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Comparison of cases with and without carpal tunnel release in volar plate fixation of AO type 23-B and 23-C fractures

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ABSTRACT

Aim: To compare the functional results and the frequency of carpal tunnel syndrome between patients who underwent Open reduction internal fixation(ORIF)+carpal tunnel release(CTR) and those who underwent isolated open reduction internal fixation in AO 23 B and C type fractures.
Methods: Patients with AO Type 23-B1, 23-B2, 23-B3, 23-C1, 23-C2, and 23-C3 fractures who underwent ORIF were included in the study. The patients who underwent ORIF were divided into two groups: those who underwent CTR and those who did not. The patients' VAS scores and Patient-Rated Wrist Evaluation (PRWE) scores were evaluated on postoperative day 1, month one, month three, month six, and month twelve.
Results: Eighty-two patients were included in the study. ORIF+CTR was performed in 46 patients, and isolated ORIF was performed in 36 patients. CTS symptoms were observed in 6 patients in the group that only underwent ORIF at postoperative three months. At the 6-month control EMG, CTS was detected in 5 out of 6 patients where only ORIF was performed.
Conclusion: Concomitant CTR during ORIF in AO type 23B and 23C fractures is an effective surgical treatment procedure in preventing the development of CTS.

Key words: Carpal tunnel syndrome, radius distal fracture, carpal tunnel release, PRWE, ORIF.

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Introduction

The treatment of distal radius fractures (DRF) were divided into surgical and non-surgical methods. During the application of non-surgical procedures, carpal tunnel syndrome may occur due to excessive Cotton-Loder position in the cast, extreme manipulation during reduction, or callus formation after the fracture [1, 2] . The incidence of carpal tunnel syndrome after surgery is also determined to be 5.4% [3]. Especially after volar plate application, there is an increase in carpal tunnel syndrome (CTS) frequency for various reasons. In selected cases, in addition to open reduction internal fixation (ORIF), carpal tunnel release (CTR) may be beneficial in reducing the frequency of carpal tunnel syndrome.

In our study, we aimed to compare the functional outcomes and the frequency of carpal

tunnel syndrome between patients who underwent ORIF+CTR and those who underwent isolated ORIF in AO 23 B and C type fractures.

Materials and methods

Our study was conducted retrospectively by selecting patients who underwent surgery for DRF between 2015 and 2020. Clinical research ethics committee approval was obtained for this study. The ethics committee number is 09.2022.578/07.09.2022. Our study was carried out in accordance with the Declaration of Helsinki

Patients with AO Type 23-B1, 23-B2, 23-B3, 23-C1, 23-C2, and 23-C3 fractures who underwent ORIF were included in the study. The patients who underwent ORIF were divided into two groups: those who underwent CTR and those who did not. The anterior Henry approach was used in all cases, and fixation was performed with volar plate and screws. Patients with a follow-up period of less than 1 year, under 18 years old or over 55 years old, alcohol or drug addiction, a history of rheumatic disease, irregular follow-up visits, incomplete or inconsistent medical records, and previous nerve or wrist surgery on the same extremity were excluded from the study. All patients were operated by a single surgeon and the same postoperative rehabilitation protocol was applied. As in previous studies, the decision to perform decompression was made by the surgeon [4].

The patient's comorbidities, occupation, dominant extremity, gender distribution, age ranges, and classification of the type of injury and fracture were recorded. The patients' VAS scores and Patient-Rated Wrist Evaluation (PRWE) scores were evaluated on postoperative day 1, 1 month, 3 months, 6 months, and 12 months. As in previous studies, EMG was performed at the third and sixth months after surgery. [4].

Statistical Analyses

Statistical analysis was performed using SPSS software (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY, USA: IBM Corp.). The conformity of the numerical variables to the normal distribution was performed using visual (histogram and probability graphs) and analytical methods (Kolmogorov-Smirnov/Shapiro-Wilk tests) .The Mann-Whitney U test was used to compare the groups. A *p*-value of less than 0.05 was considered to show a statistically significant result.

