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The Use of the Proximal Hamate as an Autograft for Proximal Pole Scaphoid Fractures

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Abstract
Background: Because of the fragile blood supply and tiny size of the proximal fragment, scaphoid fractures are difficult to treat. Recently, proximal hamate has been employed as a replacement arthroplasty for proximal pole nonunions accompanied by collapse, bone loss, and/or osteonecrosis.
Aim: so that we may assess how well proximal Hamate autograft treats proximal pole scaphoid fractures.
Methods: Twenty patients in a row with proximal pole scaphoid fractures or nonunion accompanied by collapse, bone loss, or osteonecrosis AVN were the subjects of this prospective case study. Only patients with fully developed skeletons are eligible. All patients were evaluated radiologically, with X-rays providing a true AP, lateral, and scaphoid view; CT scans helping to define fracture pattern, carpal alignment, and arthritis; and MRIs evaluating vascularity and the viability of the proximal pole. The average duration of follow-up for all patients was eleven months, with a range of nine to fourteen months.
Results: The VAS after surgery was much lower than the VAS before surgery. When comparing the Mayo score index before and after surgery, there was a significant improvement. The relationship between union time, graft size, and time to remove wires was not statistically significant.
Conclusions: Alternative treatment approaches for proximal pole scaphoid fractures, such as the nonvascularized hamate proximal pole, show promise.
One of the critical tasks to carry out the procedure well is to probe the graft size and harvest the capito-Hamate ligament.

Keywords: Scaphoid fractures, nonunion, VAS, proximal hamate, and pole

Introduction

Because of the fragile blood supply and tiny size of the proximal fragment, scaphoid fractures are difficult to treat. Avascular necrosis, a severe late consequence, affects 13% to 47% of proximal pole fractures [1]. The proximal pole is particularly vulnerable to vascular damage.

Bone grafting, both vascularised (VBG) and non-vascularized (NVBG), is one of many surgical procedures that have been used to speed recovery. NVBG has a range of 36% to 89% success rates in unionisation. Illiac crest, distal radius, and rib autografts are examples of non-vascularized bone donor sites [2, 3].

In cases where fixation has failed in the past and there is clear osteonecrosis, VBG has shown a higher incidence of union than NVBG. Union membership is said to be anything from 27% to 100% [4]. When it comes to revision surgery for proximal pole nonunions and osteonecrosis, femoral vascular grafts have shown a consistently high union rate of 84% to 100% [5]. Donor site morbidity, the need for microvascular anastomoses, and SL ligament damage are some of the drawbacks of these methods [6].

Recently, proximal hamate has been employed as a replacement arthroplasty for proximal pole nonunions accompanied by collapse, bone loss, and/or osteonecrosis. With little donor site morbidity, this graft is used for SL ligament repair; it is a nonvascularized osteochondral autograft that retains its associated volar capitohamate (CH) ligament [2].

Proximal pole harvesting is preferable for local grafts because it is unlikely to cut off blood supply to the remaining hamate because it depends only on intraosseous supply from the dorsal transverse carpal arch, which enters the bone more distally [7]. For proximal pole scaphoid fractures, the nonvascularized hamate proximal pole offers a potential substitute for current methods, especially in situations where the proximal pole cannot be repaired, such AVN or pole comminution. One of the key benefits of this technique is that it can restore carpal collapse and create a strong ligament to rebuild the SL articulation. Another advantage is that it reduces the need for microvascular anastomosis and offers a local, well-fitted osteochondral graft option with minimal known donor site morbidity [8].

Our goal was to assess the efficacy of proximal Hamate autograft in treating proximal pole scaphoid fractures.

Patients and Methods

This prospective case study was conducted on twenty consecutive patients with proximal pole scaphoid fractures or nonunions with collapse, bone loss, and/or osteonecrosis AVN. Age is limited to skeletally mature patients. Exclusion criteria were reconstructable proximal scaphoid fractures which can be internally fixed. Neurologic disorders affecting function of upper extremity. Patients with systemic disorders (e.g. anemia, coagulation disorders, diabetes, or rheumatoid arthritis). Local wrist conditions (Impaired wrist motion as in advanced arthritis, previous trauma or

surgery, nerve entrapment, infection, or malignancy). Cervical spine pathology, psychiatric disorder, or pregnancy. All patients were subjected to history taking, general examination, local neurovascular assessment of the affected limb, radiological evaluation [X-Ray (true AP, lateral and scaphoid view), CT scan (to clarify fracture pattern, carpal alignment and arthritis) and MRI (to assess vascularity and viability of proximal pole)].

