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Trans-4 Portal as a New Portal for Accessing the Lunate in Wrist Arthroscopy: a Cadaveric Study

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Abstract

Background: Evolving wrist arthroscopy requires creating new portals, and creating portals reciprocally leads to increased indications for arthroscopic wrist procedures. To facilitate access to the lunate bone and fossa for new arthroscopic procedures, a new portal was used. This is a cadaveric study of this portal.
Objectives: In this cadaveric study, we evaluated a portal in wrist arthroscopy for procedures involving the lunate bone and lunate fossa.
Materials and Methods: Seventeen wrists from 10 fresh cadavers were included in this study. After diagnostic arthroscopy, a portal (Trans-4) was made through the fourth extensor compartment, exactly along the lunate's long axis under direct visualization from the 3-4 portal. Strand retractors were used to protect the extensor tendons and posterior capsule. Lunate bone core decompression and osteoscopy were done through the portal. At the end of the procedure, the position of the decompression hole in the lunate and any possible injury to the extensor tendons, distal radius cartilage, lunate cartilage, and perilunate ligaments were investigated.
Results: Lunate bone decompression was performed successfully in all cases using the trans-4 portal. In 15 wrists, the lunate hole was located in the middle third. In the other two wrists, it was located slightly radial in one case and slightly on the ulnar side in the other case. There was no cortical penetration during decompression, and no extensor tendon, superficial nerve branches, or peri-lunate ligament injuries were observed.
Conclusions: The trans-4 portal could be a safe working portal in wrist arthroscopy that enables access to the lunate bone and lunate fossa.

Keywords: Wrist Arthroscopy, Lunate Bone, Arthroscopy Portal

1. Background

Today, diagnostic and interventional wrist arthroscopy is improving because of advancements in small-joint endoscopic technology and increased understanding of wrist kinematics (1, 2). Increased indications for wrist arthroscopy procedures are fully indebted to creating portals; however, creating working portals can increase the indications for wrist arthroscopic procedures. Hand surgeons are familiar with standard wrist portals and their applications in diagnostic and therapeutic wrist procedures (3). Thus, sometimes modification in a standard portal or even a new one is described to apply new arthroscopic procedures.

Previous studies suggested that lunate core decompression was effective in the treatment of stage 1 and 2 Kienbock's disease (4-6). However, we encountered two major problems with lunate core decompression arthroscopically. First, because of the relative position of the 3-4 and 6R portals to the lunate, there is a risk of injury of perilunate ligaments during core decompression. Second, as these portals are not along the dorso-volar axis of the lunate, it is difficult to decompress the volar part of lunate.

A portal along the lunate dorso-volar axis through the fourth extensor compartment (trans-4 portal) could provide direct access to the lunate bone.

2. Objectives

In this cadaveric study, we evaluated a portal through the fourth extensor compartment, its anatomic relationship, and possible complications.

3. Materials and Methods

From April 2015 to December 2015, 17 wrists (9 right and 8 left) from 10 fresh male cadavers, with a mean age of 41 years (28 - 52 years) were studied. Demographic data were obtained from the records of the forensic medicine organization at the legal medicine research center in Tehran. The exclusion criteria included any history or sign of hand or wrist trauma. Three wrists were excluded because of a previous injury.

We performed standard dry wrist arthroscopy. Traction (5 kg) was applied to the cadaver arm, with 90 degrees of elbow flexion. The wrists were evaluated through the 3 - 4 portal, using a 2.5 mm 30-degrees lens (ConMed Linvatec Largo, FL) to ensure that there were no ligaments or cartilage injuries. A shaver was used through the 6R portal for cleaning the joint, if necessary. Then, under direct visualization from the 3 - 4 portal, a needle was inserted to find the most appropriate point to make the trans-4 portal at the lunate dorsum. To protect the extensor tendons from the passing burr, two silk strands were passed from the 3 - 4 to the trans-4 at the radial side, and two strands were passed from the trans-4 to 6-R at the ulnar side as soft tissue retractors (Figure 1).

