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Original Research

Incidence of Carpal Tunnel Syndrome after Distal Radius Fracture

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Purpose: Carpal tunnel syndrome (CTS) can present following distal radius fracture (DRF) and may progress to require carpal tunnel release (CTR). The primary aim of this study was to determine the incidence of CTS within 6 months of a DRF and the rate of CTR in this population.
Methods: We used the PearlDiver national insurance database to determine the incidence of CTS after DRF. Patients were identified by International Classification of Diseases-10 codes, and treatment modalities for DRF and CTS were determined by respective Current Procedural Terminology codes. Patients with less than 6 months of follow-up, bilateral DRF, or preexisting CTS were excluded. Patient demographic characteristics were recorded. The time from DRF diagnosis to CTS diagnosis and CTR was determined. A multivariable analysis was performed to determine the differences between patients who underwent a CTR compared with those who were treated conservatively.
Results: We identified 23,733 patients (6,015 men; 17,718 women) who sustained a DRF. Of these patients, 79.1% were treated nonsurgically and 20.9% underwent surgical fixation. In total, 9.2% (N = 2,179) were diagnosed with CTS in their ipsilateral extremity within 6 months of sustaining the DRF. Of the patients whose DRF was treated nonsurgically, 6.3% (N = 1,198) developed CTS and 2.9% (N = 546) required CTR. Of those patients whose DRF was treated surgically, 19.8% (N = 981) developed CTS and 13.3% (N = 661) required CTR. Of those patients with symptoms severe enough to warrant CTR, 18.5% required a second surgical intervention for the CTR.
Conclusions: Distal radius fractures severe enough to require surgical fixation are associated with a higher incidence of perioperative CTS. Accordingly, careful evaluation for and counseling on CTS during surgical fixation may decrease the chance of a second surgery. We have identified a cohort of patients with DRFs who may benefit from prophylactic CTR.
Type of study/level of evidence: Diagnostic IV.

Carpal tunnel syndrome (CTS) is common following a distal radius fracture (DRF).[1,2] It may occur at the time of injury (acute) or after a delay of days to weeks (delayed).[3,4] In 4% of cases, the symptomatology is transient and will resolve spontaneously.[5]

Acute CTS develops within hours to days of sustaining a distal radius fracture and is thought to result from acutely elevated compartment pressure in the carpal tunnel.[6] The acutely elevated compartment pressure in the setting of a DRF is likely secondary to hematoma formation, fracture displacement, wrist immobilization, and/or soft tissue swelling. High-energy trauma, multiple attempts at closed reduction, fracture displacement, fracture comminution, radiocarpal dislocations, polytrauma, and women younger than 48 years of age are reported risk factors for acute CTS following DRF.[7]

In contrast, delayed CTS develop weeks after DRF, which is thought to be due to a change in the carpal tunnel anatomy after

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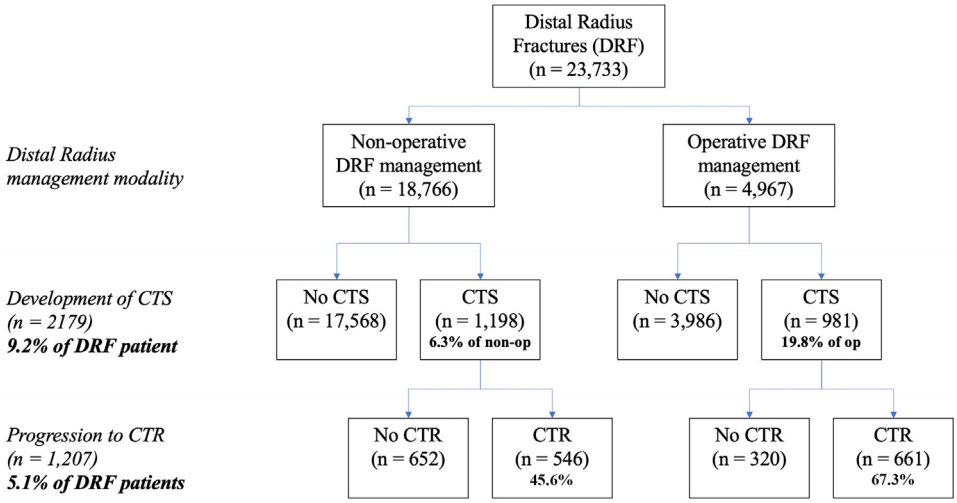