Anaesthesia

Both local and systemic anaesthesia are options. interscalene block performed prior to surgery with the use of ultrasonography for two reasons. To begin with, it lessens the requirement for a general anaesthetic throughout the procedure. And secondly, it helps with the control of pain after surgery. Twelve to eighteen hours is the typical duration of the single shot block.

Using a dorsal longitudinal wrist incision, the third extensor compartment is opened, and the extensor pollicis longus tendon is radially retracted during a dorsal approach to the wrist. The procedure involves accessing the fourth extensor compartment and elevating the capsule's retinacular flap from its proximal base.

Recycled Orthosis: Cannulated screws without heads, like Herbert or Cutrak screws. The diameters of Kirschner wires vary. Securing sutures.

Excision of the scaphoid's proximal pole

Curettage and osteotomy were used to prepare the distal proximal surface of the scaphoid until punctate bleeding was identified, and the tourniquet was deflated, after which the proximal pole of the scaphoid was excised while leaving the remaining scapholunate ligament free and linked to the lunate. After that, the graft size may be determined by harvesting the length, breadth, and depth of the defect as well as the measured removed pole.

Transplantation from the proximal pole of a Hamate plant

Maintaining the volar Capito-Hamate ligament attached to the graft and separating it from the capitate, the base of the Hamate was marked to match the size of the defect and separated using a small osteotome. At this stage, it is important to avoid injuring the distal Triquetro-Hamate ligament to prevent midcarpal instability in the future; if it is injured, suture anchor repair should be performed. In order to repair the separated scapholunate ligament, the graft was rotated 180 degrees after harvesting and compared in size to the excised scaphoid pole. Only then was it fixed.

Placing and applying the graft

After that, the graft is inserted into the proximal scaphoid defect and held in place temporarily using a Kirschner wire. The scaphoid facet of the distal radius, the SL and scaphocapitate articulations, and the cut surface of the residual distal scaphoid are all checked for a suitable fit by examining the graft's size. If there is overhang or impingement along the dorsal radial aspect of the radioscaphoid articulation or any other area where the graft's bony margins are visible, they are surgically trimmed in situ. A Kirschner derotation wire is inserted into the scaphoid when the graft is in an appropriate location and a good fit has been achieved. The next step is to use a buried antegrade single headless compression screw that runs along the centre axis of the scaphoid to provide fluoroscopic-guided fixation. After that, you may take out the derotation wire and the temporary reduction wire.

Restoring carpal alignment and reconstructing the scapholunate ligament: Alignment of Before repairing the scapholunate ligament, make sure the midcarpal connection and scapholunate interval are in good shape. After that, stabilise the lunate by reducing it to a neutral position and using the capitolunate wire accordingly. After rotating and becoming dorsal, the graft was utilised to reconstruct the scapholunate ligament by suturing the remainder of the ligament from the lunate to the capito-Hamate ligament. A dorsal capsulodesis was then performed to enhance the healing using a suture anchor that was anchored in the scaphoid. A suture anchor set in the lunate may be used to enhance the healing after scaphoid pole excision if enough scapholunate ligament could not be preserved connected to the lunate. The epidermis, subcutaneous tissues, extensor retinaculum, and capsule are all enclosed in layers. A below-the-elbow thumb splint was applied after the under-the-skin ligation of the capitolunate wire.

After the accident: The patients were monitored for an average of eleven months and assessed both clinically and radiologically throughout that time. Physiotherapy has begun after the removal of the k-wire and cast.

Assessment in the Clinic: Evaluation of cases is done using the modified Mayo wrist score, which takes into account factors such as grip strength, range of motion of the wrist, functional status, and discomfort. Case evaluations are also compared to pre-operative evaluations using DASH and VAS scores.