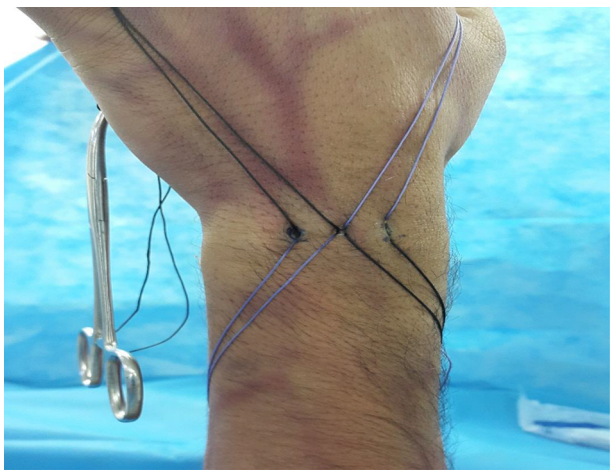


Figure 1. Final Position of the Portals Along with Retractor Strands Through the Trans-4 Portal

Observing the joint through the 3 - 4 portal, a 3-mm shieldless cutting burr was inserted through the trans-4 portal (Figure 2) while the assistant protected the soft tissue by retractors.

The lunate was decompressed along its dorso-volar axis, and the scope was changed to the trans-4 portal. Lunate osteoscopy was performed to ensure that the burr had not penetrated the lunate walls. In the final step, the skin, subcutaneous tissue, retinaculum, and capsule were dissected by a vertical incision. Then, we evaluated the relationship of the trans-4 portal and extensor tendons. The tendons and superficial nerve branches were evaluated for any fraying or damage using 2.5 $\times$ loupe magnification. The joint was opened, and the lunate bone, articular cartilage of the distal radius, lunate, scaphoid, and perilunate ligaments were evaluated, and the data were documented (Figure 3). At the end, the skin of the cadavers was sutured.

Figure 2. Arthroscopic View From the 3 - 4 Portal of the Burr Entering the Dorsal Aspect of the Lunate

