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Distal interosseous oblique bundle reconstruction with a brachioradialis tendon strip according to Aita-Mantovani technique: description of a case of misdiagnosed volar DRUJ dislocation and review of the literature

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Summary

Volar distal radioulnar joint (DRUJ) dislocation is a very rare condition, and up to 50% of cases are misdiagnosed at the emergency room, because of subtle clinical findings and inadequate evaluation of radiographs in emergency settings. Treatment options vary from closed reduction with immobilization in a pronated position, to open reduction and repair of DRUJ stabilizers in case of locked irreducible or chronic dislocation, as well as in case of unstable DRUJ after an attempt at closed reduction. Among surgical procedures, the Aita-Mantovani technique of distal oblique bundle repair with a brachioradialis tendon strip can fully restore the multiplanar stability of the distal radio-ulnar joint. We present a case of an inveterate volar DRUJ dislocation, where the ulnar head was stuck out of the sigmoid notch, which was managed with open reduction and distal oblique bundle restoration according to the Aita-Mantovani technique.

Key words: distal radioulnar joint (DRUJ), volar DRUJ dislocation, locked forearm rotation, distal interosseous oblique bundle (DOB), DOB reconstruction, Aita-Mantovani technique

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Introduction

Volar distal radioulnar joint (DRUJ) dislocation is a very rare condition, with literature the literature consisting of only a few case reports. Moreover, misdiagnosis of a volar DRUJ dislocation is not uncommon, accounting up to 50% of cases, because of the rarity of the injury with subtle clinical findings and inadequate evaluation of radiographs in emergency settings.

The traumatic mechanism is generally hypersupination of the forearm with the wrist stuck in a fixed position or a direct trauma to the DRUJ in a posterior to anterior

direction. The most prominent clinical findings of a volar DRUJ dislocation are wrist pain, absence of the dorsal ulnar head prominence, and limitation in forearm rotation.
Treatment options vary from closed reduction with immobilization in a pronated position, four-to-six weeks, to open reduction and repair of DRUJ stabilizers in case of locked irreducible or chronic dislocation, as well as in case of unstable DRUJ after an attempt of closed reduction. However, there still no established guidelines for the management of this lesion, primarily due to its rarity.
We present a case of a missed volar DRUJ dislocation where the ulnar head was stuck out of the sigmoid notch.

Case report

An 18-year-old woman presented to the hand surgery department with one-month-long right wrist pain due to a blunt trauma. Actually, one month earlier, when suffering from the accident, she had approached the emergency department, where radiographs of the wrist were prescribed, but unfortunately were incorrectly interpreted. Therefore, she was discharged with a diagnosis of wrist sprain, managed with a short volar forearm splint. After an intermediate orthopedic consultation, she was referred to a hand surgeon. At the time of presentation at the hand surgery department, her wrist was tender to palpation, no ulnar head was palpable at the dorsal aspect of the joint, and the wrist was stuck in mid-prone position, with impossibility to active prono-supination and severe pain to attempts at passive movement. Only mild flexion-extension movement of the wrist was actively present. No neurological symptoms were appreciated. No medical history of hyperlaxity was found. Comparative bilateral x-ray images were promptly done, revealing a volar DRUJ dislocation with an overlap of the ulnar head with the ulnar corner of the distal radius in a PA view (Fig. 1). In addition, she underwent a CT scan and MRI. The CT clearly showed a locked volar dislocation of the ulnar head engaged with the volar corner of the sigmoid notch (Fig. 2), while the MRI revealed soft tissue edema around the ulnar head with mild subchondral edema, caused by the impaction injury. A partial TFCC dorsal tear was detected, together with a lesion of the distal portion of the interosseous membrane.
The patient was taken to the operating room and, under axillary block, after an unsuccessful attempt of closed reduction

Figure 1. A-B) Postero-anterior and C) true lateral radiographs of the injured wrist. Notice overlap between the radius and ulna on the PA view and slight anterior position of the ulna in relation to the carpal bones on the lateral view. Select coronal cut (c) of the forearm clearly show tantalizer the ulnar head is dislocated outside of the sigmoid notch and impacted on the radius.