Radiology: X-ray taken after surgery to assess the placement of the graft, screws, and k-wires, as well as to assess the efficacy of the reduction of lunate bone, scapho-lunate reduction, and overall carpal alignment. X-ray taken semiannually.

A CT scan: Bony union may be evaluated with a computed tomography (CT) scan at 6-8 weeks if there is more than 50% bridging trabecular bone.

Evaluating Difficulties: Intra-operative problems. Potential problems that may arise soon after surgery. During the follow-up phase, complications occurred.

Analysing statistical data:

The data were analysed using the Windows version of the Statistical program for the Social Sciences (SPSS) software program, which was developed by

SPSS Inc. and is owned by IBM Corp. Its current version is 16. The Shapiro test was used to check whether the data followed a normal distribution. The qualitative data was presented using percentages and relative frequencies, which measure the number of occurrences.

Results

In terms of demographic information, the average age of the patients that were investigated was 28.0 ± 7.06 years. Twelve patients, or 60% of the total, were male and eight patients, or 40% of the total, were female. Thirteen of the patients (or 65%) in the study demonstrated hand dominance. The typical dimensions of the graft are 6.25±1.37 mm. One Table

Table 1: Group Characteristics, Graft Size, and Hand Dominance

		Total (n=20)
Age (years)		28.0 ± 7.06
Sex	**Male**	12(60%)
	Female	8(40%)
Hand dominance	**N**	7 (35%)
	D	13 (65%)
Size of graft (mm)		6.25 ± 1.37

Common ways that data is presented include mean + standard deviation or number (%).

The VAS after surgery was much lower than the VAS before surgery. When comparing the Mayo score index before and after surgery, there was a significant improvement. Part 2 of the table

Table 2: Mayo score index and visual analogue scale (VAS) of the patients under study

		Total (n=20)		P-value
		Pre-operative	**Post-operative**	
VAS	**Mean± SD**	3.7 ± 0.73	1.65 ± 1.31	<0.001*
	Range	2 - 5	0-4	
Mayo score	**Excellent**	0 (0%)	12 (60%)	<0.001*
	Good	7 (35%)	5 (25%)	
	Fair	7 (35%)	0 (0%)	
	Poor	6 (30%)	3 (15%)	

VAS: visual analogue scale, *: statistically significant (p > 0.05),

The duration of the follow-up, in terms of the results, varied between 10 and 16 months, with an average of 12.2±1.7 months. The average union time was 12.56±1.42 weeks, with a range of 11 to 16 weeks (two instances were not joined). The duration of wire removal varied between three and five weeks, with an average of three and a half weeks. Three tables

Table 3: Results for the clinical trial participants

		Total (n=20)
Follow up (months)	**Mean± SD**	12.2 ± 1.7
	Range	10 - 16
Union (weeks)	**Mean± SD**	12.56 ± 1.42
	Range	11 - 16
Time of wires removal (weeks)	**Mean± SD**	3.5 ± 0.61
	Range	3 - 5

The relationship between union time, graft size, and time to remove wires was not statistically significant. Section 4

Table 4: Associations between various factors and union time

	Union time (weeks)	
	r	**P**
Size of graft (mm)	-0.081	0.740
Time of wires removal (weeks)	0.171	0.496

The correlation coefficient is denoted as r.

Case:

An assessment was conducted on a 42-year-old male patient who was dominant with his right hand due to right wrist discomfort. He hurt his wrist in a fall six months ago and has been in constant agony ever since, making it difficult for him to do ADLs and making it impossible for him to move heavy things. (Refer to (1)

Medical Checkup: There was no abnormality, however the patient did have little swelling and pain in the anatomic snuffbox. Neither the distal radius nor the ulna were painful for him. On one side of his wrist, he could extend it 40 degrees and bend it 40 degrees, but on the other side, he could bend it 70 degrees and extend it 90 degrees. Both of his wrists were completely mobile, and he could fully rotate his forearm. Their VAS score was 6 before the procedure. A pain VAS score of 2 and a satisfactory Modified Mayo wrist score were used to evaluate functional results.

