https://doi.org/10.5272/jimab.2024304.5811

Journal of IMAB
ISSN: 1312-773X
https://www.journal-imab-bg.org

Journal of IMAB. 2024 Oct-Dec;30(4)

Case report

NEGLECTED BOTH-BONE FOREARM FRACTURE WITH DISTAL RADIOULNAR JOINT DISLOCATION: A CASE REPORT AND BRIEF LITERATURE REVIEW

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ABSTRACT

Introduction: In this case, we discuss a patient with a neglected and malunited both-bone forearm fracture with distal radioulnar joint dislocation. This pattern of fracture by itself is uncommon, but the initial negligence of this trauma makes it even more rare and challenging for surgical treatment.

Case report: The main aim of the surgery was to restore the forearm's function and anatomy. After thorough preoperative preparation, including planning the level of resections, the patient was treated with open reduction and internal fixation with a limited contact dynamic compression plate. The distal radio-ulnar joint was fixed with 2 K-wires. On control follow-up six months later, the resection sites were fully consolidated, with no visible deformation of the forearm. Pronosupination was restored up to 60% of normal functional arc.

Conclusion: This case has shown that even with careful restoration of forearm anatomy, results of the surgical treatment in neglected and malunited both-bone forearm fracture with distal radioulnar dislocation will not be a priori good or excellent. Surgeons need to remind the patients that the return of the function of the upper limb to the degree before the trauma cannot be guaranteed.

Keywords: Forearm, Galeazzi, Reconstruction, Deformity, Malunion,

INTRODUCTION

In 1934, Ricardo Galeazzi presented a series of 18 patients with a specific fracture pattern to the Lombard Surgical Society [1]. This combination of a radius shaft fracture with a dislocated distal radioulnar joint (DRUJ) is now known by his name [1]. Interestingly, this fracture pattern, originally described by Cooper in 1822, is named after Professor Galeazzi, who thoroughly described the incidence, pathomechanics, and treatment of this specific fracture pattern. [1, 2].

For fractures involving both the radius and ulna with DRUJ dislocation, terms such as Galeazzi-like or Galeazzi-variant fracture are used, following a report by Mikic in 1975 [3, 4, 5], even though this combination was first described by Knight and Purvis in 1949 [6, 7].

Later, Albert SM, et al. (1963) also published a report on DRUJ dislocation with concomitant forearm bone fractures, although the study lacked thorough details [7, 8]. Vesely's research in 1967 similarly did not provide extensive information on the management or outcomes of Galeazzi fractures, only noting that out of 201 cases managed over five years, only six involved both-bone forearm fracture with DRUJ dislocation [7, 9]. Few reports since have been published regarding this special pattern of fracture (including those by Mikic ZD, et al., Dabas V, et al., Ryan MK, et al., Bruckner JD, et al., Budgen A, et al., Jenkins NH, et al., and Vaishya R, et al.), still, none of them have addressed neglected Galeazzi-variant fractures (both-bone forearm fracture with DRUJ dislocation) [3, 5, 7, 10, 11, 12, 13].

The optimal approach for treating acute forearm fractures in adults involves restoring anatomical alignment, ensuring stable internal fixation, and maintaining the blood supply to the periosteum using a limited contact–dynamic compression plate (LC-DCP) [14, 15]. Failing to achieve these goals can result in malunion, nonunion, or pseudoarthrosis, necessitating complex reconstructive surgery [15, 16]. In our case, the challenge and uniqueness arose from the initial neglect of the fracture, which required special reconstructive surgery.

CASE REPORT

A 42-year-old male with a neglected both-bone forearm fracture and DRUJ dislocation came for consultation at the orthopedic clinic.

From medical history, it is known that he suffered an injury to his left forearm around 18 months ago and refused to be admitted to the hospital. With regards to the biomechanics of injury, the patient suffered trauma as a result of direct impact force on the forearm. The patient was hesitant to provide any additional details regarding trauma. The pre-surgical DASH score was 81.7 vs six-month score of 32.5 out 100. DASH outcome measure tool was completed in official Bulgarian language translation and downloaded from the Institute for Work & Health website [17]. It was impossible for the patient to perform active prono-supination before operative treatment.

Before surgical intervention, we measured the angulation and the degree of shortening of the radius.

Preoperatively, we planned the level of adjustment on the radius and ulna and the level of resection of the resulting synostosis between the proximal fragment of the ulna and the distal fragment of the radius.