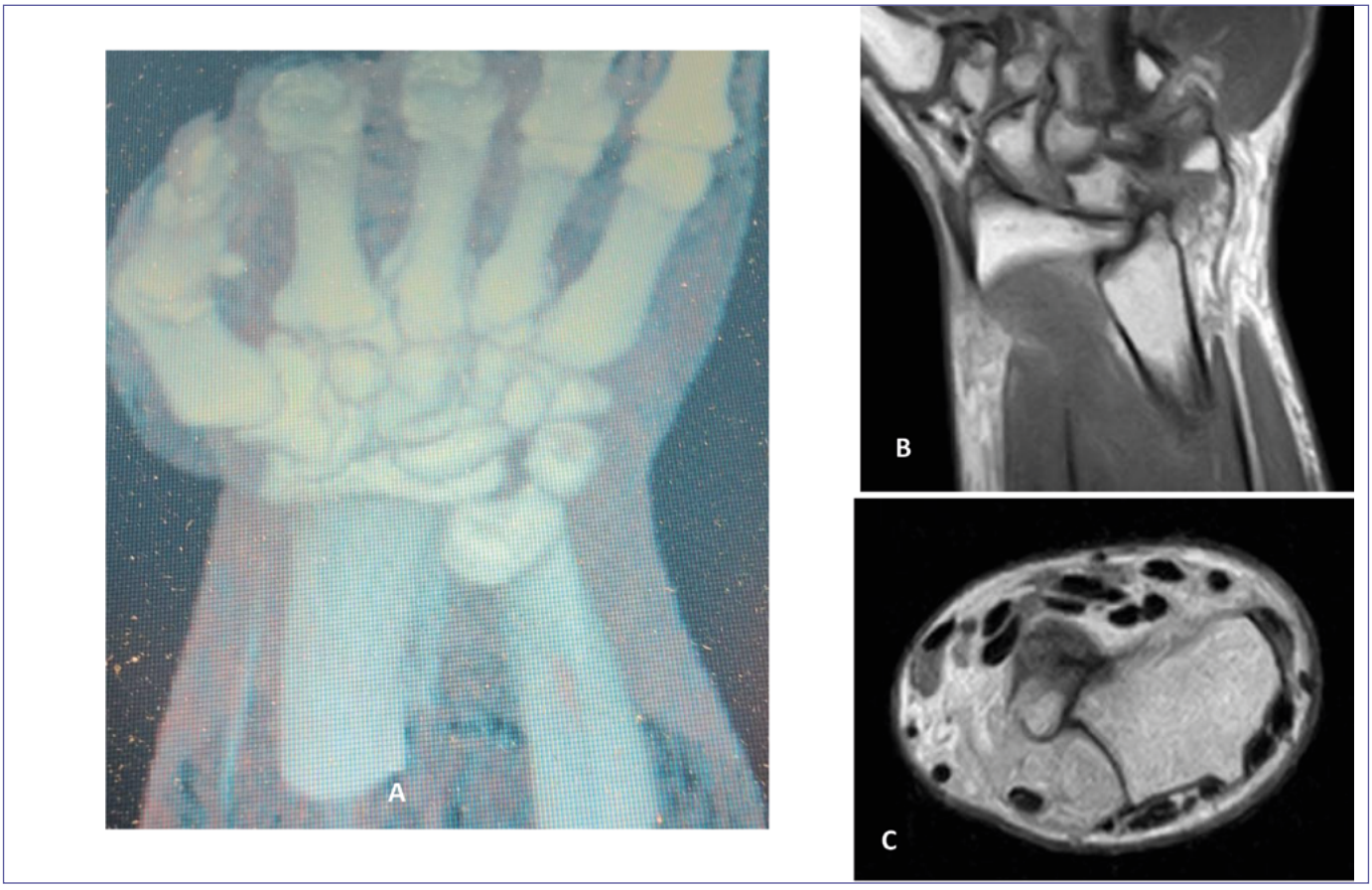

Figure 2. A) Volar view of a 3D CT scan; B) coronal view and C) axial view of a MRI of the wrist, showing a locked volar dislocation of the ulnar head engaged with the volar corner of the sigmoid notch.

by forceful pronation, she underwent an open reduction procedure. A longitudinal ulno-volar wrist incision was chosen, with ulnar neurovascular bundle protection and fine soft tissue dissection, up to the pronator quadratus exposition. Right after the release of the tight pronator quadratus and a mild superficial release of the volar DRUJ capsule, the caput ulnae reduction was obtained, but, while testing the validity of the reduction in extreme supination, the volar dislocation reappeared, defining a case of complex DRUJ instability. Therefore, we chose to perform a distal oblique bundle (DOB) reconstruction through the Aita-Mantovani approach [1].

