CASE REPORT

Bali Medical Journal (*Bali MedJ*) 2022, Volume 11, Number 3: 1897-1902
P-ISSN.2089-1180, E-ISSN: 2302-2914

Complex distal radius fracture (CDRF) with median nerve injury management using one-stage distraction bridge plate fixation (DBPF) without nerve exploration allows nerve function recovery: a case report

Benedictus Anindita Satmoko[1], Heri Suroto[2*]

[1]Faculty of Medicine, Universitas Gadjah Mada, Yogyakarta, Indonesia;
[2]Orthopedic and Traumatology Department, Faculty of Medicine, Universitas Airlangga/Dr. Soetomo General Hospital, Surabaya, Indonesia;

*Corresponding author:
Heri Suroto;
Orthopedic and Traumatology Department, Faculty of Medicine, Universitas Airlangga/Dr. Soetomo General Hospital, Surabaya, Indonesia;
heri-suroto@fk.unair.ac.id

Received: 2022-09-01
Accepted: 2022-11-12
Published: 2022-12-08

ABSTRACT

Background: Complex distal radius fracture (CDRF) associated with median nerve injury is rarely reported due to low incidence or low recognition rate. Thus, we reported the outcome of using distraction bridge plate fixation (DBPF) in managing CDRF associated with median nerve injury without volar nerve exploration.

Case description: We reported a 67-years old male who sustained pain in the right wrist with dorsal angulated deformation following a fall on an outstretched hand two hours before being admitted to the emergency department. The patient also complained of numbness in all of the fingers except the little finger of the right hand. Posteroanterior (PA)/right lateral X-rays showed grossly dorsal displaced of the comminuted distal radius fracture associated with ulnar styloid avulsion. The diagnosis was a CDRF associated with median nerve injury. He underwent surgery in an emergency setting with DBPF on the dorsal side without opening the fracture site guided by an image intensifier. Early mobilization was started as the patient could tolerate the pain, and neuromuscular electrical stimulation was given twice a week after surgery. Plate removal was done six months after surgery and continued with a range of motion exercise of the right wrist.

Conclusion: It is important to consider the anatomical reduction without additional soft tissue trauma by opening the fracture site and the early emergency surgery decision based on physical examination in CDRF management. The stable fixation allows axonal regeneration after median nerve injury, proved by good nerve functional outcomes. DBPF is suitable for post-operative wound care and decreases costs compared to staged fixation surgery and volar nerve exploration. However, we still need to further investigate this procedure through higher comparison studies.

Keywords: Complex distal radius fracture; distraction bridge plate fixation; median nerve injury.
Cite This Article: Satmoko, B.A., Suroto, H. 2022. Complex distal radius fracture (CDRF) with median nerve injury management using one-stage distraction bridge plate fixation (DBPF) without nerve exploration allows nerve function recovery: a case report. *Bali Medical Journal* 11(3): 1897-1902. DOI: 10.15562/bmj.v11i3.3680

INTRODUCTION

Distal radius fractures are one of the most common types of wrist injuries, and the incidence appears to be increasing worldwide, as more than 640,000 cases were reported in 2001 in the United States alone.[1,2] In Indonesia, 5,5% fracture prevalence was recorded, and antebrachial fractures are more prevalent in children 10-15 years old and geriatric populations. Distal radius fractures account for 25% of children and 18% of geriatric populations.[3]

Complex distal radius fractures (CDRF) are also quite common in our daily practice. CDRFs are high-energy injuries with severe articular disruption, high degrees of comminution, ligamentous instability, and neurovascular injury.[4,5] Neurological complications are rarely accompanied by distal fracture radius, yet median nerve injury has been reported in 5% to 7% of cases of this fracture.[6] Direct injury of the median nerve after distal radius fracture is unusual. The cause of acute or subacute median nerve dysfunction is more common due to hematoma, fracture displacement, swelling, and wrist position. Finding the factors associated with nerve dysfunction and appropriate detection of abnormalities on physical examination, coupled with directed intervention, are the key points in achieving optimal outcomes.[7]

