This article describes a case of a 24-year-old man with a total volar extrusion of the lunate and scaphoid proximal pole with concurrent scapholunate dissociation. The viability of the lunate and the proximal pole of the scaphoid are at high risk in this type of injury. Scaphoid nonunion, avascular necrosis of the lunate and proximal pole of the scaphoid, and carpal instability are inevitable unless the blood supply is restored. Thus, proximal row carpectomy at injury may be an acceptable option to avoid these complications and late sequelae, including chronic wrist pain and dysfunction. However, the authors attempted accurate reduction of the extruded bones and internal fixation. Final radiographs and magnetic resonance imaging 12 years postoperatively showed healing without avascular necrosis. Carpal indices involving the scapholunate angle, radiolunate angle, and carpal height ratio were similar in both wrists without evidence of carpal instability or collapse. Range of motion and grip power were 75% and 76%, respectively, compared with those of the uninjured wrist. Clinical scores showed good results, and the patient reported no pain during activities of daily living and was satisfied with his surgical results. Open reduction and internal fixation can be a viable option in this rare pattern of injury.
volar lunate dislocation is rare compared with dorsal perilunate dislocation and fracture dislocation, which are caused by a similar injury mechanism.1,2 Few cases of volar lunate dislocation accompanied by a displaced scaphoid fracture have been reported.3-8 To the authors’ knowledge, transscaphoid volar lunate dislocation combined with complete scapholunate dissociation and total extrusion (ie, complete detachment of the soft tissue) has not been reported.

The viability of the lunate and the proximal pole of the scaphoid are at high risk in this type of injury. Accurate reduction of the extruded bones can be attempted; however, scaphoid nonunion, avascular necrosis of the lunate and proximal pole of the scaphoid, and carpal instability are inevitable unless the blood supply is restored.9 Consequently, dysfunction of the wrist with pain and limited range of motion (ROM) due to degenerative arthrosis are the most likely late sequelae.2,3,10-12 Proximal row carpectomy at injury may be an acceptable option to avoid these complications.13,14

Despite the risk of failure, the authors performed open reduction and internal fixation. The patient was followed for more than 10 years; therefore, the authors present the long-term results. The patient was informed that the data concerning the case would be submitted for publication.

**CASE REPORT**

A 24-year-old, right-hand-dominant man was transferred after a fall from a height of approximately 10 m. The patient had severe pain and swelling around the right wrist with no external wound. He did not remember exactly how he fell on his right hand. Radiographs revealed a scaphoid waist fracture and a volar lunate dislocation. The lunate and proximal fragment of the scaphoid were completely extruded from the radiocarpal joint, separated from each other, and migrated proximally (Figure 1). Paresthesia and a mild sensory decrease in the territory of the median nerve were noted with normal range of 2-point discrimination. Hand circulation was not compromised. He had concomitant fractures in the second lumbar vertebra and both calcaneus bones.

Open reduction and internal fixation under general anesthesia and tourniquet control was performed on the wrist 3 days after the injury. After initial longitudinal skin incision on the volar side, the transverse carpal ligament and forearm fascia were released. The lunate and proximal fragment of the scaphoid, which were lying under the median nerve and flexor carpi radialis and compressing the median nerve, were identified (Figure 2). The soft tissues, including the scapholunate intersosseous ligament, lunotriquetral intersosseous ligament, and volar radiocarpal ligaments connecting to the lunate, were disrupted. The volar capsule of the wrist was transversely ruptured.

The extruded lunate and proximal scaphoid was manually replaced into the joint through the volar capsular rent. A subsequent dorsal approach was used to precisely reduce and securely fix the damaged structures. Using the triquetrum as a reference, the reimplanted lunate was anatomically reduced and transfixed with two 1.4-mm K-wires. The proximal fragment of the scaphoid was aligned with the reduced lunate and transfixed with K-wires. Finally, the reduced scaphoid fracture was fixed with K-wires. More stabilization was obtained by transfixed the scaphoid and capitae. No bone grafting was performed. No attempt was made to repair the scapholunate intersosseous and lunotriquetral intersosseous ligaments because of insufficient substance to be purchased. Accurate reduction, restoration of normal carpal alignment, and proper K-wire position were confirmed under an image intensifier. The volar capsule, dorsal capsule, and extensor retinaculum were repaired (Figure 3).

Postoperatively, the median nerve symptoms resolved within 2 weeks. The wrist was immobilized in a long-arm thumb spica cast for 4 weeks and then in a short-arm thumb spica cast for an additional 11 weeks until radiographs showed union of scaphoid fracture. After the K-wires were removed.
at 15 weeks, active-assisted and gentle passive range of motion exercise were started. No formal physiotherapy was administered. Six months postoperatively, he regained functional range of motion and adequate strength and returned to his previous job as an electrical engineer with some limitations.