A second dorso-radial wrist incision, just proximal to the brachioradialis insertion, was made, and the brachioradialis tendon was lifted up to the myotendinous junction and a 2.5 mm hemitendon strip was harvested by leaving its distal insertion. Next, a radio-ulnar transosseous tunnel was performed in a slight oblique direction, in a proximal to distal fashion, with a 2.7 mm cannulated drill, both under a fluoroscopy guide and through direct visualization, as much as the volar approach allowed. The brachioradialis hemitendon was passed through the bone tunnel and tensioned, while a second operator was testing the stability of the DRUJ by performing the ulnar drawer test in maximal pronation and supination. Finally, the tendon strip was fixed to the distal ulnar diaphysis with a bone anchor, and the DRUJ was stabbed in mid-pronation with a blocking transverse K-wire.

A sugar-tong cast was applied and kept for three weeks, and a follow-up X-ray exam was conducted to confirm the reduction of the DRUJ at the time of K-wire removal. A rehabilitation protocol was initiated with isometric strengthening to DRUJ dynamic stabilizers and co-contraction of extensor and flexor carpi ulnaris, followed by cautious reintroduction of weight-bearing and passive prono-supination movements.

The patient was clinically and radiographically reassessed after 6 and 12 weeks by testing the anatomical position of the ulnar head, relative to the distal radius, and the complete ossification of the bone tunnels, meaning a satisfactory osteointegration of the tendon graft (Fig. 3).

Progressively, over 3 months, the patient had regained wrist stability with complete flexion-extension movement, axial loading on the wrist, and neuromuscular control; the rotation of the forearm was painless and the pronation was complete,

Figure 3. Radiographical assessment at A) the 6th and B) the 12th week show the anatomical position of the ulnar head, relative to the distal radius, and the complete ossification of the bone tunnels, as to say a satisfactory osteointegration of the tendon graft.

while the supination lacked in the final 20° compared to the contralateral uninjured side (Fig. 4).
The quick DASH score at the final follow-up check at 4 months was 0.

Discussion

Epidemiology

As opposed to a dorsal dislocation of the ulnar head at the distal radioulnar joint (DRUJ), an event that is quite common, especially in association with distal radius fractures, volar DRUJ dislocation is a very rare condition, with literature knowledge consisting of only case reports [2,3].
Therefore, there is no clear epidemiological information about the incidence of this injury. Moreover, misdiagnosis of a volar DRUJ dislocation is not uncommon, accounting for up to 50% of cases, because of the rarity of the injury with subtle clinical findings and inadequate evaluation of radiographs in emergency settings [4,5].

Physiopathology

The anatomic features of the radial notch, with its larger arc of articular surface, and the ulnar head, with its smaller arc, allow the caput ulnae to translocate over the DRUJ during the forearm rotation by slightly sliding volarly in supination [6]. As this occurs, the superficial volar and the deep dorsal radio-ulnar ligaments tighten while the deep volar and superficial dorsal fibers become lax [7]. Therefore, hypersupination movements can lead to volar DRUJ dislocation because of a tear of the deep dorsal radio-ulnar joint and the volar capsule. Direct trauma to the DRUJ in a posterior-to-anterior direction, such as a fall on an outstretched hand, is another possible mechanism of injury. The traumatic energy can lead to the disruption of the static DRUJ stabilizers, i.e. the ulnar collateral ligament, the anterior and posterior radio-ulnar ligaments, the triangular fibrocartilage discus, and the distal oblique bundle (DOB) of the interosseous membrane (IOM), as well as the dynamic stabilizers, or the pronator quadrates and the extensor carpi ulnaris [3,8]. These stabilizing structures, when injured and displaced by the trauma, may become entrapped at the level of the sigmoid notch, impeding close reduction of the DRUJ.

Figure 4. Functional outcomes at three months post-op: the rotation of the right forearm was painless, the pronation was complete, while the supination lacked in the final 20° compared to the contralateral uninjured side.

Clinical presentation

Clinical findings of a volar DRUJ dislocation consist of the disappearance of the ulnar head profile on the dorsal wrist, associated with a dimple sign on the dorsal-ulnar side of the wrist, together with a limitation in prono-supination movement of the forearm. Despite the fact that these are the most relevant clinical signs of a volar DRUJ dislocation, they are not always evident in an acute traumatized wrist, and the overall appearance should bring out the suspicion of a blocked volar dislocation of the ulnar head [4].