4. Results

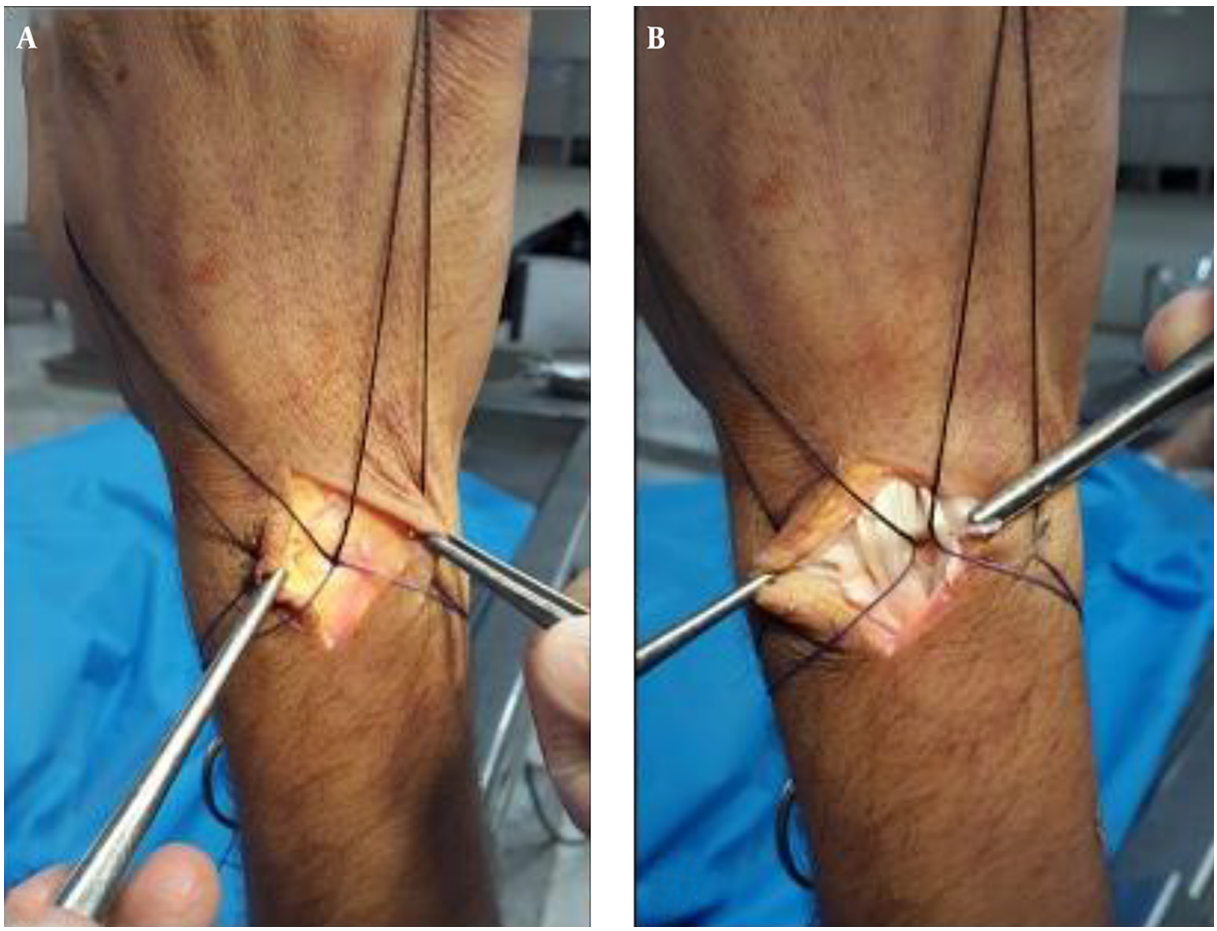
Lunate core decompression through the trans-4 portal was performed successfully in 17 wrists. In all cases, osteoscopy confirmed that the cortices of the lunates had not been accidentally penetrated by the burr.

In all 17 wrists, the trans-4 portal was made through the fourth extensor compartment but was between different tendons (Table 1).

There was no fraying or damage to the extensor tendons. The location of the decompression hole was at the middle third of the lunate in 15 wrists (Figure 4).

In one case, the entrance was 3 mm radial to the lunotriquetral ligament. In another case, it was on the radial side of the lunate, 5 mm away from the scapho-lunate ligament. The perilunate ligaments were intact in all the wrists. There was no cartilage injury in the distal radius or carpal bones.

Figure 3. Soft Tissue Dissection at the end of the Procedure



3A, Trans-4 portal through the extensor retinaculum; 3B, no fraying or any damage of the extensor tendons using the trans-4 portal as the working portal.

5. Discussion

Since 1979, wrist arthroscopy has continually evolved, with advances in both endoscopic technology and the understanding of wrist kinematics (2). Not only is such involvement indebted to creating new portals but also creating portals reciprocally has led to increasing the indications for arthroscopic wrist procedures.

Arthroscopic management of Kienbock's disease mainly consisted of salvage procedures that were directed toward the treatment of advanced stages when the cartilage of the lunate or perilunate area was damaged (7). Recently, a direct arthroscopic approach to the lunate for the treatment of early-stage Kienbock's disease has been reported. Menth-Chiari et al. treated Stage III a,b of Kienbock's disease with debridement of the necrotic particles of the lunate surface and achieved good functional outcomes in a short-term follow-up (6). They used the 3 - 4 portal to place the arthroscope and the 4 - 5 portal for instrumentation.