Figure 1. Flowchart representing the study population. Notably, 45.6% of patients treated nonsurgically for DRF that developed subsequent CTS required CTR, compared with 67.3% of patients treated surgically for DRF that developed CTS.

healing the fracture. The proposed pathophysiology for delayed CTS following a DRF includes fracture malunion, chronically inflamed tenosynovium, volar callus formation, scar formation, and/or offending hardware.[2,3,8,9]

The incidence of CTS following open reduction internal fixation (ORIF) for a DRF has been reported to be between 1% and 22%.[3,9] It has been debated whether prophylactic carpal tunnel release (CTR) should be performed for patients undergoing surgical treatment of DRFs and, if so, which population is at risk and at what timeframe. Identifying patients at risk for developing CTS severe enough to warrant CTR would improve surgical decision-making regarding whether these patients should have a CTR simultaneously during DRF treatment.

We hypothesize that patients who undergo surgical treatment for a DRF are more likely to develop CTS than those who undergo nonsurgical treatment for a DRF. The primary aim of this study is to use a national insurance database to determine the incidence of a new diagnosis of CTS within 6 months of a new diagnosis of a DRF and to determine the rate of CTR in this population. The secondary aim is to determine the characteristics of patients who require a CTR.

Materials and Methods

Data were collected from the Humana subset of the PearlDiver Insurance database (www.pearldiverinc.com) from 2015 to 2017. The PearlDiver database is a deidentified record of over 22 million patients. We searched the database for all patients with at least 6 months of follow-up after a diagnosis of a unilateral DRF. Exclusion criteria included preexisting CTS, bilateral DRF, and indeterminate diagnostic laterality. International Statistical Classification of Diseases, Tenth Revision coding was used to ensure laterality, and patients were excluded if the laterality of CTS or DRF could not be determined. Patients who met the inclusion criteria were stratified into 2 cohorts based on the management modality of their DRF, conservative treatment versus surgical intervention.

For both cohorts, patient data were analyzed to determine whether a diagnosis of CTS was made within 6 months of DRF and whether CTR was performed. A CTS diagnosis and CTR were identified using International Statistical Classification of Diseases, Tenth Revision and current procedural terminology coding, respectively.

The specific current procedural terminology and International Statistical Classification of Diseases, Tenth Revision coding used to identify patients is outlined in Appendix 1 (available on the Journal's website at www.jhsgo.org). In addition, the contralateral uninjured extremity for each patient was studied regarding the same parameters to provide an internal control for each cohort.

Statistical analyses to determine incidence included Pearson's chi-square test with a P value of <.05. A multivariable analysis was performed to determine the differences between patients who underwent CTR and those whose carpal tunnel symptoms were treated conservatively. The diagnostic codes for CTS and CTR were evaluated at 4 specified time intervals relative to when the DRF was diagnosed: at the time of the DRF, within 2 weeks following the DRF, between 2 and 12 weeks of the DRF, and between 12 weeks and 6 months of the DRF.

Results

A total of 23,733 patients were identified with a new diagnosis of a DRF in the PearlDiver database in the specified period who met the inclusion criteria. There were 6,015 men and 17,718 women. Of these patients, 79.1% (N = 18,766) of the DRFs were treated conservatively and 20.9% (N = 4,967) underwent surgical intervention. In total, 9.1% (N = 2,179) of patients were given a new diagnosis of CTS in their ipsilateral extremity within 6 months of their DRF diagnosis. This was significantly different from the rate of CTS diagnosed in the patients' contralateral extremity (3.1%, N = 733, P <.01; Fig. 1).

Of the patients who were treated conservatively for DRF, 6.3% (N = 1,198) developed CTS in the ipsilateral extremity, and 2.9% (N = 546) progressed to CTR. Regarding their contralateral extremity, 2.6% (N = 488) of these patients developed CTS (P <.001; a 3.7% absolute increase in CTS in the DRF extremity; Fig. 2).