It is also important to exclude, at the time of clinical evaluation, any possible complications of a volar DRUJ dislocation, such as subcutaneous traumatic rupture of the extensor digitorum communism and/or extensor digiti minimi at the musculotendinous junction [9].

Radiographic imaging

Despite the high rate of misdiagnosis in up to 50% of cases, the suspicion in the presence of an evident clinical deformity of the wrist and the lock of forearm rotation may orient diagnosis. A true lateral X-ray view in a strictly neutral position, especially if compared to the contralateral uninjured side, can show a mismatch in coaxiality of the volar cortex of distal radius and ulna due to the loss of overlap of the ulnar head on the sigmoid notch. Meanwhile, in a postero-anterior view, a slight overlap of the ulnar head over the ulnar corner of the distal radius, due to the pull of the pronator quadratus, can also be seen [6]. Furthermore, the central projection of the ulnar styloid is atypical, consistent with a hypersupinate forearm.

Despite all these claims, a volar DRUJ dislocation may pass misdiagnosed on X-rays mainly because of the poor execution of the exam. Therefore, good execution of a true lateral radiograph should be confirmed by evaluating the scapho-piso-capitate relationship. The volar cortex of the pisiform should project within the interval between the volar cortices of the capitate and distal pole of the scaphoid, ideally within the central third of this interval [10]. Rotation of as little as 10° can lead to false negatives or positives in terms of DRUJ injuries. In other words, it may lead to an inaccurate diagnosis [11]. However, it is also correct to say that an X-ray exam can be difficult to accurately perform in a patient suffering from a DRUJ dislocation due to poor compliance of the patient affected by severe pain and functional limitations.

In general, it can be concluded that any unclear volar displacement of the ulna beyond the volar cortex of the radius on an appropriate lateral view should raise the suspicion of DRUJ displacement and bring the clinician to further investigations [12].

CT may be helpful in confirming diagnosis and may add later information in the case of an unreducible joint, such as in the case of an engagement of the ulnar head to the radial notch or eventual osteochondral impaction fractures, similar to a Hill-Sachs lesion [13,14]. On the other hand, MRI gives important details about potential soft-tissue injuries or interpositions, which may help to determine the appropriate management [6,15].

Treatment options

The first treatment option, in case of an acute volar DRUJ dislocation, is closed reduction with extreme pronation and cast immobilization with the forearm in neutral or semi-pronated position [5,16,17]. The maneuver can be performed under conscious sedation or by means of an axillary block in order to release the contraction of the pronator quadratus and, consequently, to avoid excessive pressure directly on the volar aspect of the ulnar head, which can provoke a compression injury of the ulnar neurovascular bundle [18]. Previous reports recommend immobilization for 6-8 weeks in order to allow TFCC and the interosseous membrane to heal [16]. However, in cases of residual DRUJ instability at the ulnar drawer test, radio-ulnar K-wire transfixation seems to be crucial to restore stability, leaving the K-wire arthrodesis until capsule and soft tissue complete healing.

Failed closed reduction and residual instability can be caused by capsulo-ligamentous or tendinous interposition (extensor carpi ulnaris, extensor digitorum communis to the ring and little finger, extensor digiti minimi, flexor pollicis longus), as well as by a stuck ulnar head impacted to the radial notch or by a vigorous retraction of the pronator quadratus [4,19,20].

On the other hand, some authors advocate surgical repair of capsular ligaments and TFCC irrespective of whether closed or open reduction had been performed, especially in young patients. Actually, the integrity of the capsulo-ligamentous structures is essential to achieve perfect clinical results [15].

Treatment options for inveterate cases

In case of long-lasting misdiagnosed cases, as well as in case of secondary DRUJ dislocation, it may be necessary to perform salvage procedures like resection of the distal extremity of the ulna (Darrach procedure) or osteotomy of the distal ulnar metaphysis and DRUJ arthrodesis (Sauvé-Japandji procedure) [21,22]. However, modern studies have focused on the beneficial effects of restoring the DOB in cases of chronic DRUJ instability, using both suture buttons and tendon grafts [23-27].

Among these techniques, it is worth to remember DOB reconstruction procedures by using the brachioradialis tendon, while keeping its distal insertion onto the radial styloid [28-30]. The advantages of these techniques are the use of a forearm tendon, whose removal does not affect upper limb function, and the ease to properly tense the graft during the bone tunnel passage, thanks to the preservation of the brachioradialis insertion [31,32].

The latest technique of ligament reconstruction of the distal IOM by using the brachioradialis, published in 2018 by Aita et al., simplified the surgical steps compared to previous studies, and had better respected the pathophysiology of the distal forearm [1].