Numerous surgical techniques treat these fractures, including percutaneous pinning, external fixation, and plate fixation. The goals of surgical treatment are anatomic reduction of the distal radius, placement of a stable construct to enable fracture healing, and restoration of normal wrist kinematics. Dorsal bridge plate fixation (DBPF) is the best alternative surgical option for managing high-energy distal radius fracture. It provides early mobilization benefits to the patient by allowing the use of the injured upper extremity for weight-bearing and daily activities.[8,9] DBPF is well-known in recent years for its effectiveness in managing complicated distal radius fractures, such as high-energy trauma with the extensive intra-articular and meta-diaphyseal comminution, fracture instability, multi-trauma requiring immediate upper

extremity weight bearing, and poor bone quality.[10,11] Similar to an external fixator, DBPF relies on ligamentotaxis to provide indirect fracture reduction and provides a relatively less invasive means for advantageous stabilization.[12]

Dorsal bridge plate fixation is a desirable treatment option for multiple reasons. As the plate crosses the radiocarpal joint, ligamentotaxis helps to obtain and maintain the reduction while offloading the joint surface.[12] Possible future reconstruction is allowed due to volar soft tissue preservation. This is useful when the volar soft tissue envelope is not amenable to surgery. Moreover, being placed in the second dorsal compartment, the plate predominantly has minimal contact with the digital extensor muscle tendons. This allows for unhindered digital motion.[13] This paper aims to report the outcomes of using one-stage DBPF in managing CDRF associated with median nerve injury without nerve exploration.

CASE PRESENTATION

Mr. T, a 67-year-old man admitted to the emergency department of dr. Soetomo General Hospital with pain in his right wrist after a fall on an outstretched hand. He fell from a slippery staircase around 2 hours before admission. The pain in the right wrist progressively increased, followed by paresthesia and numbness in all of the fingers of the right hand except the little finger of the right hand. He had no other injuries and no history of diabetes mellitus or other chronic diseases. The patient was an active worker using his dominant right hand before the trauma. The clinical examination showed that the right wrist was swollen and grossly displaced to the dorsal side of the right wrist, with a limited wrist range of movement (ROM) due to the pain, as seen in Figure 1. A significant volar skin tenting could be observed on the right wrist, indicating potential risks of arteries or nerve injuries. Both radial and ulnar arteries were palpable, with good color and warmth of the right hand. The median nerve examination showed the weakness of thumb opposition movement to the other fingers while the patient did the OK sign with his right hand. Hypoesthesia was found on all of the fingers except the little finger during pinprick and light touch objective sensation examination.

Figure 1. After trauma, the clinical picture of the right wrist showed a dorsal deformity of the right wrist (blue arrow) and volar skin tenting that indicates nerve compression (red arrow).

The radiological examination of the X-ray right forearm PA/lateral showed a comminuted distal radius fracture with significant displacement at the dorsal side of the radiocarpal joint, as seen in Figure 2A. The proximal fragments of the distal radius displaced to the volar side with ulnar styloid avulsion. An Electrodiagnostic test was not a routine examination in emergency settings to confirm the median nerve lesion. As we observed from the distal radius fracture configuration, we could consider that median nerve compression was highly possible. The findings of muscle weakness and hypoesthesia in clinical examination led to the diagnosis.

Surgical Procedure

The patient underwent emergency surgery under general anesthesia. Closed reduction under image intensifier continued by mini-open of a dorsal approach using DBPF without opening the fracture site or additional K-wire fixation, as shown in Figure 2B. This allows pure ligamentotaxis fracture reduction by applying a short segment of the small DCP plate of 3.5 mm with two screws placed on the radius bone proximal to the radiocarpal joint and two screws placed on the second metacarpal bone. The exploration of the median nerve from the volar side was not necessary because the realignment of the wrist could simultaneously decompress the nerve.