Mehrpour et al. treated stage 1 to 3b Kienbock's disease with an open technique, lunate core decompression, in 20 patients (4). They reported pain relief and a significant increase in the range of motion in the wrist in 5 years of follow-up. Arthroscopic core decompression of the lunate is a relatively new technique, with few reports. Bain et al. described arthroscopic core decompression of the lunate in two patients and reported 6 years of follow up, with acceptable functional results. They used a 2-mm drill in the 3-4 portal and confirmed the correct position of the drill by fluoroscopy. They did not detect any arthroscopy-related complications in their two patients (5). Recently, Rajfer et al. described a treatment technique for Kienbock's disease that utilized bone morphogenetic protein and the classic dorsal wrist portals (8).

Table 1. The Location of the Trans-4 Portal Among the Extensor Tendons

Cadaver Number	Location of the Trans-4 Portal Between the Extensor Tendons	
	Right Wrist	Left Wrist
1	EIP-EDC2	EIP-EDC2
2	Excluded	EDC4-EDC5
3	EDC3 - 4[a] - 5	EDC3-EDC4
4	EDC3-EDC4	EDC3-EDC4
5	EDC2-EDC3	Excluded
6	EDC5-EDQ	Excluded
7	EDC2 - 3	EDC2 - 3
8	EDC3 - 4	EIP-EDC2
9	EDC3 - 4	EPL-EDC2
10	EDC3 - 4	EDC2 - 3

[a] EDC 4 was interposed between retractors.

Figure 4. The Location of the Burr Hole Was in the Middle Third of the Lunate Bone Using the Trans-4 Portal as the Working Portal

There are no previous studies on the efficacy and complications of lunate core decompression from the 3 - 4 portal. We believe that the most important problem in arthroscopic core decompression of the lunate via the 3 - 4 portal is the angulation of this portal to the dorso-volar axis of the lunate bone. This angulation may prevent complete decompression. There is also a risk of damaging the scapholunate or lunotriquetral ligaments at the beginning or end of decompression. Furthermore, it is not possible to view the entrance point of the burr from 4-5 or 6R portal (5). Instead, the entrance point has to be confirmed using C-arm images

Our technique, which involves the creation of a trans-4 portal for this procedure, resolves these problems, but it may increase the risk of injury of the extensor tendons in the fourth compartment. The most significant complications in wrist arthroscopy are tendon and nerve damage that occurs during portal entry (3, 9, 10). Previous cadaveric studies proved that there is a small risk of sensory branch injury on the fourth compartment at the wrist level (9, 11). Therefore, we focused on the possibility of tendon injuries during the use of this working portal. We used retractors to protect THE extensor tendons. There was no tendon injury in our study. The decompression hole was central and was along the long axis of the lunate in 15 of the 17 wrists. This cadaveric study clearly proves the safety of this portal. In addition, by changing the scope to this portal, it is possible to perform osteoscopy of the decompressed lunate.

Demonstrating the safety of this portal will increase the indications for its use in arthroscopic procedures on the lunate bone and lunate fossa, for example, curettage of lunate ganglion cysts and debridement of the lunate fossa in radio-lunate arthritis.

However, this portal has some drawbacks, such as a short distance between the portal and 3 - 4 and 6R portals. Working is more difficult when the arthroscopic portal and the working portal are close to each other. Although the dorsal aspect of the fourth extensor compartment is

the safest part of the dorsal wrist for creating a portal with respect to the sensory cutaneous nerve branches, we did not evaluate possible injury to the terminal branch of the posterior interosseous nerve in our procedure. We also did not compare lunate decompression through the trans-4 with 3 - 4 or 6R portal in our study.

The trans-4 portal is a safe portal in wrist arthroscopy for working on the lunate and lunate fossa. Using this portal can simplify and increase indications for wrist arthroscopy interventions.

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Footnote

Authors' Contribution: Reza Shahryar-Kamrani and Hossein Saremi developed the original idea and the protocol, Hossein Saremi and Leila Oryadi-Zanjani abstracted and analyzed data, and wrote the manuscript, Mohammad Hossein Nabian, Azita Amoozadeh and Amir Hossein Moradi contributed to the development of the protocol and prepared the manuscript.

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