Aita-Mantovani technique

The physiopathological idea behind this technique is that, among the dynamic wrist stabilizers, the distal interosseous oblique bundle (DOB) plays an important role in DRUJ restraint. In fact, a complete dissociation of the DRUJ does not occur unless there is a tearing of the DOB. Some biomechanical studies have shown the DOB to be a major restraining structure of the DRUJ against volar dislocation, while the IOM to have a primary constraining effect on dorsal DRUJ stability [33,34]. The stabilizing effect of the DOB should be identified in its insertion on the volar osteocartilagenous lip of the sigmoid notch, acting as a hammock against any dorso-palmar shifting effect on DRUJ [31,35]. Moreover, the DOB appears to present a continuity with the radio-ulnar ligaments of the triangular fibrocartilage complex.

According to Moritomo's studies on the distal interosseous membrane, apart from the DOB, which extends from the proximal margin of the ulnar head up to its insertion on the proximal part of the dorsal rim of the sigmoid notch of the radius, there is another entity that takes part in the stability effect on the DRUJ, named "distal radio-ulnar tract", previously described by Gabl et al. [36-38]. It extends from the radial shaft proximally, about 22 mm proximal to the distal dorsal corner of the sigmoid notch, to the dorsal capsule of the DRUJ, running in an opposite direction to the DOB [39]. It has been estimated to have a considerable variation in shape and dimensions, about 8 mm wide (4-12 mm), 31 mm long (25-50 mm), and 1.0 mm thick (0.6-1.3 mm). This tract represents an important constraining element against palmar dislocation of distal ulna.

Previous cadaveric biomechanical studies demonstrated that the DRUJ is not affected by dislocation as long as the distal IOM remains intact, even if the TFCC is completely sectioned. Furthermore, the degree of displacement of the distal ulna relative to the radius is directly proportioned to the percentage of damage to the distal IOM.

Starting from this acknowledgement, Aita and Mantovani in their biomechanical studies showed that the restoration of the distal radio-ulnar tract, with its disto-proximal inclination opposite to the DOB's one, has a higher stability effect on the DRUJ when longitudinal forces are applied. Therefore, they identified an expendable tendon that can be grafted, while keeping its distal insertion, i.e. the brachioradialis, to restore the stability of the DRUJ in case of a major instability. The tendon should be grafted entirely up to the myotendinous junction, and then the graft is shaped in dimension in order to reach a diameter slightly inferior to 3.5 mm, which is the dimension of the bit chosen for bone drilling. Bone tunnels should be placed in a 20° to 30° angle with respect to the long axis of the ulna, replicating the anatomy of the native distal IOM, or in other words, the native distal radio-ulnar tract (Fig. 5). The forearm should be placed in a neutral position, as it is the optimal position to tighten the graft in order to obtain the greatest strengthening properties. The proximal end of the tending graft is retrieved through the bone tunnel, properly tensioned, and secured through a knotless anchor placed over the distal ulnar metaphysis.

Actually, in the case report reported, a slight modification of the original technique was applied, as the bone tunnels were