Fig. 1. a), b) Preoperative X-ray

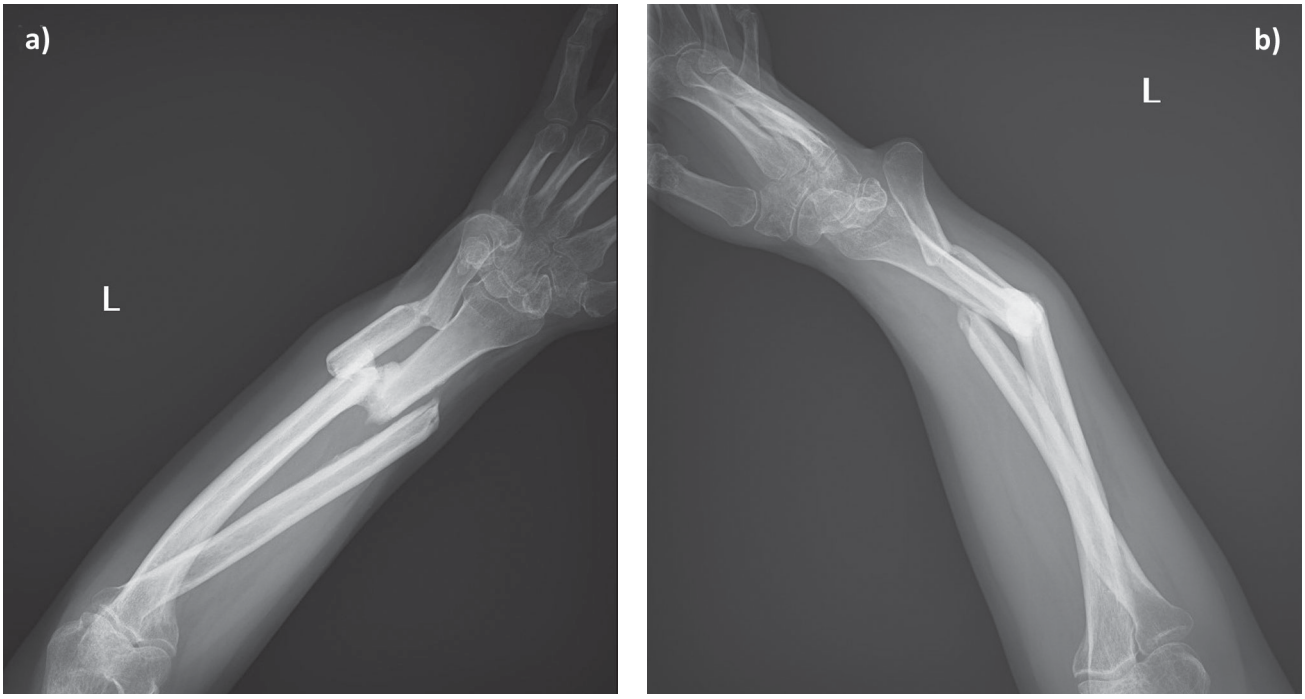
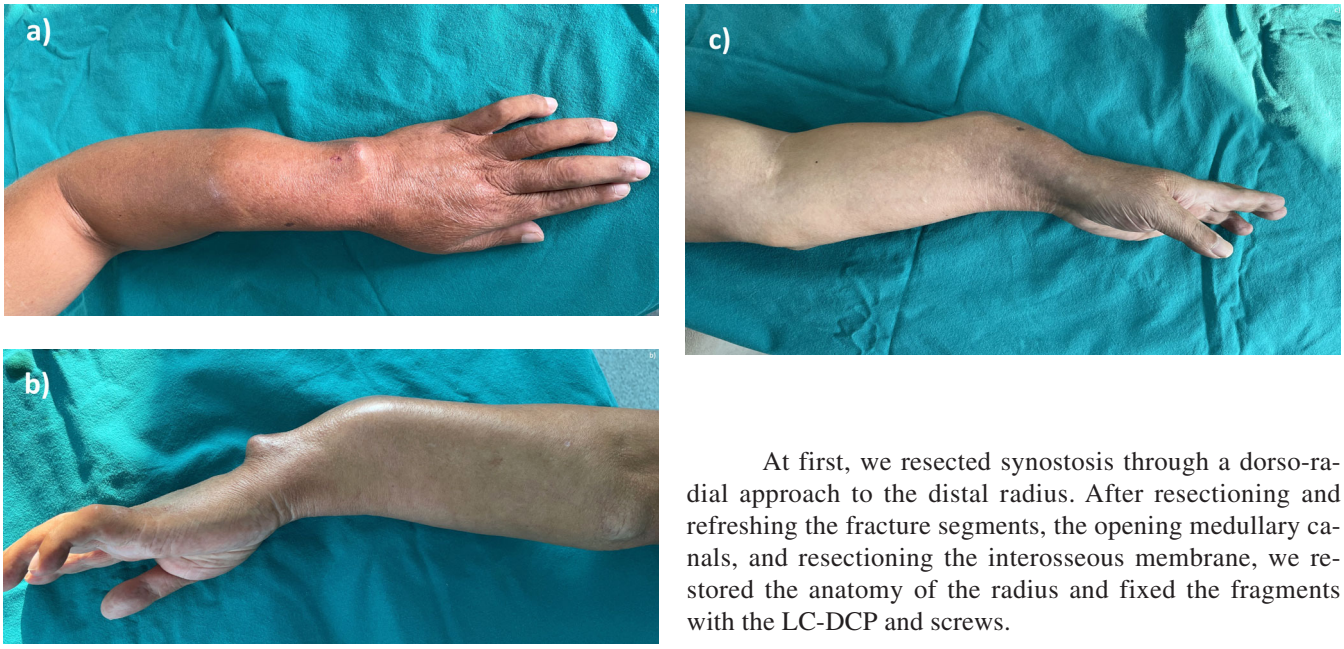


Fig. 2. a), b), c). Preoperative visible deformation of the forearm



At first, we resected synostosis through a dorso-radial approach to the distal radius. After resectioning and refreshing the fracture segments, the opening medullary canals, and resectioning the interosseous membrane, we restored the anatomy of the radius and fixed the fragments with the LC-DCP and screws.

