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Avascular necrosis of the lunate secondary to perilunate fracture dislocation: Case report and review of the literature

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Abstract

This is a 39-year-old male, fell from a bike, left wrist with trans-styloid perilunate fracture dislocation that underwent open reduction internal fixation, 20 months after surgery the patient developed avascular necrosis of the lunate, final wrist fusion was performed secondary to the arthritic changes on the wrist. Anatomic dissection was performed and vascularity of the lunate was identified, its origin is from the volar palmar arch, when dislocated palmarly and more than 90 degrees the vessel is still intact. More than 512 patients with perilunate dislocation and perilunate fracture dislocation are included we identified in the literature transient avascular necrosis of the lunate in nine and seventeen of pure avascular necrosis of the lunate. Concluding that avascular necrosis of the lunate after perilunate dislocation or perilunate fracture dislocation is an infrequent finding especially when the volar ligaments are intact.

Keywords

Perilunate dislocation, perilunate fracture dislocation, lunate, avascular necrosis, trans-scaphoid fracture, lunate dislocation

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Introduction

Perilunate dislocations (PLDs) and perilunate fracture dislocations (PLFDs) caused by high-energy injuries. Diagnosis is challenging and prompt treatment is required in order to avoid long-term complications.[1] Ligament injuries, or PLD, are referred to as lesser arc injuries, whereas dislocations with associated fractures are referred to as grater arc injuries, or PLFDs.[2] After the diagnosis of PLDs or PLFDs, one should attempt provisional closed reduction and proceed to urgent open reduction and internal fixation (ORIF) through a dorsal or volar approach or both approaches are needed some times. If closed reduction is unsuccessful open repair of the ligaments are necessary.[2] There is little evidence or description of avascular necrosis (AVN) of the lunate secondary to ORIF after to a PLDs or PLFDs. We present a case report and a review of the literature in order to identify the lunate AVN after these terrible injuries.

Case report

A 39-year-old male was injured in a bicycle accident and sustained a left wrist trauma. After that, the patient complained about pain and had a visual deformity of the wrist. Initial radiographs (Image 1(a)) showed a trans-styloid PLFD. The patient underwent ORIF of the trans-styloid PLFD at another institution. The wrist and distal aspect of the radius was exposed through a dorsal approach, and the distal radius was fixed with a dorsal plate. After percutaneous fixation of the lunate with scapholunate, scaphocapitate, and lunacapitate Kirschner wires (K-wire), the dorsal scapholunate ligament was repaired to the dorsal side of the lunate using a bone anchor (Image 1(b)). The K-wires were removed 1 month after surgery (Image 1(c)). Five months after surgery, wrist extension/flexion was 70/50 degrees, wrist ulnar/radial deviation was 20/50 degrees, and forearm pronosupination was 80/60 degrees. Seventeen months after the surgery, the patient consulted another hand surgeon complaining about left wrist pain and decreased grip strength. The physical examination at that moment was flexion of the

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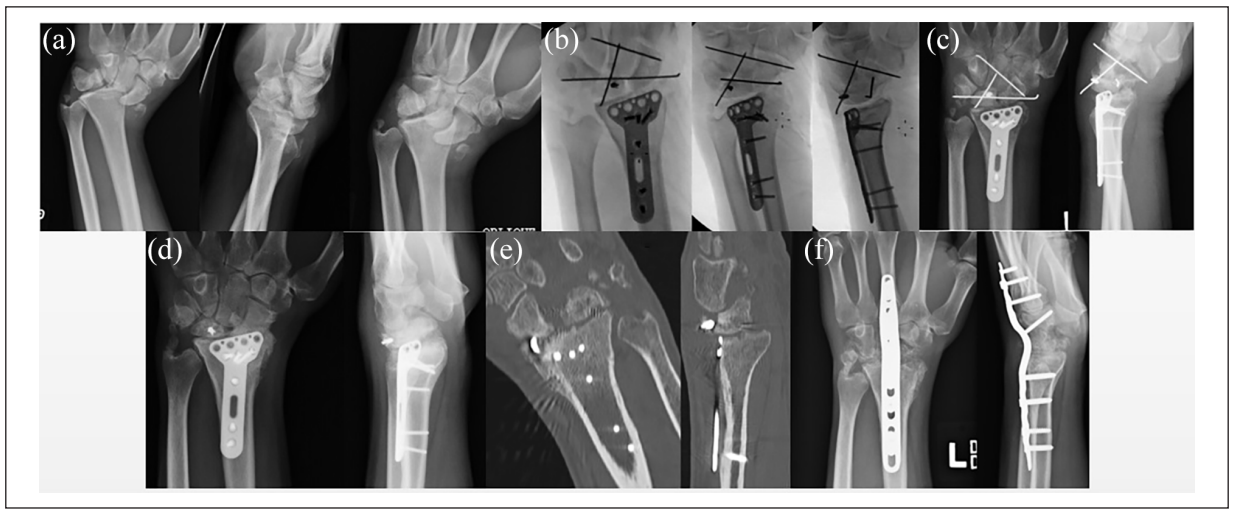