Results

When the data on the patients were analyzed, it was determined that 97 patients underwent surgery due to AO Type 23-B1, 23-B2, 23-B3, 23-C1, 23-C2, and 23-C3 fractures. Considering the exclusion and inclusion criteria, 82 patients were included in the study. Demographic data, comorbidities, occupations, dominant extremities, the mechanism of injury, and fracture type of the patients are given in Table 1.

The VAS and PRWE scores of the patients in both groups were compared on postoperative day 1, 1 month, 3 months, 6 months, and 12 months in Table 2 and Table 3. No CTS findings were detected in the control EMG performed at 3 months in both groups. However, CTS symptoms like numbness and tingling in digits, pain and paresthesias that awaken patient at night were observed in 6 patients in the group that only underwent ORIF.

At the 6-month control EMG, CTS was detected in 5 out of 6 patients where only ORIF was performed. Statistically, CTS was significantly more common only in the group where ORIF was performed (p=0.042).

Table 1. Demographic data of the patients and description of the population.

Parameters	ORIF+CTR	ORIF NOT CTR
Number of patients	46	36
Gender (ratio,male/female)	37:9	30:6
Dominant side	42	26
Range and mean age of the patients	18-55(37.84)	20-55(37)
The fracture type according to the AO classification		
23-B1	3 (6.5%)	3(8.3%)
23-B2	6 (13%)	9(25%)
23-B3	12 (26.1%)	7(19.4%)
23-C1	6 (13%)	6(16.7%)
23-C2	10 (21.7%)	5(13.9%)
23-C3	9 (19.6%)	6(16.7%)
Comorbidities		
Diabetes Mellitus (DM)	2	2
Hypertension (HT)	3	1
HT+DM	1	1
Thyroid dysfunction	2	0
Yok	38	32
Occupation		
Farming-livestock	13 (28.3%)	12 (33.3%)
Security forces	2 (4.3%)	2 (5.6%)
Self-employment	8 (17.4%)	9 (25%)
Desk job	8 (17.4%)	6 (16.7%)
Student	4 (8.7%)	2 (5.6%)
Industrial sector	11 (23.9%)	5 (13.9%)
Type of travma		
Battered	7 (15.2%)	3 (8.3%)
Traffic accident	16 (34.8%)	14(38.9%)
Fallen	22 (47.8%)	16 (44.4%)
Sports accident	1 (2.2%)	3 (8.3%)

Table 2. PRWE scores of the patients on day 1, month 1, month 3, month 6, and month 12.

Time	Average PRWE score of NOT CTR	Average PRWE score of ORIF+CTR	*P* value
Day 1	79.22	77.26	0.354
Month 1	51.52	51.28	1.000
Month 3	32.88	30.67	0.288
Month 6	18.80	17.32	0.459
Month 12	8.44	8.39	0.791

Table 3. VAS scores of the patients on day 1, month 1, month 3, month 6, and month 12.

Time	Average VAS score of NOT CTR	Average VAS score of ORIF+CTR	*P* value
Day 1	6.36	6.41	0.882
Month 1	4.13	4.08	0.883
Month 3	2.44	2.54	0.670
Month 6	1.19	0.95	0.318
Month 12	0.77	0.47	0.219

Discussion

In our study, we compared functional outcomes of patients who underwent isolated open reduction and internal fixation with the release of the transverse carpal ligament in distal radius fractures with intra-articular extension. Functional outcomes and pain levels of patients in both groups were statistically similar at 1 day, 1 month, 3 months, 6 months, and 12 months after surgery. However, the statistical analysis showed that the incidence of carpal tunnel syndrome was significantly higher in the group that underwent isolated ORIF.