Fig. 3. a), b) Radius reconstruction.

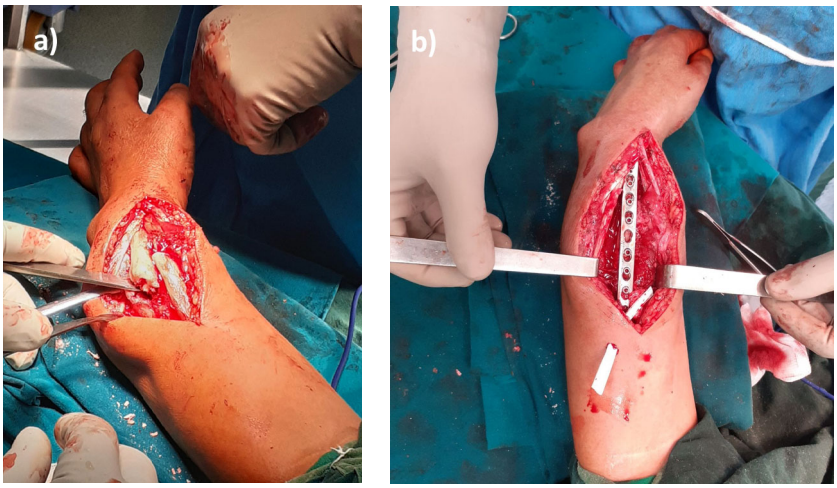
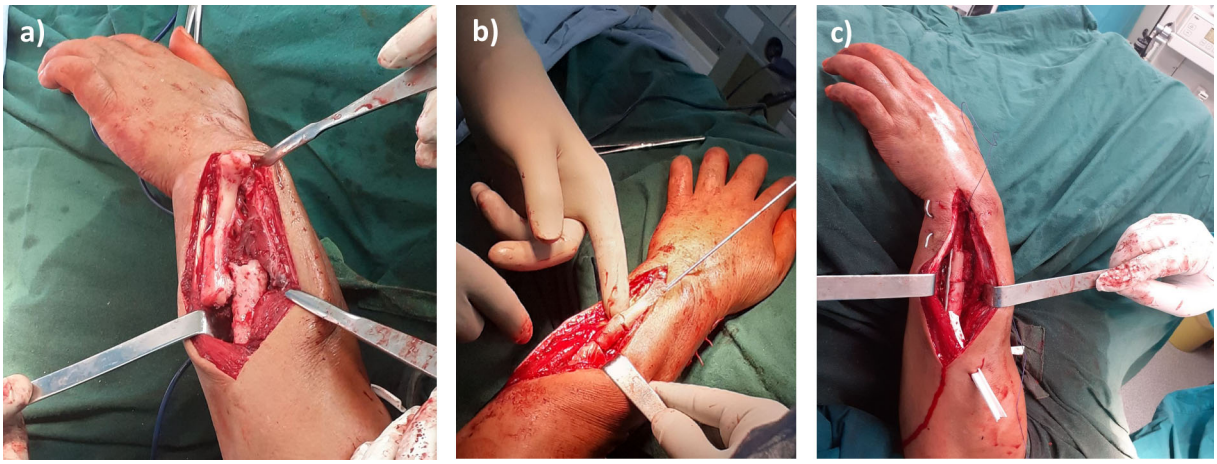
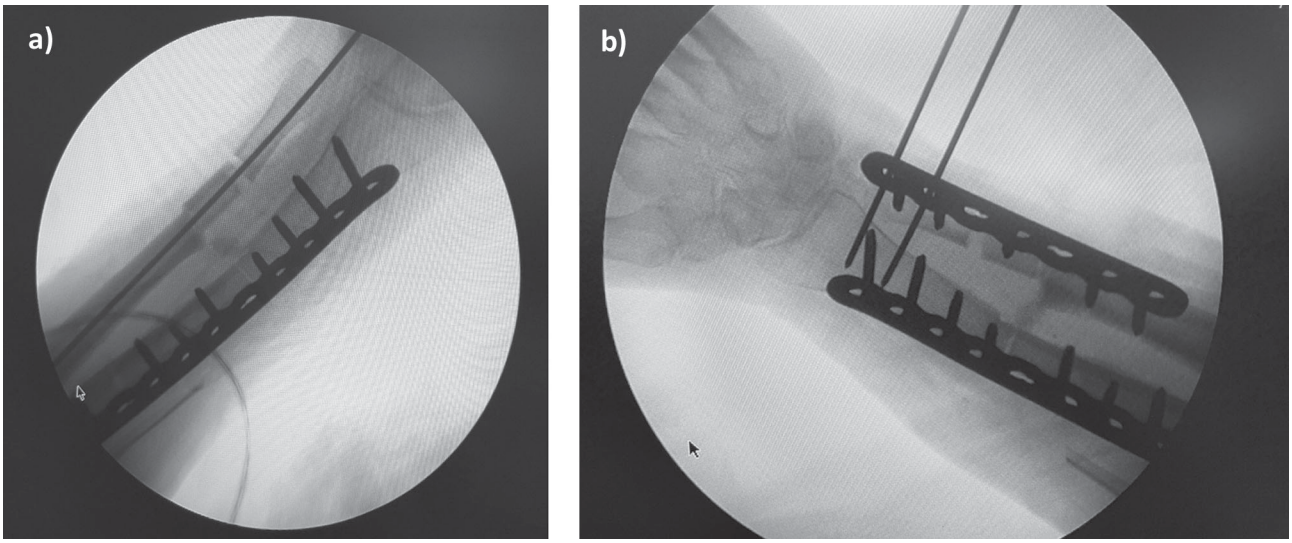