The distraction was maintained all the time while applying DBPF. Using an image intensifier, the distraction can be evaluated by observing the widening of the

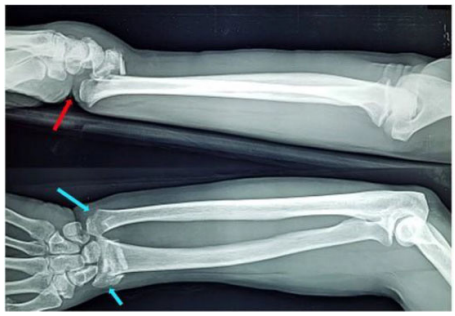

Figure 2A. Preoperative right forearm PA/Lateral X-rays showing the significant dorsal displaced comminuted distal radius fracture with ulnar styloid avulsion (the blue arrows). Volar skin tenting demonstrated from a lateral view indicates the risk of median nerve compression (the red arrow).

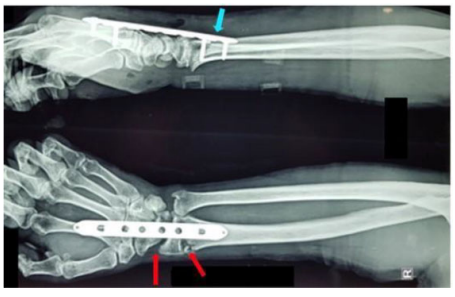

Figure 2B. Post-operative right wrist PA/Lateral X-rays showing a nearly anatomical reduction of the radiocarpal joint using DBPF (blue arrow) with metaphyseal bone defect noted by the widening of radiocarpal joint space (the red arrows).

radiocarpal joint space. The mechanical alignment must prioritize the intermediate column by checking the length and volar tilt. As the intermediate column is the primary load-bearing column of the wrist, the intermediate column evaluation must consider mechanical alignment, articular congruence, and translational stability.

