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A CASE SERIES OF NON-UNION OF FRACTURE SCAPHOID TREATED WITH MUSCLE PEDICLE(PRONATOR QUADRATUS) BONE GRAFT

Orthopaedics

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KEYWORDS

INTRODUCTION

Fracture of the scaphoid bone is the most common type of carpal bone fractures, often occurs after a fall on the outstretched hand after hyperextension[1,2],or a forced dorsiflexion injury of the wrist[3,4].Patients usually present with pain, tenderness and swelling in the snuffbox and decrease in range of motion specifically in extension and radial deviation. The fracture might show up in a PA X-ray view but it is not always the case. These patients often treated with casts or splints and a second X-rays is taken about 7 to 10 days later[5,6].

Because fractures may disturb the scaphoid's tenuous blood supply, osteonecrosis is said to occur in 13%–50% of cases, and the incidence of osteonecrosis is most in those with involvement of the proximal 1/3 of the scaphoid[7,8,9].

The rate of nonunion of scaphoid fractures is as high as 10%, on X-ray, can progress to carpal collapse and degenerative arthritis and decrease in the quality of life[10,11].Surgical treatment is directed with ORIF by placing a screw with bone grafting[2,12,13].

The blood supply of the scaphoid is primarily from the radial artery via the artery to the dorsal ridge of the scaphoid, whose branches enter scaphoid via foramina at the dorsal ridge at the level of the waist of the scaphoid[8,14].Subsequently, these vessels divide and run proximally and palmarly to supply the proximal pole of the scaphoid[8]. Other branches provide 20%–30% of the blood flow and appear from the distal palmar area of the scaphoid, arising either directly from the radial artery or from the superficial palmar branch[14,15].The proximal pole is dependent entirely on intraosseous blood flow. Nonunion may occur (in 5%–10% of all cases, with an even higher incidence in displaced fractures), and in many series document progression of nonunion to arthritis and collapse [9,16,17].

Cystic changes in the scaphoid and the adjoining bones followed by osteonecrosis can occur after untreated fractures, but this is not an absolute indication for surgery. Nonunion is expected more often if the scaphoid fracture is untreated for 4 or more weeks. Vascularized bone grafts are indicated when circulation to the proximal pole is poor.

If there is significant scaphoid collapse or radioscaphoidarthrosis, scaphoid excision combined with capitate-lunate-triquetrum-hamate fusion or with proximal row carpectomy may be required.

CLASSIFICATION

Classification of scaphoid fractures has been well described in the literature. One of the most widely used classifications for scaphoid fractures include the Herbert classification.

Scaphoid Fracture: Herbert Classification

A.	Acute, Stable	A1	Tubercle
		A2	Nondisplaced crack in the waist
B.	Acute, Unstable	B1	Oblique, distal third
		B2	Displaced or mobile, waist
		B3	Proximal pole
		B4	Fracture-Dislocation
		B5	Comminuted
C.	Delayed Union		
D.	Established non-union	D1	Fibrous
		D2	Sclerotic

DIAGNOSIS AND TREATMENT OF ACUTE SCAPHOID FR ACTURES

The diagnosis of a scaphoid fracture can sometimes be difficult to establish, as patients may have normal Xray early in their clinical course. Most patients demonstrate tenderness over the anatomic snuff box or over the distal scaphoid tubercleand limited range of motionand pain at the end arc of motion, especially with flexion and radial deviation[18,19,20].Reduced grip strength may be noted[18,19,20].

Classically, patients with clinical findings suspicious for scaphoid fracture but negative initial radiographs were treated with 2 weeks of cast immobilization followed by repeat examination and radiographic studies, with the idea that the time delay allows bony resporption adjacent to the fracture site to occur, making the fracture visible[18,21].

Alternative imaging techniques may be useful for diagnosing a fracture, and MRI is superior to repeat radiographs for detecting an occult scaphoid fracture[22].

A suggested algorithm, therefore, in a patient with wrist trauma is to obtain three radiographic views of the wrist, AP, lateral, and oblique. If a scaphoid fracture is identified on the radiographs, a CT scan can be then obtained for surgical planning. If the radiographs are negative or equivocal, a limited MRI examination of the wrist is then obtained to determine the presence or absence of a scaphoid fracture. If needed, a CT scan can also be obtained after MRI to help plan for surgical treatment.

TREATMENTS OF SCAPHOID NONUNIONS

The undisplaced stable nonunion without degenerative changes may be treated with bone grafting with or without hardware. Nonvascularized autogenous bone graft from the distal radius or iliac crest may be sufficient, although vascularized bone grafting should be considered in the presence of an avascular proximal pole as determined by MRI or intraoperative findings. The fracture site should be freed from fibrous nonunion or interposed tissue, and hardware may or may not be placed. Hardware placement provides additional stability but requires bony removal for placement. Kirshner wires may be used, but screw fixation may provide the advantage of compression of fracture fragments.

BONE GRAFTING

When the scaphoid is salvageable and bone grafting is attempted, one must consider the relative risks and benefits of nonvascularized or vascularized bone grafting. Pedicled grafts can be simply bone or may include bone, muscle, fascia, and/or skin. They remain the most commonly used method of vascular bone grafting in the wrist. VBGs including muscle pedicle bone graft with PQ muscle help facilitate bone healing and revascularize bone without creeping substitution and thus accelerate fracture healing[23,24].Osteocytes are preserved[25,26,12]and this results in accelerated graft consolidation[27,28,29].It has been clearly established that vascular bone grafts offer superior biological and mechanical properties over nonvascular bonegrafts[30,31,32], this preserves bone mass, which minimizes osteopenia and maintains bone strength and structural integrity after grafting[33,34,35].