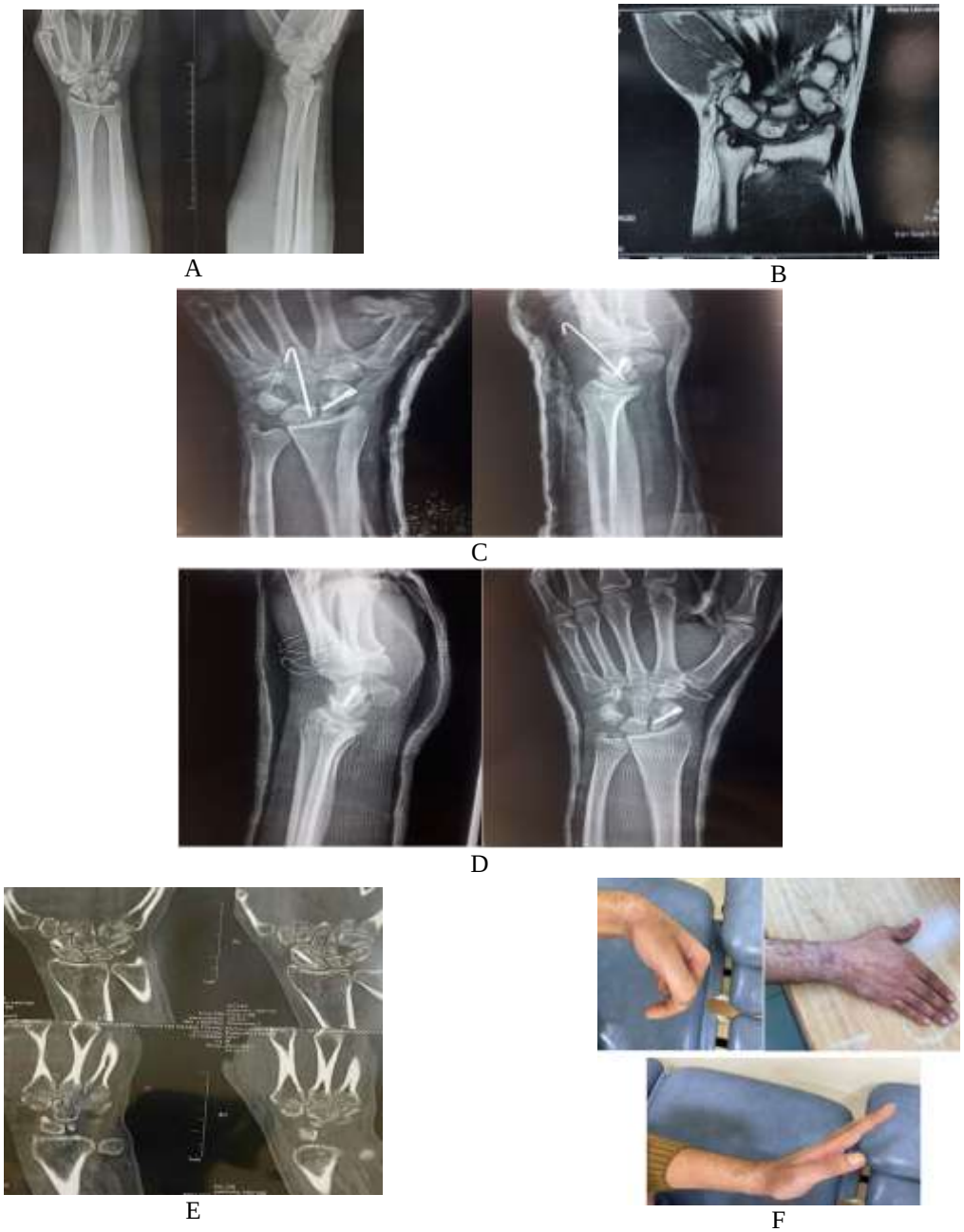

Fig. (2) A) Scaphoid nonunion on preoperative X-ray; B) Scaphoid nonunion on preoperative MRI coronal cuts; C) X-ray taken immediately after surgery; D) X-ray taken one month later; E) CT scan taken three months later demonstrating full union; F) Range of motion measured three months after surgery

Discussion

One potentially effective option is proximal scaphoid rib graft arthroplasty, which has shown positive results.All 47 patients who had osteochondral transplant treatment were considered effective by Sandow. After a median of fifteen

months of follow-up, all patients reported an improvement in wrist function. Nevertheless, there are still dangers involved with the rib graft harvest operation, which may lead to complications such pneumothorax and pleural rips [9].