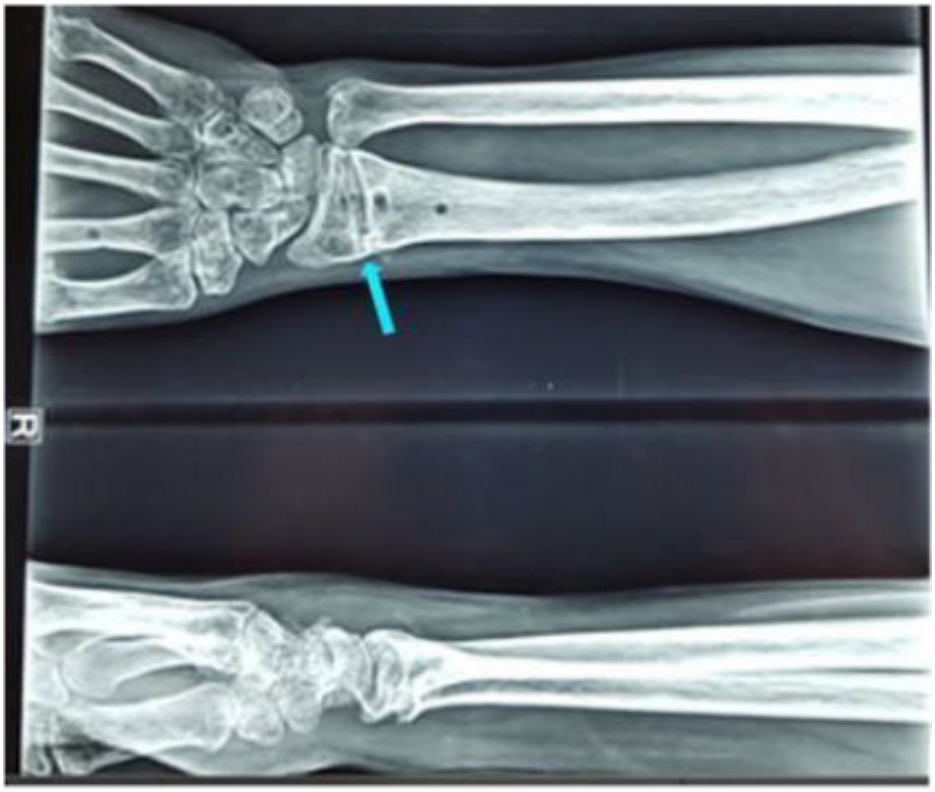

Figure 3. Radiological examination 6 months after trauma following implant removal showing a distal radius consolidation (the blue arrow).

Figure 4. Radiological examination 1 year after trauma showed a distal radius fracture union and congruent radiocarpal joint (the blue arrows).

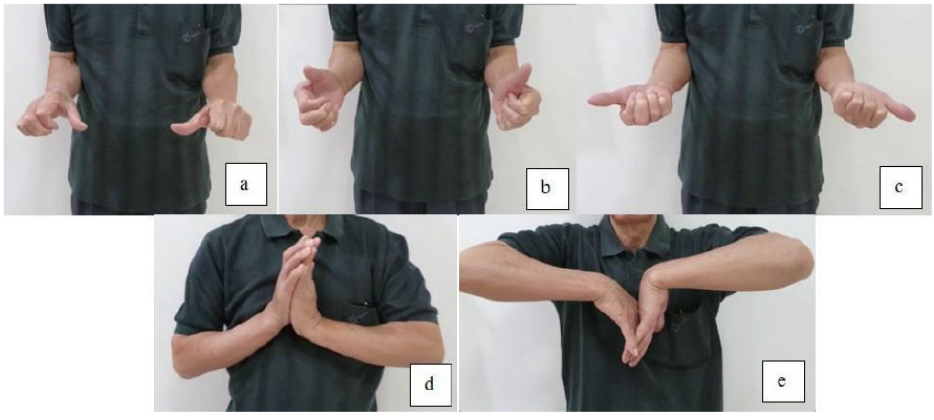

Figure 5. The clinical picture of the wrist range of motion (ROM) from (a) pronation, (b) neutral position, (c) supination, (d) palmar flexion, and (e) dorsal flexion.

A neutral ulnar variant must be achieved because it will prevent the impaction of the ulnocarpal joint and the incongruity of the distal radioulnar joint (DRUJ). The second author performed the surgery. The procedure took one hour, from closed reduction to bandaging the hand and forearm. The radiographic assessment showed that distraction by using ligamentotaxis could be achieved effectively in nearly normal parameters. The results were radial inclination 26°, radial length 12 mm, ulnar variant neutral, and volar tilt 0°, respectively, as seen in Figure 2B.

Post-operative

Post-operative care included gentle active-progressive and active-assisted ROM exercises that allowed flexion and extension of all the fingers and wrist rotation as long as the pain could be tolerated. The dorsal and palmar flexion of the wrist was restricted. The patient came to the orthopedic outpatient clinic for post-operative follow-up evaluation and started the neuromuscular electric stimulation (NMES) 2 weeks after surgery. The NMES was done regarding the post-operative treatment of the median nerve injury. The examination showed the full ROM of all fingers during flexion and extension movements. However, the flexion and extension of the wrist were restricted due to the fixation. Six months after surgery, the patient had no pain or swelling in the right wrist and was admitted to the hospital for implant removal surgery. The radiological examination showed desirable results, as shown in Figure 3. On 1 year after surgery, the clinical examination of the right radiocarpal/wrist joint active ROM results were 90° of supination, 63° of pronation, 53° of dorsal flexion, and 55° of palmar flexion, respectively, as we can see in Figure 5. Although there were some restrictions on flexion and extension of the right wrist, the patient still could do the daily routine activity. The median nerve function, thumb opposition movement, showed full recovery, as seen in Figure 6. The limitation of wrist joint movement complications could be predicted because of past radiocarpal and radioulnar joint instability. DASH Score results were 5.8 points scores.