MATERIALS AND METHODS

In this prospective interventional study, a total of 5 patients with nonunion scaphoid fracture were included in the study. The subjects were recruited from OPD of the VIMS Kolkata between October 2012 and March 2014. Written informed consent was obtained from all subjects prior to the study.

All subjects are between the ages 25 and 40 years, who had a waist scaphoid fracture (fracture in the middle third of the scaphoid bone) during the six months before initiation of the study were included. Subjects with a history of systemic disorders affecting the musculoskeletal system, bone tumors, or bone infection were excluded. We also excluded subjects with a simultaneous fracture of other wrist bones, apparent degenerative changes in wrist bones, or radiologically proven scapholunate dissociation from the study.

We evaluated avascular necrosis in the proximal pole of the scaphoid bone by X-ray and MRI modalities. Overall, 5 patients underwent surgery with the muscle pedicle bone graft with PQ muscle after the initial examinations. In this method, by adopting a palmar approach (which would be less likely to cause damage to the blood supply of the scaphoid), the proximal and distal parts of the bone were excavated by removing all the necrotic bone, cartilage, and fibrous tissue at the fracture site using a dental burr through the palmar incision. Then a small square block of bone(shaped to fit the excavated cavity better) marked at the insertion of Pro Quad muscle on the radius and was elevated from distal border of the muscle taking 25% of muscle and inserted into the prepared cavity of scaphoid and transfixed along the # fragment with K wire and the fracture alignment assesed with a C-arm three-dimensional imaging system.

The union was considered to have occurred when there was no tenderness at the anatomical snuffbox and there was evidence of bony trabeculae crossing the fracture line or a sclerotic band present at the site of the fracture on at least three views. Mean time to radiological union for all fractures is nine weeks[3,39]. Thus, we evaluated the union in patients four and six months after surgery, to ensure that the surgery had its effect on the patient.

The patients were assessed based on the Mayo wrist score (MWS) questionnaire on a follow-up after six months. The questionnaire consists of questions assessing pain intensity, functional status, range of motion, and grip strength. Scores are recorded in four groups: 90-100: Excellent, 80-90: Good, 60-80: Satisfactory, below 60: poor.

ROM in dorsiflexion, palmar flexion, radial flexion, and ulnar flexion in the affected wrist was measured using a goniometer, and was reported as a percentage. Grip strength was measured by asking the patient to squeeze the index finger of the examiner, and the strength was compared on the contralateral side using a dynamometer, and reported as a percentage.

Statistical analysis was performed using SPSS (version 18, Chicago, IL, USA). Data are expressed as mean ± standard deviation for numerical variables and as percent (%) for categorical variables.

RESULTS

A total of 5 male patients with nonunion scaphoid fracture were evaluated in this study. Mean age of the subjects was 21.08 ± 6.09 years ranging from 25 to 40 years.

Sixteen weeks after surgery, fracture in all 5 patients was united.

MAYO WRIST SCORE:

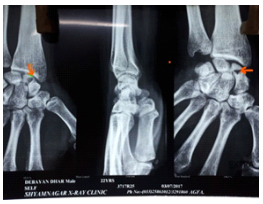
Section 1 - Pain Intensity	Section 2 - Functional Status
No pain	Returned to regular employment
Mild Occasional	Restricted employment
Moderate, tolerable	Able to work, but unemployed
Severe to intolerable	Unable to work because of pain

Section 3 (choose either 3a or 3b)	
3a - Range of Motion (% of normal side)	3b - If only injured hand examined
100%	Greater than 120 degrees
75-99%	90-120 degrees
50-74%	60-90 degrees
25-49%	30-60 degrees
0-24%	less than 30 degrees

Interpreting the Wrist Mayo Score	
90-100	Excellent
90-100	Good
80-90	Satisfactory
Below 60	Poor

Sixmonths after surgery, mean Mayo Wrist Score was 73.0 ± 8.36 in all the subjects, ranging from 65 to 85. One subjects (20%) were grouped as excellent, 2 (40%) good and 2 (40.0%) satisfactory.

Pre Op xray



1m **2m**

DISCUSSION

In this study, we evaluated 5 patients with nonunion scaphoid fracture who underwent the muscle pedicle bone graft with pronator quadratus muscle after minimum six months of injury. The results were satisfactory based on the Mayo wrist score questionnaire.

In a study by Bullens *et al*., 29 symptomatic scaphoid nonunions treated by a simple, minimally invasive procedure using a percutaneous autologous corticocancellous bone graft were evaluated after an average follow-up of 3.5 years. None of the patients had pain at work and all had an almost-normal range of motion and grip strength. No progression to osteoarthritis was observed[40].

Bertelli *et al*. studied the persistence of nonunion in # scaphoid present for longer than two years, who were treated using a vascularized bone graft harvested from the thumb and pedicled on the first dorsal metacarpal artery by a palmar approach. After one year, 90% of the patients had bone healing with significant pain relief with an improved range of motion and grip strength[41]. This union rate is also almost the same as in our study.

This study shows that the muscle pedicle bone graft with pronator quadratus muscle, although old, is still a reliable and inexpensive method for the treatment of scaphoid bone nonunion, showing high percentages of healing and functional improvement, and it can be used in line with the new vascularized surgery methods.

CONCLUSIONS

In the setting of an established scaphoid nonunion without significant arthritis, vascularized bone grafting with metallic hardware, prefer ably a screw, is advised. When significant degenerative changes precl ude scaphoid reconstruction, salvage procedures such as proximal row carpectomy, neurectomy, or limited or complete wrist arthrodesis are indicated.

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