Fig. 4. a), b), c). Ulna reconstruction



Subsequently, a new approach was made to the middle-distal third of the ulna. After a two-stage osteotomy, we adjusted the ulna position and anatomy. Utilizing K-wire for temporary fixation allowed us to use an intraoperative control x-ray, after which we definitively fixed the ulna with LC-DCP and screws. The corrected position of DRUJ was held in place by transfixion with two K-wires.

Fig. 5. a), b). Intra-operative X-ray



Six months postoperatively, X-ray proof of the resection site consolidation in an anatomically correct position was recorded. No visible deformation of the forearm was noticeable, and pronosupination was restored up to 60% of the normal functional arc. Normal position and stability of DRUJ were also recorded.

Fig. 6. Control X-ray six months later.

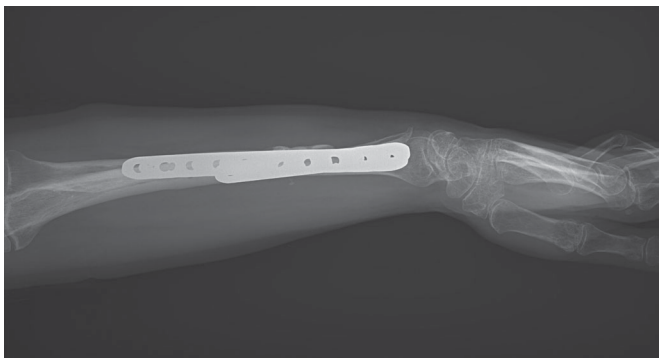
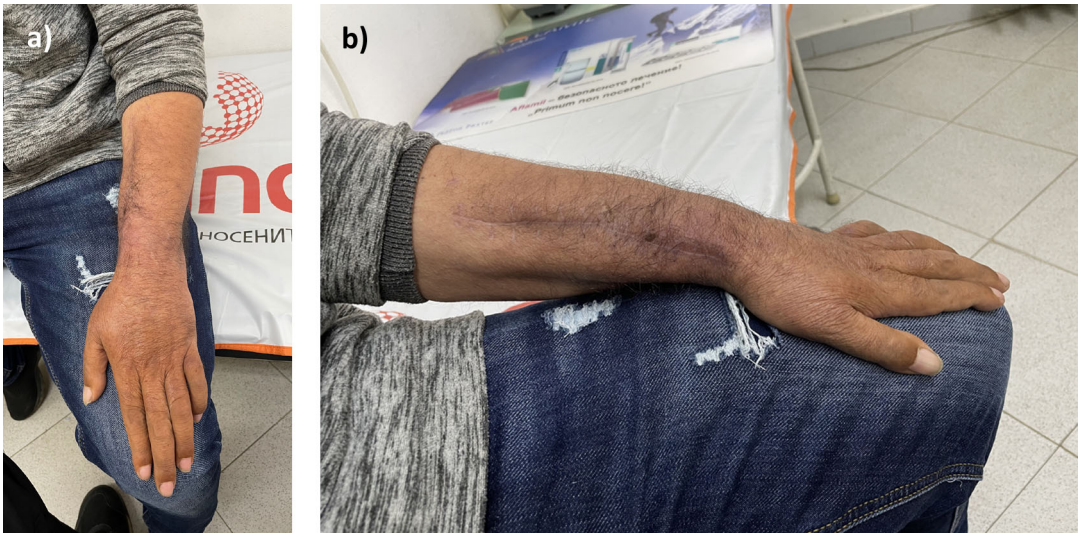


Fig. 7. a), b). No visible deformation is seen six months later.



DISCUSSION

To understand the pathomechanics of forearm trauma, we rely on the concepts established by Dumontier and Soubeyrand [18, 19, 20].

According to their concept, the forearm functions as a single functional unit and is made of:

1. Two bones: Radius and Ulna
2. Interosseus membrane (IOM)
3. Functional joint – referred to as middle radioulnar joint (MRUJ) (LaStayo and Lee 2006) [21], composed of IOM and forearm bones. Its biomechanical relevance to forearm stability was shown only recently by Soubeyrand M, et al. [19].
4. Two anatomical joints – proximal and distal radioulnar joint (PRUM and DRUJ).