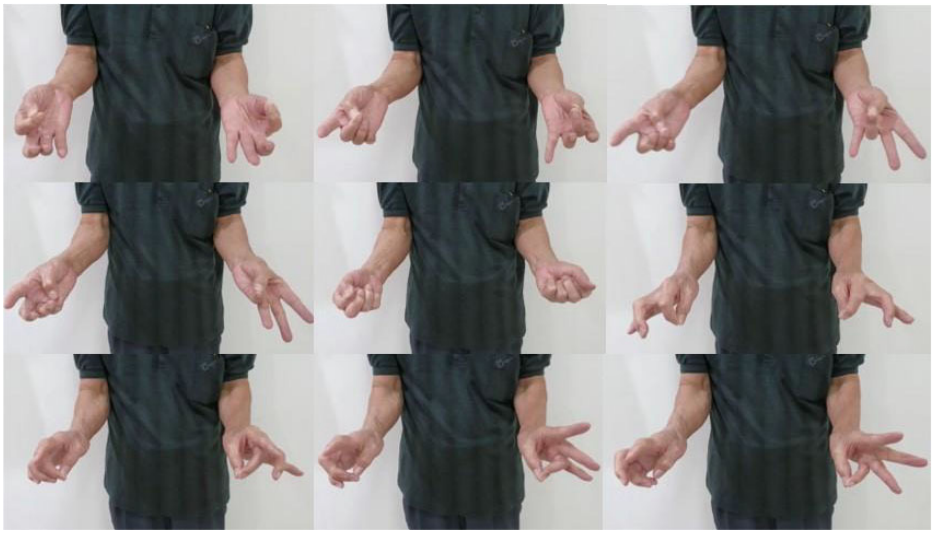

Figure 6. The clinical picture of recovered median nerve function.

The post-operative evaluation was done 6 months and 1 year after trauma to assess clinical results and radiological union of distal radius fracture. The radiological result 6 months and 1 year after trauma can be seen in Figure 3 and Figure 4, respectively. Based on sequential radiological examination, there was no loss of reduction of all parameters until the consolidation of the distal radius fracture. Radiological evaluation results were radial inclination 25°, radial length 12 mm, ulnar variant neutral, and volar tilt 0°, respectively.

The intervention of the bridging plate trans-articularly will cause stiffness in the wrist joint. Yet, it still could achieve some flexion and extension movements of the wrist by using distraction. Surprisingly, this technique gave a full range of supination and pronation movement outcomes. A stable wrist joint also allowed axonal regeneration of the median nerve, which we could observe from the nerve function recovery.

DISCUSSION

Laceration of the median nerve from fractured bone is rare, but several studies have reported the events. The soft tissue protection afforded to the median nerve, relative to the radius, as it lies superficially within the carpal tunnel, protects the median nerve by the pronator quadratus and partially by the flexor pollicis longus and the deep and superficial flexor tendons.[7,14] The lack of a reference standard for diagnosing the median nerve pathology associated with distal radius fracture and the limitation of the current evidence regarding median traumatic neuropathy make acute median neuropathy in patients with distal radius fracture a challenging problem for orthopaedists to treat the fractures. As stated in the distal radius fracture guideline of the American Academy of Orthopaedic Surgeons (AAOS), there are no qualified studies to address any recommendation either for or against nerve decompression surgery in patients with distal radius fractures.[15,16]