Image 1. (a) Trans-styloid perilunate fracture dislocation of the left wrist. (b) Immediately post-operative fluoroscopy images, posteroanterior oblique and lateral radiographs of the left wrist after Open Reduction Internal Fixation of the distal radius dorsal aspect and reduction of the perilunate fracture dislocation with anchor in the lunate and K-wires. (c) One month X-rays of the left wrist, posteroanterior and lateral radiographs. (d) 17 months follow-up, X-rays of the left wrist, posteroanterior and lateral radiographs, arthritic changes in the radio-scaphoid fossa, dorsal distal radius collapse, and avascular necrosis of the lunate. (e) CT scan 20 months after surgery, severe post-traumatic arthrosis and traumatic deformity of the radius, scaphoid, and lunate. Dorsal plate and screws fixation of the radius is present without hardware fracture. The distal radial side of the plate, however, extends into the articular scaphoid, sclerotic partially collapsed and osteonecrosis of the lunate scapholunate interval widening compatible with ligamentous disruption, and dorsal capitate subluxation relative to the lunate fossa. (f) Final follow-up five months X-rays of the left wrist, posteroanterior and lateral radiographs with healed wrist fusion.

left wrist 30 degrees, extension 45 degrees, left-hand grip strength 40 pounds (lbs), and right-hand grip strength 100 lbs.

Wrist radiographs showed radio-scaphoid osteoarthritis 17 months after the initial injury, dorsal collapse of the distal radius, and AVN of the lunate secondary to fragmentation and cystic changes. Four-corner fusion was recommended, but the patient did not have surgery (Image 1(d)). Finally, 20 months after the initial surgery, the patient came to our clinic and was evaluated by the senior author (H.T.), due to the findings in the computerized tomography of the wrist, that shows arthritic changes, is important to recognize that the best way to identify AVN of any bone is the magnetic resonance imaging (MRI) (Image 1(e)). The main goal of the patient was to keep using his left hand and keep bicycling. With the findings in the computed tomography (CT), four-corner fusion was not an option due to the arthritic changes in the lunate fossa and the dorsal inclination of the radius. Total wrist fusion was proposed, and the patient accepted this procedure. Total wrist fusion was performed 29 months after the initial injury. At 5 months after the total wrist fusion, the patient had no complaints, no pain, full range of motion of the fingers, and is back to regular activities (Image 1(f)).

Discussion

To the best of our knowledge, there is scarce evidence or description of lunate AVN secondary to a PLD or PLFD.[1] Throughout the literature, a total of 151 PLDs and 367 PLFDs were identified, with a follow-up of 58 months. We identified 9 cases of transient AVN of the lunate and 17 cases of pure AVN of the lunate. Only one series described a treatment for the AVN of the lunate proximal row carpectomy was performed in two cases (Table 1).