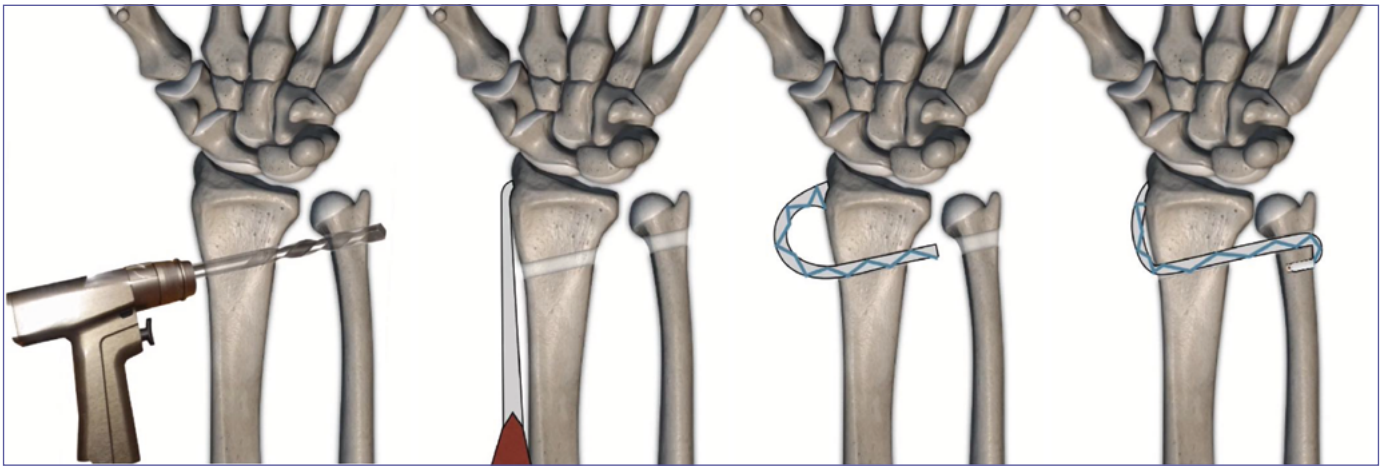

Figure 5. Bone tunnel performing, by placing the drill in a 20° to 30° angle with respect to the long axis of the ulna, in order to replicate the anatomy of the native DOB. The procedure should be performed either in full supination or in neutral position, than securing the graft to the distal ulna throught a knotless anchor (by kind permission of Aita MA and Mantovani G. 1.

performed with a 2.7 mm drill bit instead of a 3.5 mm, because of the globally small dimension of the wrist of the patient,. Therefore, this it was harvested a hemitendon graft of 2.5 mm in thickness instead of the whole tendon, with the consequent effect of no functional forearm flexion deficit.

Another technical trick that was employed during surgery was to insert a 14-G needle into the radio-ulnar bone tunnel, through which a Prolene 2/0 loop was passed to grab the end of the brachioradialis hemitendon in order to pass it easily along the tunnel [40].

No tendon loosening was noticed during follow-up, despite the slight undersize of the graft compared with the original technique. In the case reported of a one-month inveterate volar DRUJ dislocation, MRI showed impaction injury of the ulnar head and radial notch with a partial TFCC tear, which did not require additional intervention [41].

As the joint appeared perfectly stable at the end of the procedure, it seemed acceptable to propose a short period of immobilization in order to start physiotherapy after 3 weeks [42]. This management also yielded good results in our patient.

Conclusions

In case of a volar DRUJ dislocation, a possible therapeutical strategy, combined with an open reduction of the DRUJ, is DOB reconstruction through the Aita-Mantovani procedure, which may provide favorable results without prolonged immobilization and thanks to early rehabilitation. For the exact management algorithm of this type of injury, further case series are needed to definitively demonstrate the validity of the technique.

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Conflict of interest statement

The authors declare no conflict of interest.

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Author contributions

MP (first author): mainly wrote this manuscript and performed the acquisition, analysis and interpretation of data; DDF, LC, AL (corresponding authors): mainly performed the conception and design of this study. All Authors read and approved the final manuscript.

Ethical consideration

The research was conducted ethically, with all study procedures being performed in accordance with the requirements of the World Medical Association's Declaration of Helsinki. Written informed consent was obtained from each patient for study participation and data publication.

References

[1] Aita MA, Mallozi RC, Ozaki W, et al. Ligamentous reconstruction of the interosseous membrane of the forearm in the treat-