The goal of successful CDRF treatment is to restore alignment. Displaced CDRF must be restored in anatomical alignment. Radiographic criteria of acceptable alignment include: (1) less than 2 mm of radial shortening, (2) radial inclination no less than 10 degrees, (3)10° dorsal to 20° volar tilt, and (4) intra articular step-off less than 2 mm.[17,18] The most important factor impacting the long-term outcome of CDRF or highly comminuted radius fractures is anatomic articular surface restoration. The optimal method of fixation for CDRF remains a topic of debate and is often a result of a surgeon's clinical experience. Common methods used to treat CDRF include volar locking plates, fragment-specific implants, external fixation with or without percutaneous pins, and distraction bridge plates.[18] Although volar-locking plates have greatly advanced treatment, it is often unsuitable for stabilizing CDRF, and the external fixator is associated with a high complication rate. K-wire pinning of individual fragments is simple, but it lacks stability, particularly in porotic bone.[19] Arthroscopic-assisted osteosynthesis is a sophisticated technique requiring a highly trained orthopedic surgeon and a special instrument. This technique is not eligible for additional injury of the wrist or forearm.[20,21] The use of a CDRF was initially prompted for intra-articular, comminuted, and displaced (>2mm) distal radius fracture (AO type C3) where the comminuted articular fragments are too small to be captured by the fixation and required stability.[22]

DBPF offers a procedure to stabilize multi-fragmentary articular fractures of the distal radius with minimal complications and similar functional outcomes to the other treatment methods.[23] The disadvantages of DBPF are the need for plate removal, wrist stiffness after prolonged immobilization, and less strength in axial loading compared to volar-locked plating.[8,10,12] Wolf JC et al. reported that DBPF of the radiocarpal joint is an effective treatment method in patients with comminuted radius fractures based on joint distraction compression. The forces are deflected away from the fracture site, followed by its reduction. The application of a direct plate at the dorsal side of the radius provides posterior support.[24] Richard MJ et al. also reported good outcomes with this technique in a cohort of elderly patients with comminuted distal radius fractures of the osteoporotic bone that are not ideal for volar plating.[10] Margaliot Z et al. did not find any statistically significant difference in pooled grip strength, range of motion, or radiographic outcomes between DBRF and non-spanning internal fixation.[25]

In this report, the early decision of emergency surgery based on physical examination becomes crucial in determining the outcomes. The DBPF achieved almost anatomical alignment in CDRF fixation. The DBPF provides stabilization of CDRF by an internal wrist-spanning fixation method. We can assess whether the ligamentotaxis worked properly by the widening radiocarpal joint and neutral ulnar variant. The pure ligamentotaxis fracture reduction in the DBPF procedure allows median nerve decompression on the volar side. In this

case, median nerve exploration is not needed to avoid median nerve fibrosis complications. As reported by Nourbakshs A et al., their case demonstrates that scarring around the median nerve, proximal to the carpal canal, can occur after the palmar approach to the distal radius, leading to progressive median nerve palsy. Many factors, including the skin incision and prolonged use of a self-retaining retractor, also became the cause of median nerve fibrosis.[4] Due to this operation risk report, we consider that single-one DBPF without nerve exploration could be the possible alternative procedure to allow the decompression of the median nerve without risking it into a fibrosis event; moreover, satisfying anatomical alignment could be achieved by this procedure. The distal fixation on the second metacarpal was applied because it is technically easier, faster, and safer for the common extensor tendons than the third metacarpal fixation. Furthermore, it accommodates restoring radial inclination and height.[12,13]

After fixation surgery, the patient could neither flex nor extend the wrist for a moment. Meanwhile, both the rotation movement of the wrist and the finger motion were allowed regarding early mobilization after surgery to avoid stiffness. The one-step of DBPF can solve the instability of radiocarpal and radioulnar joints problems. However, we must focus more on limiting distraction around <5 mm and avoiding extensor tendon tightness. Achieving the neutral ulnar variant and controlling the widening of the radiocarpal joint are the main targets of this procedure to provide desirable outcomes. A distraction bridge plate should be removed after the fracture consolidation has been seen on radiological examination, typically after 3 to 4 months post-surgery. As reported by Sumarwoto T et al., the surgeon must carefully weigh the advantages of early hand function and advice the patient to visit for plate removal 3 to 6 months later.[9,26]