Bain et al.[26] described that AVN of the lunate is caused by a compartment syndrome of the bone. The factors that contribute to this compartment syndrome are increased intraosseous pressure including the arterial supply, emboli formation, decrease in venous drainage, and destruction of the intraosseous bone marrow. White and Orner[3] first described the transient AVN of the lunate after PLFDs in 3 out of 24 patients who underwent ORIF. During the immobilization, all carpal bones underwent some osteopenic changes between the first and the fourth month after initial operative treatment. Normal lunate was seen between 5 and 32 months after trauma. Reasons for this transient AVN is decreasing inflow and outflow from the bone creating a so-called compartment syndrome of the bone.[3] The details can be found in Table 1.

Herzberg[7] described AVN of the lunate in 5 out of 166 patients and of them underwent ORIF. In two cases, the lunate was found to be rotated over 180 degrees with respect of the radius. Four cases underwent urgent surgery in less than a week, and one case underwent delayed surgery 45 days after the initial trauma. All cases of AVN are listed in Table 1.

Table 1. Transient and avascular necrosis of the lunate after perilunate dislocation (PLD) and perilunate fracture dislocation (PLFDs).

Series, year	PLDs	PLFDs	Type of fixation ORIF or closed	Follow-up (months)	Transient AVN	AVN	AVN treatment
White, 1984[3]		24	ORIF	96	3	0	No info
Viegas, 1987[4]		8	ORIF	18	0	0	No info
Gellman, 1988[5]		1	ORIF	52	1	0	No info
Conway, 1989[6]		3	ORIF	19	0	0	No info
Herzberg, 1993[7]	56	104	64 ORIF	75	0	5	No info
Sotereanos, 1997[8]	3	8	ORIF	30	0	0	No info
Inoue, 1997[9]	14		8 ORIF	29	0	1	No info
Inoue, 1997[10]		29	ORIF	24	0	0	No info
Hildebrand, 2000[11]		23	ORIF	21	1	1	No info
Herzberg, 2002[12]		14	ORIF	103	4	0	No info
Trumble, 2004[13]	22		ORIF	49	0	0	No info
Knoll, 2005[14]		25	ORIF	44	0	0	No info
Souer, 2007[15]		18	ORIF	44	0	0	No info
Martinage, 2008[16]	7	7	ORIF	25	0	0	No info
Komurcu, 2008[17]		12	ORIF	45	0	0	No info
Forli, 2010[18]	11	7	ORIF	156	0	0	No info
Kailu, 2010[19]	1	11	ORIF	90	0	0	No info
Laporte, 2012[20]	6	11	13 ORIF	26	0	0	No info
Akane, 2014[21]	1		ORIF	6	0	1	No info
Krief, 2015[22]	14	16	18 ORIF	216	0	2	Proximal row carpectomy
Wilke, 2015[23]	1		ORIF	14	0	1	No info
Meszaros, 2018[24]	1	20	ORIF	112	0	6	No info
Dunn, 2018[25]	14	26	ORIF	47	0	0	No info
	n = 151	n = 367		Mean follow-up = 58.30 months	n = 9	n = 17	
	Total 518						

ORIF: open reduction and internal fixation; AVN: avascular necrosis.

The vascular supply of the lunate is originally described by Gelberman et al.[27] He described that the external vascular supply of the lunate is by direct dorsal blood supply from the dorsal plexus of vessels on the mid-dorsum of the carpus and fed by the branches of the radial artery and the dorsal branch of the anterior interosseous artery. The volar carpus is supplied by four arteries: the ulnar artery, the radial artery, the volar branch of the anterior interosseous artery, and the recurrent branch of the deep palmar arch.

In the study performed by Lamas et al.[28] on the dorsal aspect of the lunate, vessels enter through one of the three foramina located in the proximal, central, or ulnar, nonarticular space of the bone. On the volar aspect, one to five nutrients vessels enter the volar pole through various ligamentous insertions, including the ligament of Testut-Kuentz, radiolunate triquetrum ligament (now called long radiolunate ligament),[29] and ulnar lunotriquetral ligament (Image 2). (This anatomic dissection was performed by the authors.)