ment of instability of the distal radioulnar joint. Rev Bras Ortop 2018;53:184-191. https://doi.org/10.1016/j.rboe.2018.02.010
2 Sonohata M, Mine H, Tsuruta T, et al. Traumatic volar dislocation of the distal ulna with a fracture of the ulnar styloid. Hand Surg 2012;17:383-386. https://doi.org/10.1142/S0218810412720379
3 Kaya O, Ozkunt O, Kurt I. A case report of volar dislocation of ulnar head: a very rare wrist injury easy to overlook and easy to diagnose. J Orthop Case Rep 2021;11:70-73. https://doi.org/10.13107/jocr.2021.v11.i07.2322
4 Bouri F, Fuad M, Elsayed et al. Locked volar distal radioulnar joint dislocation. Int J Surg Case Rep 2016;22:12-14. https://doi.org/10.1016/j.ijscr.2016.03.012
5 Starnoni M, Colzani G, De Santis G, et al. Management of locked volar radio-ulnar joint dislocation. Plast Reconstr Surg Glob Open 2019;7:E2480. https://doi.org/10.1097/GOX.0000000000002480
6 Duryea DM, Payatakes AH, Mosher TJ. Subtle radiographic findings of acute, isolated distal radioulnar joint dislocation. Skeletal Radiol 2016;45:1243-7124. https://doi.org/10.1007/s00256-016-2411-x
7 Hagert E, Hagert CG. Understanding stability of the distal radioulnar joint through an understanding of its anatomy. Hand Clin 2010;26:459-466. https://doi.org/10.1016/j.hcl.2010.05.002
8 Gofton WT, Gordon KD, Dunning CE, et al. Soft-tissue stabilizers of the distal radioulnar joint: an in vitro kinematic study. J Hand Surg Am 2004;29:423-431. https://doi.org/10.1016/j.jhsa.2004.01.020
9 Kameyama M, Shiraishi T. Traumatic rupture of the extensor digitorum communis and extensor digiti minimi at the musculotendinous junction associated with volar dislocation of the distal radioulnar joint – A case report. Hand Surg 2000;5:165-168. https://doi.org/10.1142/s0218810400000284
10 Goldfarb CA, Yin Y, Gilula LA, et al. Wrist fractures: what the clinician wants to know. Radiology 2001;219:11-28. https://doi.org/10.1148/radiology.219.1.r01ap1311
11 Carlsen BT, Dennison DG, Moran SL. Acute dislocations of the distal radioulnar joint and distal ulna fractures. Hand Clin 2010;26:503-516. https://doi.org/10.1016/j.hcl.2010.05.009
12 Amrami KK, Moran SL, Berger RA, et al. Imaging the distal radioulnar joint. Hand Clin 2010;26:467-475. https://doi.org/10.1016/j.hcl.2010.07.001
13 Nakamura R, Horii E, Imaeda T, et al. Criteria for diagnosing distal radioulnar joint subluxation by computed tomography. Skeletal Radiol 1996;25:649-653. https://doi.org/10.1007/s002560050152
14 Henmi S, Yonenobu K, Akita S, et al. Diagnosis of distal radioulnar joint subluxation in patients with rheumatoid wrist by computed tomography. Mod Rheumatol 2007;17:279-282. https://doi.org/10.1007/s10165-007-0603-x
15 Dukan R, Kassab Hassan S, Delvaque JG, et al. Isolated Volar dislocation of the distal radioulnar joint: a case report. J Orthop Case Rep 2020;10:97-100. https://doi.org/10.13107/jocr.2020.v10.i02.1716
16 Larrivée S, Matthewson G, Barron L. Closed reduction of an acute volar dislocation of the distal radio-ulnar joint by a modified technique. Case Rep Orthop 2018;2018:4289406. https://doi.org/10.1155/2018/4289406
17 Tarallo L, Adani R, Catani F. Closed reduction of acute volar dislocation of the distal radioulnar joint. J Hand Surg Eur Vol 2013;38:572-574. https://doi.org/10.1177/1753193412474400
18 Glazier MT, Schuette HB, Schnee BA, et al. Isolated volar dislocation of the distal radioulnar joint treated with successful closed reduction. Cureus 2021;13:E15656. https://doi.org/10.7759/cureus.15656
19 Poppler LH, Moran SL. Acute distal radioulnar joint instability: evaluation and treatment. Hand Clin 2020;3:429-441. https://doi.org/10.1016/j.hcl.2020.07.005
20 Iannuzzi NP, Kollitz KM, Huang JI. Acute distal radioulnar joint instability in adults: a critical analysis review. JBJS Rev 2014;2:E2. https://doi.org/10.2106/JBJS.RVW.M.00110
21 Nakamura R, Tsunoda K, Watanabe K, et al. The Sauvé-Kapandji procedure for chronic dislocation of the distal radio-ulnar joint with destruction of the articular surface. J Hand Surg Br 1992;17:127-132. https://doi.org/10.1016/0266-7681(92)90071-9
22 Moore R, O'Leary R, Gonzalez G, et al. Sauvé-Kapandji and darrach salvage procedure rates and perioperative parameters for distal radioulnar joint arthritis and instability. Hand (NY) 2022;17:6S-11S. https://doi.org/10.1177/15589447221092055
23 Mau M, Livingstone J, Lee G, et al. Optimizing the orientation of a suture button to stabilize the distal radioulnar joint in a sawbones model. J Hand Surg Glob Online 2022;4:355-359. https://doi.org/10.1016/j.jhsg.2022.06.007
24 Satria O, Abubakar I, Novera D. Double suture-button reconstruction for chronic volar dislocation of distal radioulnar joint: A case report. Ann Med Surg (Lond) 2022;82:104705. https://doi.org/10.1016/j.amsu.2022.104705
25 Hsiao YN, Chien CS, Wu TM. Treatment of acute distal radioulnar joint instability with distal oblique bundle augmentation of the interosseous membrane by suture-button suspension: a case series. Jt Dis Relat Surg 2022;33:658-665. https://doi.org/10.52312/jdrs.2022.765
26 Brink PR, Hannemann PF. Distal oblique bundle reinforcement for treatment of DRUJ instability. J Wrist Surg 2015;4:221-228. https://doi.org/10.1055/s-0035-1556856
27 Kang L, Patel Y. Technique of tendon interposition arthroplasty for chronic volar dislocation of the distal radioulnar joint. J Hand Surg Am 2019;44:621.E1-621.E7. https://doi.org/10.1016/j.jhsa.2019.01.007
28 Charlotte G, Honecker S, Xavier F, et al. Acute Essex-Lopresti Syndrome: about a case of brachioradialis tendon transfer. J Wrist Surg 2021;11:76-80. https://doi.org/10.1055/s-0041-1729759
29 Riggenbach MD, Wright TW, Dell PC. Reconstruction of the distal oblique bundle of the interosseous membrane: a technique to restore distal radioulnar joint stability. J Hand Surg Am 2015;40:2279-2282. https://doi.org/10.1016/j.jhsa.2015.08.019
30 Riggenbach MD, Conrad BP, Wright TW, et al. Distal oblique bundle reconstruction and distal radioulnar joint instability. J Wrist Surg 2013;2:330-336. https://doi.org/10.1055/s-0033-1358546
31 Low SL, Clippinger BB, Landfair GL, et al. A biomechanical evaluation of the DRUJ after distal oblique bundle reconstruction. J Hand Surg Am 2020;45:452.E1-452.E8. https://doi.org/10.1016/j.jhsa.2019.10.011
32 Boland MR, Spigelman T, Uhl TL. The function of brachioradialis. J Hand Surg Am 2008;33:1853-1859. https://doi.org/10.1016/j.jhsa.2008.07.019
33 Watanabe H, Berger RA, Berglund LJ, et al. Contribution of the interosseous membrane to distal radioulnar joint constraint. J Hand Surg Am 2005;30:1164-1171. https://doi.org/10.1016/j.jhsa.2005.06.013