Recent reports detail procedures that make use of a vascularised osteochondral flap taken from the medial femoral trochlea. After an average of fourteen months of follow-up, Burger et al. found that fifteen of sixteen patients had healed and that twelve had completely resolved their pain. By removing the infected part of the scaphoid while protecting the far end of the scapholunate ligament, the inventors of this method hoped to solve the problem of scapholunate instability. We don't yet know the technique's long-term effects, mid-term effects, or donor site morbidity [10].

There was a wide age range of 19–42 years among the patients that were investigated, with an average age of 28.0 ± 7.06 years. Twelve patients, or 60% of the total, were male and eight patients, or 40% of the total, were female.

Thirteen of the patients (or 65%) in the study demonstrated hand dominance. The average graft size for the patients analysed was 6.25±1.37 mm, and it varied between 4 and 9 mm.

The VAS after surgery was much lower than the VAS before surgery. The Mayo score index after surgery was much higher than the preoperative index.

With an average of 12.2±1.7 months, the follow-up time varied between 10 and 16 months. Two instances were not unified, and the nuion time varied from 11 to 16 weeks, with an average of 12.56±1.42 weeks. The duration of wire removal varied between three and five weeks, with an average of three and a half weeks. The relationship between union time, graft size, and time to remove wires was not statistically significant.

We found similar outcomes to those in a research by Elhassan B et al. In order to treat a proximal pole scaphoid nonunion with avascular necrosis, the results of a proximal hamate autograft were described in [2].Three and a half years after the procedure, the patient is still symptom-free, and there is no sign of scapholunate instability; this supports the conclusion that proximal hamate autograft is an effective method for treating proximal pole scaphoid nonunions caused by avascular necrosis.

In order to measure how comparable the topology of the scaphoid and Hamate articulating surfaces are, Kakar et al. [11] conducted a research. The researchers discovered that the two articular surfaces were comparable; in fact, 60% of the Hamate autografts showed more than 90% surface correlation to the scaphoid.Findings from 29 cadaveric investigations that included anthropometric examination of the scaphoid proximal pole to the proximal Hamate were 70% concordant (Wu et al., 2012).

In their study, Burnier et al. [13] evaluated the restoration of native wrist kinematics after proximal scaphoid reconstruction via proximal Hamate rebuilding using a wrist simulator to move the wrist through a cyclical motion on fresh-frozen mid-forearm cadaver specimens. Based on their findings, scapholunate kinematics were restored to a near-intact condition in terms of radial-ulnar deviation and flexion-extension using proximal Hamate grafts.

The 15 patients treated by Greg Sommerkamp et al. [14] with vascularised bone grafts from the palmar radiocarpal artery had all of their fractures healed within 12 weeks on average, and they were immobilised for 8.8 weeks on average.Using a 12-week mean duration and a 100% union rate, Mark S. Morris et al. [15] conducted a retrospective investigation on patients treated with intercompartmental supraretinacular artery vascularised grafts and compression screw fixation.

We found similar outcomes to a research conducted by Chan et al. [8] using the same approach. They too showed a 120-degree arc of wrist flexion-extension, complete pronosupination, and equivalent grip strength to the nonoperative limb and an outstanding Mayo Wrist Score. Three years after surgery, radiographs showed that the incision had healed and that there was very little arthritis.

The short follow-up time, low patient numbers, and absence of a control group were the study's drawbacks. To evaluate functional results over the long run, larger-scale research using randomised control trials are required.

Conclusions

Alternative treatment approaches for proximal pole scaphoid fractures, such as the nonvascularized hamate proximal pole, show promise. One of the key benefits of this technique is that it can restore carpal collapse and create a strong ligament to rebuild the SL articulation. Another advantage is that it reduces the need for microvascular anastomosis and offers a local, well-fitted osteochondral graft option with minimal known donor site morbidity. One of the critical tasks to carry out the procedure well is to probe the graft size and harvest the capito-Hamate ligament.

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