It is generally accepted that the radiolunate ligaments remain intact in PLDs and PLFDs. Mayfield et al.[30] described the volar radiotriquetral ligament as the largest of the wrist. It arises from the volar aspect of the radial styloid process next to radiocapitate ligament. It is directed across the volar aspect of the lunate, to which is connected and ends in the palmar surface of the triquetrum, then the radiotriquetral ligament, named the short and long radiolunate ligament according to Berger.[29] Of many combinations of ligamentous disruptions created around the wrist, Mayfield et al.[30] did not find a single rupture of the proximal portion of the volar radiotriquetral ligaments from the radius to the lunate or the ulnolunate ligaments. Sauder[31] and Berger[29] state that the volar radiolunate ligament remains intact during PLDs and PLFDs (Image 3). (This anatomic dissection was performed by the authors.)

In our case, AVN of the lunate could be secondary to the PLFDs itself because of disruption of the volar and dorsal vessels entering in the lunate or secondary to the hardware after the first surgery. During surgery, volar and dorsal approach may be necessary to reduce the PLFDs, K-wires may be useful to reduce the scaphoid, the lunate and also used them both as a joystick to maintain the reduction, reconstruction of the dorsal scapholunate ligament can be performed using anchors, the volar lunotriquetrum

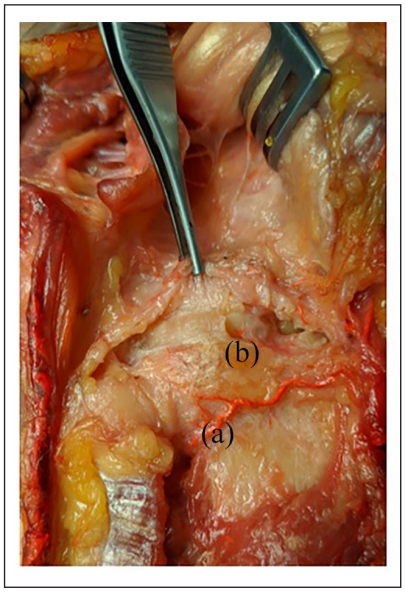

Image 2. Anatomic dissection, volar aspect of the radius, (a) volar palmar arch, (b) nutrient vessels to the lunate.
Source: Own authorship.

Image 3. Anatomic dissection, volar dislocation of the lunate, radiolunate ligament remains intact with nutrient vessels (red box).
Source: Own authorship.

ligament also repairs with anchors, the challenging part of this reconstruction is the perfect reduction of the carpal bones, after the reduction, ligament reconstruction should be done.

Indeed, there are some case reports describing AVN of the lunate that are believe to be secondary to application of hardware. Akane et al.[21] reported an initial reduction of PLDs that was performed with two K-wires from the scaphoid to the lunate and two more from the triquetrum to the lunate. A dorsal anchor micro-Mitek was used to repair the dorsal scapholunate ligament. AVN of lunate was seen 6 months after initial treatment, but no second intervention was performed. Wilke and Kakar[23] published one case of AVN of the lunate secondary to PLDs after fixation with K-wires and a double approach for reconstruction of the dorsal scapholunate ligament and volar lunotriquetral ligament. Again, no further surgery was performed.

The learning point, in this case, is that major dissection of the volar ligaments from the radius to the lunate must be avoided to preserve the blood supply, intercarpal bone fixation with K-wires and reconstruction of the intercarpal ligaments should be performed but with less hardware to avoid AVN of the lunate in PLDs and PLFDs.

Conclusion

Despite the massive trauma to the surrounding tissues, AVN secondary to PLD or fracture dislocation is an infrequent event. This is probably due to the enormous blood supply that the lunate has from the volar and the dorsal aspect. Especially when the volar ligaments are still intact, they provide irrigation to the lunate.

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Ethical approval

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Human and animal rights

All procedures were in accordance with the ethical standards of the responsible committee on human experimentation and with the Helsinki Declaration on 1975, as revised in 2008.

Informed consent

Written informed consent was obtained from the patient(s) for their anonymized information to be published in this article.

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