In this case, the DBPF procedure without volar nerve exploration gives excellent functional and radiological outcomes. The accuracy of physical examination and the emergency surgery decision provides the advantage of achieving desirable outcomes. The compressed nerve could be released through pure ligamentotaxis fracture reduction and allow the recovery of median nerve function in the early setting. Stable fixation allows axonal regeneration after median nerve injury. CDRF is usually managed by staged fixation surgery, including external and internal fixation sequentially. DBPF is suitable for post-operative wound care and decreases costs compared to staged fixation surgery.[25,27] However, we still need to conduct a further investigation through higher comparison studies for this procedure. This report has some limitations, such as the electroneuromyography was not conducted to confirm nerve lesion recovery and lacks the intra-operative clinical picture, which could present how the procedure was done.

CONCLUSION

In conclusion, it is important to consider the anatomical reduction without additional soft tissue trauma by opening the fracture site and the early emergency surgery decision based on physical examination in CDRF management. The stable fixation allows axonal regeneration after median nerve injury, proved by good nerve functional outcomes. DBPF is suitable for post-operative wound care and decreases costs compared to staged fixation surgery and volar nerve exploration.

ETHICAL CONSIDERATION

This research was conducted based on the agreement with the patient and signed informed consent regarding publishing his clinical case in an academic journal without exposing his identity.

CONFLICT OF INTEREST

The authors have no conflicts of interest to disclose.

FUNDING

This case report received no specific grant from any funding agency in the public or non-profit sector.

AUTHOR CONTRIBUTION

Both authors contributed equally to the study.

REFERENCES

1. Chung KC, Spilson S V. The frequency and epidemiology of hand and forearm fractures in the United States. J Hand Surg Am. 2001;26(5):908-915.
2. MacIntyre NJ, Dewan N. Epidemiology of distal radius fractures and factors predicting risk and prognosis. J Hand Ther. 2016;29(2):136-145.
3. Gde N, Panji A, Sudharma K, Gede Ekawiratnaya I. Distal Radius Fracture Prevalence Among Geriatric Patient in RSUP Sanglah Denpasar 2013-2014. Med Udayana. 2019;8(10):2597-8012.
4. Nourbakshs A, Tan V. Median nerve fibrosis at the distal forearm after volar plate fixation of distal radius fracture. J Hand Surg Am. 2010;35E(9):768-769.
5. Ficke B, Ransom EF, Hess MC, et al. Outcomes of Staged Treatment for Complex Distal Radius Fractures. Cureus. 2018;10(9).
6. Dauzere F, Delclaux S, Pham TT, Rongières M, Mansat P. Combined median and ulnar nerve palsy complicating distal radius fractures. Orthop Traumatol Surg Res. 2018;104(6):871-875.
7. Dennison DG. Median Nerve Injuries Associated With Distal Radius Fractures. Tech Orthop. 2006;21(1):48-53.
8. Lauder A, Agnew S, Bakri K, Allan CH, Hanel DP, Huang JI. Functional Outcomes Following Bridge Plate Fixation for Distal Radius Fractures. J Hand Surg Am. 2015;40(8):1554-1562.
9. Dodds SD, Save A V., Yacob A. Dorsal Spanning Plate Fixation for Distal Radius Fractures. Tech Hand Up Extrem Surg. 2013;17(4):192-198.
10. Richard MJ, Katolik LI, Hanel DP, Wartinbee DA, Ruch DS. Distraction plating for the treatment of highly comminuted distal radius fractures in elderly patients. J Hand Surg Am. 2012;37(5):948-956.
11. Huang JI, Peterson B, Bellevue K, Lee N, Smith S, Herfat S. Biomechanical Assessment of the Dorsal Spanning Bridge Plate in Distal Radius Fracture Fixation: Implications for Immediate Weight-Bearing. Hand (N Y). 2018;13(3):336-340.
12. Hyatt BT, Hanel DP, Saucedo JM. Bridge Plating for Distal Radius Fractures in Low-Demand Patients With Assist Devices. J Hand Surg Am. 2019;44(6):507-513.
13. Lewis S, Mostofi A, Stevanovic M, Ghiassi A. Risk of tendon entrapment under a dorsal bridge plate in a distal radius fracture model. J Hand Surg Am. 2015;40(3):500-504.
14. Chu C-H, Chih C-J, Wei K-Y, Tsuang Y-H. Entrapment Of Index Flexor Digitorum Profundus And Median Nerve: An Usual Complication Of Distal Radial Fracture - A Case Report. Kaohsiung J Med Sci. 1998;14:303-307.
15. Özkan S, Mudgal CS, Evans BT, Watkins CJ, Heng MM, Bloemers FW. Surgical Decision-Making in Median Neuropathy Associated with Distal Radius Fractures. J Wrist Surg. 2019;08(05):366-373.
16. Bienek T, Kusz D, Cielinski L. Peripheral nerve compression neuropathy after fractures of the distal radius. J Hand Surg Am. 2006;31(3):256-260.