According to Artiaco S et al., the forearm contains three stabilizing elements: two anatomical and one functional, consisting of the radius, ulna, and interosseous membrane (IOM) [20]. These "lockers" ensure the forearm's stability and function [20]. Injury to just one locker has minimal impact on longitudinal stability [20]. However, if two lockers are injured, the third cannot compensate. Based on Artiaco S et al.'s classification, the patient had a 2IRU fracture type [20]. In the literature, we may find that the term "Galeazzi fracture" is sometimes used inaccurately, with some variations misnamed as Galeazzi equivalents. We agree with Artiaco S, et al. and Samford MP, et al. that the term "Galeazzi fracture" should be reserved exclusively for its original pattern to avoid confusion [20, 22, 23, 24].

Fig. 8. Three locker concepts. Cited from Artiaco S, et al. [20].

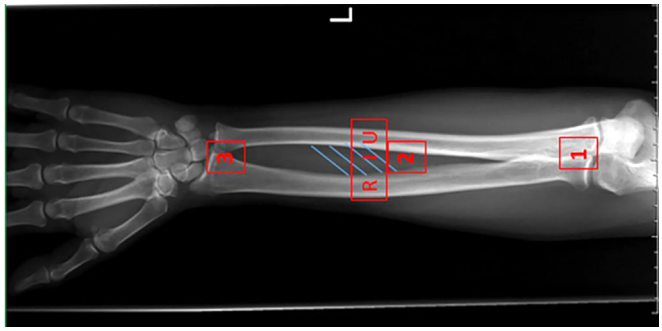
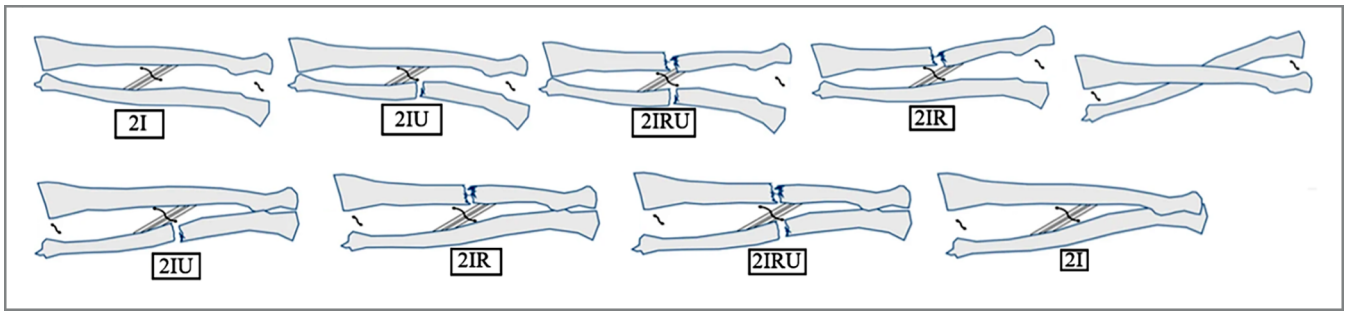
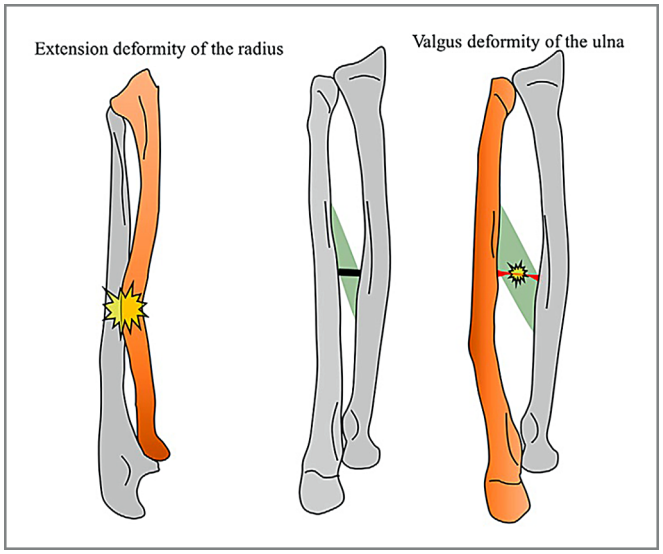


Fig. 9. Two locker injury patterns. Adapted and cited from Artiaco S, et al. [20].



The primary goal of the surgery, in this case, is to reconstruct anatomy, ensure fracture site healing and restore prono-supination movement of the forearm. Normal ranges for forearm pronation and supination are 75-85 degrees and 80-90 degrees, respectively, with a functional arc of 100 degrees of prono-supination necessary for daily activities such as feeding and personal hygiene. From the study of Graham TJ, et al. (1998), we may note that angular deformity of the radius and/or ulna can cause tension in the IOM and bone impingement, thereby obstructing the radius's rotation around the mechanical axis [26, 27].

Fig. 10. Extension deformation of the radius and valgus deformity of the ulna. Cited from Abe S, et al. [28]



Cadaver studies have indicated that angular deformities of less than 10 degrees in forearm bones do not significantly impair rotation [29, 30]. But, dorso-volar angular deformities greater than 15 degrees significantly restrict prono-supination [15]. Radial malrotation exceeding 30 degrees leads to considerable rotational limitations [15].