Distal radius fractures are one of the most common fracture types encountered in the emergency departments. These fractures have a bimodal distribution, occurring after high-energy trauma in young male patients and after low-energy trauma in elderly female patients. Studies have shown that the relationship between DRF and CTS is stronger than previously thought[5-8].

Distal radius fractures can result in a wide range of complications. Malunion, nonunion, joint stiffness, intra-articular fractures with arthritis, chronic regional pain syndrome, and carpal tunnel syndrome (CTS) are some of the potential complications. CTS can occur acutely, transiently, or delayed following a distal radius fracture[9, 10]. Many factors are blamed for the development of CTS, including volar displaced fracture fragments, increased carpal tunnel pressure due to local anaesthetic agents at the fracture site, oedema in carpal tunnel structures associated with the fracture, hematoma from the fracture increasing carpal tunnel pressure, placement of a volar plate on the distal radius, fibrosis development due to excessive manipulation and soft tissue dissection during fracture reduction, excessive callus formation during fracture healing, and compression of the median nerve due to malunion of the fracture [7, 11].

It has been stated in many publications that the presence of volar displaced fracture fragments and volar plating pose a risk in the development of carpal tunnel syndrome. [7, 11-13] This is due to the compression of the median nerve due to the healing of the fracture fragments with callus tissue. In addition, fibrosis development due to soft tissue dissection during volar plate application is also blamed.[14]. In a meta-analysis, it was found that the safest method for the development of carpal tunnel syndrome is dorsal plate fixation. [15]. In our study, in accordance with the literature, in cases where volar plate fixation was performed, and carpal tunnel release was not performed, carpal tunnel syndrome has been observed to develop more frequently.

There is no consensus in the literature regarding the prophylactic use of carpal tunnel release (CTR) in distal radius fracture surgery [16-18]. Fuller et al. showed that the intra-carpal tunnel pressure decreased within 24 hours after volar plating fixation in distal radius fractures. Therefore routine prophylactic CTR was not recommended [16]. However, this study was conducted on a small sample size. Similarly, a systematic review by Al-Amin et al. concluded that prophylactic CTR is unnecessary in volar plating applications [3]. On the other hand, there are publications that recommend prophylactic CTR[19-21]. In a study examining 23,733 patients, it was reported that patients might benefit from prophylactic CTR (carpal tunnel release) [12]. Medici et al. Recommended

CTR during fracture fixation in their study of 35 patients [4]. Gwathmey et al. found that CTR during fracture fixation using the Hybrid Flexor Carpi Radialis Approach could reduce median nerve dysfunction [5]. Distal radius fractures are often complicated by carpal tunnel syndrome,

which is a preventable pathology in most cases. Factors that can help prevent carpal tunnel syndrome during treatment include avoiding long-term immobilization, achieving anatomical fracture reduction, druing reduction manipulating soft tissues without causing damage, respecting soft tissues during surgical approaches, and performing appropriate physical therapy during the final stages of treatment. The most significant factor affecting functional outcomes in distal radius fractures is carpal tunnel syndrome[7].

Our study has some limitations, as only intra-articular fractures were included. Further research is needed with a broader patient group, including all fracture types. In addition, a prospective randomized controlled study would increase the value of the research.

In conclusion, concomitant CTR during ORIF in AO type 23B and 23C fractures is an effective surgical treatment procedure in preventing the development of CTS.

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References

[1] Özçelik İB, Yazar M, Mersa B, et al. Early results with arthroscopic repair of peripheral tears of the triangular fibrocartilage complex (Palmer Type 1B). Göztepe Tıp Dergisi. 2012;27(2):62-7.

[2] Brüske J, Niedźwiedź Z, Bednarski M, Zyluk A. Acute carpal tunnel syndrome after distal radius fractures--long term results of surgical treatment with decompression and external fixator application. Chir Narzadow Ruchu Ortop Pol. 2002;67(1):47-53.