Radiographs 6 months postoperatively revealed no evidence of carpal malalignment or avascular necrosis. Three years postoperatively, bone absorption was noted in the articulation between the scaphoid and lunate (Figures 4A, B). The evidence of avascular necrosis and carpal instability was unclear, although slightly increased radiodensity in the lunate and mild arthritic change between the scaphoid and capitae was suspicious.

Final radiographs 12 years postoperatively showed widened scapholunate interval without further bone absorption. The density in the lunate and scaphoid proximal pole appeared to become normal. Mild arthritic change was evident, with an irregular surface in the scaphocapitate joint. The viability of lunate could be verified on MRI, although it was impossible to show the scaphoid proximal pole and scapholunate joint articulation due to a metal artifact from the remnant K-wire (Figures 4C-F). The radiographic measurements of scapholunate angle (59°), radiolunate angle (4°), and carpal height ratio (.51) were similar in both wrists, with no evidence of carpal instability or collapse. Range of motion (volar flexion, 70° vs 80°, respectively; dorsiflexion, 50° vs 80°, respectively; radial deviation, 20° vs 20°, respectively; and ulnar deviation, 25° vs 40°, respectively) and grip power (75 vs 85 lb) were measured to be 75% and 76%, respectively, compared with those of the uninjured wrist. The patient demonstrated a negative scaphoid shift test. The Disabilities of the Arm, Shoulder, and Hand score was 7 (best score, 0; worst score, 100), the patient-rated wrist score was 4 for pain (best score, 0; worst score, 50) and 6 for function (best score, 0; worst score, 100), and the modified Mayo Wrist Score was 85 (best score, 100; worst score, 0). The patient reported no pain during activities of daily living and mild pain after strenuous exercise. He was satisfied with his surgical results.

**DISCUSSION**

The current patient presented with a rare pattern of perilunate fracture dislocation. Case reports have been published of transscaphoid volar lunate dislocation with or without disruption of the scapholunate interosseous ligament and transscaphoid transtriquetral volar lunate fracture dislocation. The current case is unique because it involved a totally extruded pattern because the lunate and proximal fragment of the scaphoid had no soft tissue attachments.

Given the potential risks of avascular necrosis, scapholunate instability, and the development of secondary arthritis after open reduction, the results should be evaluated based on long-term follow-up. The authors examined the patient and obtained radiographs until 12 years after injury.
The treatment principle for a volar lunate fracture dislocation is to perform open reduction and internal fixation to achieve normal carpal alignment and proper healing. Many reports demonstrated that avascular necrosis of the lunate rarely develops because the blood supply is maintained through intact volar radiocarpal ligaments. Ekerot reported that revascularization of the lunate may be achieved through a united scaphoid fracture and an intact scapholunate intersosseous ligament. However, complete extrusion of the lunate and proximal scaphoid fragment with no soft tissue connections should result in total disruption of the blood supply with a high risk of avascular necrosis. Significant numbers of avascular necrosis of the lunate or scaphoid proximal pole in transscaphoid perilunate dislocation was noted, and the reported outcomes were less satisfactory because of secondary arthritic changes.

Some authors have reported satisfactory results by proximal row carpectomy in cases with marked displacement of the carpal bones and complete ligamentous disruption. The current case may represent an indication for primary proximal row carpectomy. However, the current authors were determined to attempt reduction of displaced fragments to restore the normal carpal joint. They thought that proximal row carpectomy could be performed subsequently if open reduction and internal fixation failed. The extruded lunate and proximal scaphoid fragment could be easily replaced into the joint through the volar approach. However, the dorsal approach is required to achieve anatomic reduction and secure fixation, which is essential to avoiding complications, including scaphoid nonunion, carpal collapse, and late arthrosis. Although the authors repaired no interosseous ligaments, excellent functional recovery was achieved with the restoration of normal carpal alignment.

The scaphoid fracture healed uneventfully 15 weeks postoperatively, and no evidence existed of necrosis of the scaphoid proximal pole. The authors assumed that the avascular proximal pole had been revascularized through the creeping substitution as the fracture healed. Despite the concern about avascular necrosis in the current patient, recent radiographs showed the recovery of normal radiodensity, indicating revascularization. It was confirmed based on magnetic resonance imaging 12 years after injury. However, it is difficult to explain how an avascular large bone can be successfully revascularized simply by replacing it. Another remarkable radiographic finding was bone resorption between the scaphoid and the lunate, which was noted 2 years postoperatively. It suggests the possibility of scapholunate instability; however, no further resorption occurred, and carpal alignment was maintained with no evidence of dorsal intercarpal segmental instability.

**CONCLUSION**

Transscaphoid volar lunate dislocation with complete ligament disruption can be treated successfully with early open reduction and internal fixation despite the risks of avascular necrosis and carpal instability.

**REFERENCES**