In another study, Dumont et al. found that isolated malunion of the radius in supination greatly reduces pronation, while malunion in pronation significantly limits supination [31]. Interestingly, isolated rotational malunion of the ulna has minimal impact on forearm rotation [32].

Dumont et al. report that rotational malunion of both forearm bones in the same direction produces results similar to those of isolated malunion of the radius [30]. When both forearm bones are malunited in opposite directions, it results in the most significant reduction of prono-supination [30]. A study by Schemitsch and Richards found that restoring the radial bow's location to within 4% and the maximal bow of the radius to within 1.5 mm of the contralateral forearm restores at least 80% of normal prono-supination and significantly improves grip strength [32, 33].

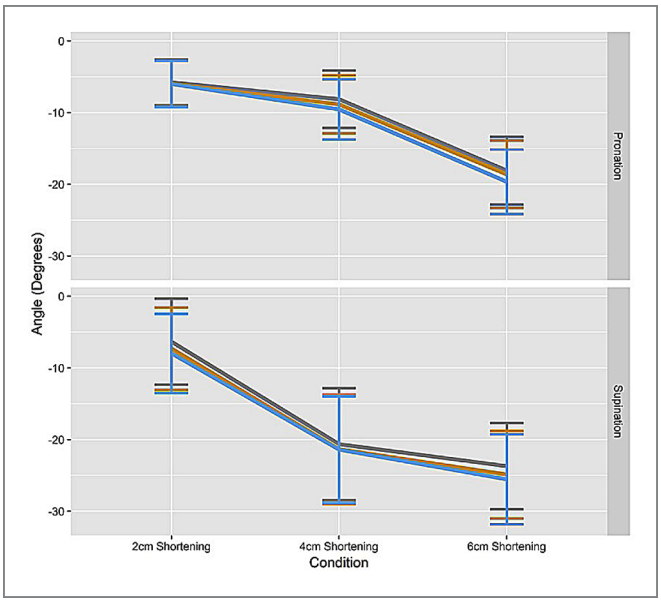
From a practical point of view, we concur with Jayakumar P, et al. that anatomy restoration is crucial for restoring forearm function [15]. In our case, we used the contralateral limb to plan normal anatomy restoration.

Because ORIF of both radius and ulna does not guarantee DRUJ stability, we advise performing transcutaneous fixation with 2 K-wires [7, 34].

During the operation, shortening the ulna by ~1 cm was necessary to reconstruct the radius and ulna anatomically. After achieving the anatomical restoration, the bones were rigidly fixed using the LC-DCP. Another important factor to consider is the contracture of the IOM, which occurs secondary to the angular deformation of the radius and ulna [35]. Therefore, we decided to perform an IOM release to improve forearm function. It is crucial to note that an IOM release should not be performed automatically. According to Chia et al., contracture of the IOM does not necessarily limit the rotational movement of the forearm in all cases [36]. It is interesting to note that in the Chia et al. study, the average time between the original fracture and corrective osteotomy was 41.8 months (ranging from 7 to 168 months) [36].

An interesting study published by Barinaga G, et al. 2022, investigated the effect of radius and ulna shortening on the forearm range of motion [36]. They found that supination decreases more between 2-4 cm of shortening, whereas pronation decreases more after 4-6 cm of shortening [36]. Therefore, excessive osteotomy of the forearm bones is not advised, as it will impair forearm function.

Fig. 11. Effect of forearm shortening on prono-supination. Cited from Barinaga G, et al. [37].



We find that anatomical reconstruction will not achieve good outcomes in neglected malunited both-bone forearm fracture and DRUJ dislocation. We agree with Dabas V, et al. that surgical treatment could lead to better functional outcomes if anatomical reconstruction is done earlier [5]. Thus, we may correlate the outcome in this case to the missed optimal surgical window. Nonetheless, from the patient's perspective, the patient was satisfied with greater functional independence and the ability to perform self-care activities such as cooking meals or sanitary activities. It is beyond the scope of this article to describe rehabilitation protocol for this case, as it demands its own comprehensive investigation and discussion.

This study's limitation was the inability to use 3D deformity analysis due to the non-availability of software and hardware. We want to highlight the high-relevance work of Alemayehu DG, et al. regarding 3D deformity analysis and 3D printing of preoperative models [38]. In our case, as was shown by the work of Xiong L, et al. and Morgan C, et al., it could have contributed to a better understanding of preoperative 3D anatomy, more precise deformity correction planning, and lesser operative time [39, 40]. Moreover, studies have shown that 3D-printed models can be sterilized and used as templates during surgery to provide visible guidance to the surgeon [41]. We believe using this technology is crucial for success in unique and challenging cases.

CONCLUSION

Neglected both-bone forearm fracture with ipsilateral DRUJ dislocation is uncommon, and this injury pattern has been sparsely characterized in the literature. We hope this report will help surgeons who encounter this neglected pattern of fracture better plan the surgery and hopefully achieve good results. Still, patients will need to be reminded of the possibility of poor or average surgical outcomes and that a pre-fracture state of function is unlikely to be achieved.

Informed consent

The patient has provided written informed consent.