[3] Al-Amin Z, Senyürek S, Van Lieshout E, et al. Systematic review and pooled analysis of the rate of carpal tunnel syndrome after prophylactic carpal tunnel release in patients with a distal radius fracture. Hand Surg Rehabil. 2018;37(3):155-9.

[4] Medici A, Meccariello L, Rollo G, et al. Does routine carpal tunnel release during fixation of distal radius fractures improve outcomes? Injury. 2017;48 Suppl 3:S30-s3.

[5] Gwathmey Jr FW, Brunton LM, Pensy RA, et al. Volar plate osteosynthesis of distal radius fractures with concurrent prophylactic carpal tunnel release using a hybrid flexor carpi radialis approach. J Hand Surg. 2010;35(7):1082-8. e4.

[6] Earp BE, Mora AN, Floyd IV WE, et al. Predictors of acute carpal tunnel syndrome following ORIF of distal radius fractures: a matched case–control study. J Hand Surg Global Online. 2019;1(1):6-9.

[7] Jagadish U, Ethiraj P, Umesh M, et al. Incidence of Carpal Tunnel Syndrome in Distal Radius Fractures Treated by Various

Modalities in a Tertiary Care Center: A Single Center Study. Cureus. 2023;15(2):e35346.

[8] Leow JM, Clement ND, McQueen MM, et al. The rate and associated risk factors for acute carpal tunnel syndrome complicating a fracture of the distal radius. Eur J Orthop Surg Traumatol. 2021;31(5):981-7.

[9] Pope D, Tang P. Carpal tunnel syndrome and distal radius fractures. Hand Clin. 2018;34(1):27-32.

[10] Chauhan A, Bowlin TC, Mih AD, et al. Patient-reported outcomes after acute carpal tunnel release in patients with distal radius open reduction internal fixation. Hand. 2012;7(2):147-50.

[11] Paley D, McMurtry R. Median nerve compression by volarly displaced fragments of the distal radius. Clin Orthop Related Res. (1976-2007). 1987;215:139-47.

[12] Cooke ME, Gu A, Wessel LE, et al. Incidence of Carpal Tunnel Syndrome after Distal Radius Fracture. J Hand Surg Global Online. 2022;4(6):324-7.

[13] Fernandez DL, Jupiter JB. Fractures of the distal radius: a practical approach to management: Springer Science & Business Media; 2002.

[14] Wipperman J, Goerl K. Carpal tunnel syndrome: diagnosis and management. Am Fam Physician. 2016;94(12):993-9.

[15] Zhao H-L, Wang G-B, Jia Y-Q, et al. Comparison of risk of carpal tunnel syndrome in patients with distal radius fractures after 7 treatments. Med Sci Monit. 2015;21:2837.

[16] Fuller D, Barrett M, Marburger R, et al. Carpal canal pressures after volar plating of distal radius fractures. J Hand Surg. 2006;31(2):236-9.

[17] Henry M, Stutz C. A prospective plan to minimise median nerve related complications associated with operatively treated distal radius fractures. Hand Surg. 2007;12(03):199-204.

[18] Itsubo T, Hayashi M, Uchiyama S, et al. Differential onset patterns and causes of carpal tunnel syndrome after distal radius fracture: a retrospective study of 105 wrists. J Orthop Sci. 2010;15(4):518-23.

[19] Shukla R, Jain RK, Sharma NK, et al. External fixation versus volar locking plate for displaced intra-articular distal radius fractures: a prospective randomized comparative study of the functional outcomes. J Orthop Traumatol. 2014;15(4):265-70.

[20] Bisaccia M, Rinonapoli G, Falzarano G, et al. Clinical and radiological outcomes of distal radius fractures treated with orif with volar fixed-angle plates. Euromediterranean Biomed J. 2016;11(2):9-14.

[21] Thorninger R, Madsen ML, Wæver D, Borris LC, Rölfing JHD. Complications of volar locking plating of distal radius fractures in 576 patients with 3.2 years follow-up. Injury. 2017;48(6):1104-9.