthop trauma 2013;4:3-10.
5. Claessen FMAP, Schol I, Kolovich GP, Ring D. Avascular necrosis of the scaphoid preiser disease. Arch bone Joint Surg 2020;8:94-8.
6. Grewal R, Suh N, MacDermid JC. The missed scaphoid fracture-outcomes of delayed cast treatment. J Wrist

Surg 2015;4:278-83.
7. Hackney LA, Dodds SD. Assessment of scaphoid fracture healing. Curr Rev Musculoskelet Med 2011;4:16-22.
8. Lee SK, Park JS, Choy WS. Scaphoid fracture nonunion treated with pronator quadratus pedicled vascularized bone graft and headless compression screw. Ann Plast Surg 2015;74:665-71.
9. Gras M, Wahegaonkar AL, Mathoulin C. Treatment of avascular necrosis of the proximal pole of the scaphoid by arthroscopic resection and prosthetic semireplacement arthroplasty using the pyrocarbon adaptive proximal scaphoid implant (APSI): long-term functional outcomes. J Wrist Surg 2012;1:159-64.
10. Kawai H, Yamamoto K. Pronator quadratus pedicled bone graft for old scaphoid fractures. J Bone Joint Surg Br 1988;70:829-31.
11. Zaidemberg C, Siebert JW, Angrigiani C. A new vascularized bone graft for scaphoid nonunion. J Hand Surg Am 1991;16:474-8.
12. Kumar M, Kumar R, Ranjan RK, Kumar A, Ali F, Kumar S. Results of pronator quadratus pedicle bone graft as primary procedure for treatment of scaphoid nonunion. Int J Orthop Sci 2017;3:1008-12.
13. Lutsky K. Preoperative magnetic resonance imaging for evaluating scaphoid nonunion. J Hand Surg Am 2012;37:2383-5.
14. Sharifi MD, Moghaddam HZ, Zakeri H, Ebrahimi M, Saeedian H, Hashemian AM. The accuracy of pain measurement in diagnosis of scaphoid bone fractures in patients with magnetic resonance imaging: report of 175 cases. Med Arch 2015;69:161-4.
15. Obada B, Serban AO, Badauta M, Obada AT, Costea D. Treatment of nonunion of the scaphoid with pronator quadratus pedicled bone graft. J Orthop Trauma Surg Relat Res 2015;10.
16. Goel V, Valecha N, Bhuyan B, Sharma S, Singh V. Nonunion scaphoid treated with vascularized pronator quadratus osteomuscular transposition flap: a review of 11 cases. J Orthop Traumatol Rehabil 2017;9:106-11.
17. Charan R, Verma P. Outcome of vascularised muscle pedicle bone graft for scaphoid nonunion. Int J Res Orthop 2018;4:203-8.
18. 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;40:1797-1805.
19. Sahu RL. Results of Herbert screw fixation in scaphoid fracture: A prospective study. Sport Orthop Traumatol 2018;34:45-53.
20. Hegazy G. Percutaneous Screw Fixation of Scaphoid Waist Fracture Non-Union Without Bone Grafting. J Hand Microsurg 2015;7:250-5.