Abbreviations

DRUJ – Distal radio-ulnar joint
IOM – interosseous membrane
LC-DCP - Limited contact dynamic compression plate

REFERENCES:

1.Sebastin SJ, Chung KC. A Historical Report on Riccardo Galeazzi and the Management of Galeazzi Fractures. *J Hand Surg Am.* 2010 Nov;35(11):1870-7. [PubMed]

2.Panagopoulos A, Solou K, Tatani I, Kouzelis A, Kokkalis Z. A Case of Bilateral Galeazzi Fracture-Dislocations. *Cureus.* 2021 Aug 27;13(8):e17491. [PubMed]

3.Mikiæ ZD. Galeazzi fracture-dislocations. *J Bone Joint Surg Am.* 1975 Dec;57(8):1071-80. [PubMed]

4.Jain SK, Kohli GBS Diaphyseal Fracture of both Bone Forearm with Distal Radio-Ulnar Joint Dislocation-An Unusual Entity. *J Clin Exp Orthop.* 2018; 4(1):53. [Crossref]

5.Dabas V, Bhatia N, Agrawal G. Both Bone Forearm Fracture with Complex DRUJ Dislocation: What Are the Odds? *J Wrist Surg.* 2021 Dec 13;12(1):81-85. [PubMed]

6. Knight RA, Purvis GD. Fractures of both bones of the forearm in adults. *J Bone Joint Surg Am.* 1949 Oct;31A(4):755-64. [PubMed]

7. Ryan MK, MacKay BJ, Tejwani NC. Both-bone forearm fracture with distal radioulnar joint dislocation. *Am J Orthop (Belle Mead NJ).* 2013 May;42(5):E30-2. [PubMed]

8. Albert SM, Wohl MA, Rechtman AM. Treatment of the disrupted radioulnar joint. *J Bone Joint Surg Am.* 1963 Oct;45(7):1373-1381 [PubMed]

9. Vesely DG. The distal radio-ulnar joint. *Clin Orthop Relat Res.* 1967 Mar-Apr;51:75-91. [PubMed]

10. Bruckner JD, Lichtman DM, Alexander AH. Complex dislocations of the distal radioulnar joint. Recognition and management. *Clin Orthop Relat Res.* 1992 Feb;(275):90-103. [PubMed]

11. Budgen A, Lim P, Templeton P, Irwin LR. Irreducible Galeazzi injury. *Arch Orthop Trauma Surg.*

1998;118(3):176-8. [PubMed]

12. Jenkins NH, Mintowt-Czyz WJ, Fairclough JA. Irreducible dislocation of the distal radioulnar joint. *Injury.* 1987 Jan;18(1):40-3. [PubMed]

13. Vaishya R, Shrestha SK, Vaish A. A Galeazzi-variant type fracture-dislocation in adults. *Chin J Traumatol.* 2013; 16(6):344-63. [PubMed]

14. Nagy L, Jankauskas L, Dumont CE. Correction of forearm malunion guided by the preoperative complaint. *Clin Orthop Relat Res.* 2008 Jun;466(6):1419-28. [PubMed]

15. Jayakumar P, Jupiter JB. Reconstruction of malunited diaphyseal fractures of the forearm. *Hand (N Y).* 2014 Sep;9(3):265-73. [PubMed]

16. Dimartino S, Pavone V, Carnazza M, Cuffaro ER, Sergi F, Testa G. Forearm Fracture Nonunion with and without Bone Loss: An Overview of Adult and Child Populations. *J Clin Med.* 2022 Jul 15;11(14):4106. [PubMed]

17. Gummesson C, Atroshi I, Ekdahl C. The disabilities of the arm, shoulder and hand (DASH) outcome questionnaire: longitudinal construct validity and measuring self-rated health change after surgery. *BMC Musculoskelet Disord.* 2003 Jun 16;4:11. [PubMed]

18. Dumontier C, Soubeyrand M. The Forearm Joint. In: Bentley, G. (eds) European Surgical Orthopaedics and Traumatology. Springer, Berlin, Heidelberg. 2014, pp.1509-1524. [Crossref]

19. Soubeyrand M, Wassermann V, Hirsch C, Oberlin C, Gagey O, Dumontier C. The middle radioulnar joint and triarticular forearm complex. *J Hand Surg Eur Vol.* 2011 Jul;36(6):447-54. [PubMed]

20. Artiaco S, Fusini F, Sard A, Dutto E, Massè A, Battiston B. Fracture-dislocations of the forearm joint: a systematic review of the literature and a comprehensive locker-based classification system. *J Orthop Traumatol.* 2020 Dec 2;21(1):21. [PubMed]

21. LaStayo PC, Lee MJ. The forearm complex: anatomy, biomechanics and clinical considerations. *J Hand Ther.* 2006 Apr-Jun;19(2):137-44. [PubMed]

22. Somford MP, Nieuwe Weme RA, van Dijk CN, IJpma FF, Eygendaal D. Are eponyms used correctly or not? A literature review with a focus on shoulder and elbow surgery. *Evid Based Med.* 2016 Oct;21(5):163-71. [PubMed]