[34] Nakamura T, Yabe Y, Horiuchi Y. Functional anatomy of the interosseous membrane of the forearm - Dynamic changes during rotation. Hand Surg 1999;4:67-73. https://doi.org/10.1142/s0218810499000034

[35] Tolat AR, Stanley JK, Trail IA. A cadaveric study of the anatomy and stability of the distal radioulnar joint in the coronal and transverse planes. J Hand Surg Br 1996;21:587-594. https://doi.org/10.1016/s0266-7681(96)80136-7

[36] Moritomo H. The distal interosseous membrane: current concepts in wrist anatomy and biomechanics. J Hand Surg Am 2012;37:1501-1507. https://doi.org/10.1016/j.jhsa.2012.04.037

[37] Moritomo H. The distal oblique bundle of the distal interosseous membrane of the forearm. J Wrist Surg 2013;2:93-94. https://doi.org/10.1055/s-0032-1333428

[38] Gabl M, Zimmermann R, Angermann P, et al. The interosseous membrane and its influence on the distal radioulnar joint. An anatomical investigation of the distal tract. J Hand Surg Br 1998;23:179-182. https://doi.org/10.1016/s0266-7681(98)80170-8

[39] Moritomo H. The Function of the distal interosseous membrane and its relevance to the stability of the distal radioulnar joint: an anatomical and biomechanical review. Handchir Mikrochir Plast Chir 2015t;47:277-280. https://doi.org/10.1055/s-0035-1545348

[40] Carozzo M, Pajardi G, Basso MA, et al. Transosseous cannula suture suspensionplasty for thumb basal joint arthritis: a novel technique. Tech Hand Up Extrem Surg 2023;27:140-147. https://doi.org/10.1097/BTH.0000000000000426

[41] Köroglu M, Özdeş HU, Taşkıran G, et al. Acute isolated volar distal radioulnar joint dislocation: first surgery or conservative?. Trauma Case Rep 2023;48:100952. https://doi.org/10.1016/j.tcr.2023.100952

[42] Werthel JD, Masmejean E, Silvera J, et al. Acute isolated volar dislocation of the distal radio-ulnar joint: case report and literature review. Chir Main 2014;33:364-369. https://doi/org/10.1016/j.main.2014.06.001