17. Graham TJ. Surgical Correction of Malunited Fractures of the Distal Radius. J Am Acad Orthop Surg. 1997;5(5):270-281.
18. Nana AD, Joshi A, Lichtman DM. Plating of the distal radius. J Am Acad Orthop Surg. 2005;13(3):159-171.
19. Huard S, Blanchet N, Leclerc G, et al. Les fractures du radius distal après 70ans: ostéosynthèse par plaque palmaire ou broches? Chir Main. 2010;29(4):236-241.
20. Varitimidis SE, Basdekis GK, Dailiana ZH, Hantes ME, Bargiotas K, Malizos K. Treatment of intra-articular fractures of the distal radius. J Bone Jt Surg - Ser B. 2008;90(6):778-785.
21. Del Piñal F, Klausmeyer M, Moraleda E, De Piero GH, Rúas JS. Arthroscopic reduction of comminuted intra-articular distal radius fractures with diaphyseal-metaphyseal comminution. J Hand Surg Am. 2014;39(5):835-843.
22. Vakhshori V, Alluri RK, Stevanovic M, Ghiassi A. Review of Internal Radiocarpal Distraction Plating for Distal Radius Fracture Fixation. Hand. 2020;15(1):116-124.
23. Sharareh B, Mitchell S. Radiographic Outcomes of Dorsal Spanning Plate for Treatment of Comminuted Distal Radius Fractures in Non-Elderly Patients. J Hand Surg Glob Online. 2020;2(2):94-101.
24. Wolf JC, Weil WM, Hanel DP, Trumble TE. A Biomechanic Comparison of an Internal Radiocarpal-Spanning 2.4-mm Locking Plate and External Fixation in a Model of Distal Radius Fractures. J Hand Surg Am. 2006;31(10):1578-1586.
25. Margaliot Z, Haase SC, Kotsis S V., Kim HM, Chung KC. A meta-analysis of outcomes of external fixation versus plate osteosynthesis for unstable distal radius fractures. J Hand Surg Am. 2005;30(6):1185.e1-1185.e17.
26. Sumarwoto T, Poetera CY, Abimanyu D. Peripheral nerve injury and its regeneration processes: a biomolecular point of view. Bali Medical Journal. 2021;10(2):927–934.
27. Suyasa IK, Lestari AAW, Prabawa IPY, Marta KKA. Water Sport-Related Spine Injury in Bali: A Review and Preliminary Study. Indonesia Journal of Biomedical Sciences. 2019;13(2):72-76.

This work is licensed under a Creative Commons Attribution