23. Viveen J, Somford MP, Koenraadt KLM, van den Bekerom MPJ, Eygendaal D, Schipper IB, et al. The Use of Eponyms for Surgical Approaches and Fractures in Elbow Surgery: Accuracy and Reliability Pre- and Post-Training. *Arch Bone Jt Surg.* 2019 Mar;7(2):191-198. [PubMed]

24. Murphy F., Gunn H. Eponyms in imaging of the upper limb: A historical review. *Radiography.* 2012 May;18(2):123-131. [Crossref]

25. Schulte LM, Meals CG, Neviaser RJ. Management of adult diaphyseal both-bone forearm fractures. *J Am Acad Orthop Surg.* 2014 Jul;22(7):437-46. [PubMed]

26. Graham TJ, Fischer TJ, Hotchkiss RN, Kleinman WB. Disorders of the forearm axis. *Hand Clin.* 1998 May;14(2):305-16. [PubMed]

27. Roth K, van Es E, Kraan G, Eygendaal D, Colaris J, Stockmans F. Accuracy of 3D Corrective Osteotomy for Pediatric Malunited Both-Bone Forearm Fractures. *Children (Basel).* 2022 Dec 23;10(1):21. [PubMed]

28. Abe S, Murase T, Oka K, Shigi A, Tanaka H, Yoshikawa H. In Vivo Three-Dimensional Analysis of Malunited Forearm Diaphyseal Fractures with Forearm Rotational Restriction. *J Bone Joint Surg Am.* 2018 Sep 5;100(17):e113. [PubMed]

29. Tarr RR, Garfinkel AI, Sarmiento A. The effects of angular and rotational deformities of both bones of the forearm. An in vitro study. *J Bone Joint Surg Am.* 1984 Jan;66(1):65-70. [PubMed]

30. Miyake J, Oka K, Kataoka T, Moritomo H, Sugamoto K, Murase T. 3-Dimensional deformity analysis of malunited forearm diaphyseal fractures. *J Hand Surg Am.* 2013 Jul;38(7):1356-65. [PubMed]

31. Dumont CE, Thalmann R, Macy JC. The effect of rotational malunion of the radius and the ulna on supination and pronation. *J Bone Joint Surg Br.* 2002 Sep;84(7):1070-4. [PubMed]

32. Schemitsch EH, Richards RR. The effect of malunion on functional outcome after plate fixation of fractures of both bones of the forearm in adults. *J Bone Joint Surg Am.* 1992 Aug;74(7):1068-78. [PubMed]

33. Lee SK, Kim YH, Kim SM, Choy WS. A comparative study of three different surgical methods for both-forearm-bone fractures in adults. *Acta Orthop Belg.* 2019 Sep;85(3):305-316. [PubMed]

34. Xiao AX, Graf AR, Dawes A, Daley C, Wagner ER, Gottschalk MB. Management of Acute Distal Radioulnar Joint Instability Following a Distal Radius Fracture: A Systematic Review and Meta-Analysis. *J Hand Surg Glob Online.* 2021 Mar 31;3(3):133-138. [PubMed]

35. Mader K, Koolen M, Flipsen M, van der Zwan A, Pennig D, Ham J. Complex forearm deformities: operative strategy in posttraumatic pathology. *Obere Extrem.* 2015;10(4):229-239. [PubMed]

36. Chia DS, Lim YJ, Chew WY. Corrective osteotomy in forearm fracture malunion improves functional outcome in adults. *J Hand Surg Eur Vol.* 2011 Feb;36(2):102-6. [PubMed]

37. Barinaga G, Rodriguez-Feo C, Rasmussen E, Telfer S, Iannuzzi N. The Effect of Forearm Shortening on Forearm Range of Motion. *J Hand Surg Am.* 2022 Jan;47(1):87.e1-87.e7. [PubMed]

38. Alemayehu DG, Zhang Z, Tahir E, Gateau D, Zhang DF, Ma X. Preoperative Planning Using 3D Printing Technology in Orthopedic Surgery. *Biomed Res Int.* 2021 Oct 12;2021:7940242. [PubMed]

39. Xiong L, Li X, Li H, Chen Z, Xiao T. The efficacy of 3D printing-assisted surgery for traumatic fracture: a meta-analysis. *Postgrad Med J.* 2019 Aug;95(1126):414-419. [PubMed]

40. Morgan C, Khatri C, Hanna SA, Ashrafian H, Sarraf KM. Use of three-dimensional printing in preoperative planning in orthopaedic trauma surgery: A systematic review and meta-analysis. *World J Orthop.* 2020 Jan 18;11(1):57-67. [PubMed]

41. Meyer-Szary J, Luis MS, Mikulski S, Patel A, Schulz F, Tretiakow D, et al. The Role of 3D Printing in Planning Complex Medical Procedures and Training of Medical Professionals-Cross-Sectional Multispecialty Review. *Int J Environ Res Public Health.* 2022 Mar 11; 19(6):3331. [PubMed]

Please cite this article as: Simeonov E. Neglected both-bone forearm fracture with distal radioulnar joint dislocation: a case report and brief literature review. *J of IMAB.* 2024 Oct-Dec;30(4):5811-5818.
[Crossref - https://doi.org/10.5272/jimab.2024304.5811]

Received: 15/04/2024; Published online: 11/10/2024

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