Of the patients who were treated surgically for their DRF, 19.8% (N = 981) developed CTS in the ipsilateral extremity and 13.3% (N = 661) progressed to CTR. Regarding their contralateral extremity, 4.9% (N = 245) of these patients developed CTS (P <.001; an absolute increase of 14.9% in the DRF extremity (Fig. 2).

Of the patients who developed CTS, surgical intervention for CTS was performed in 67.3% of surgically managed DRF and 45.6% of nonsurgically managed DRF (OR 2.47). Patients who required

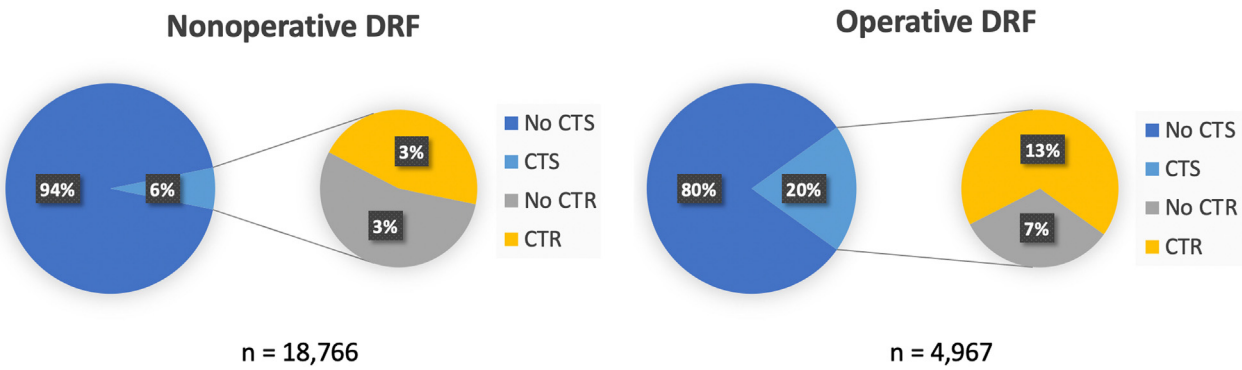

Figure 2. Pie-charts of the study population, comparing the development of CTS and progression to CTR within nonsurgical and surgical DRF cohorts.

Table
Multivariable Analysis Identified Risk Factors in Patients who Underwent CTR After DRF

	Odds Ratio	95% Confidence Interval		*P* Value
		Lower Bound	Upper Bound	
Female sex	1.421	1.213	1.645	<.001
50–59 y	1.23	1.159	1.31	<.001
60–69 y	1.421	1.353	1.494	<.001
70–79 y	1.15	1.095	1.208	<.001
80–89 y	0.915	0.864	0.969	.002
≥90 y	0.96	0.877	1.051	.377
Diabetes	1.362	1.314	1.411	<.001
Hypothyroidism	1.255	1.204	1.309	<.001
Smoking	1.231	1.021	1.421	<.001
Depression	0.886	0.843	0.931	<.001
Obesity	0.819	0.771	0.871	<.001

surgical intervention for their DRF and developed CTS were 1.5 times more likely to undergo surgical CTR than those with a conservatively treated DRF (67.3% vs 45.6%, P <.001).

The average time from DRF to carpal tunnel diagnosis was similar between the nonsurgical and surgical patients (2.5 vs 1.9 months, P =.06). However, patients treated surgically for their DRF underwent surgical management for CTS earlier, on average, than those treated conservatively (1.2 vs 2.5 months, P =.01). Notably, of those patients who developed CTS symptoms severe enough to warrant a CTR within 6 months of a surgically treated DRF, 18.5% required a subsequent second procedure for the CTR.

The multivariable analysis identified several risk factors for patients with carpal tunnel symptoms severe enough to require a CTR. Female gender, age between 50 and 80 years, diabetes, hypothyroidism, smoking, depression, and obesity were each significantly associated with an increased likelihood of the progression to CTR after CTS diagnosis (Table).

Discussion

In this large national database study, we described the epidemiology of CTS and CTR within 6 months of an ipsilateral DRF. We identified an overall incidence of new CTS diagnoses following a DRF to be 9.1%, with 5.1% of patients developing CTS symptoms severe enough to require a CTR. These findings are consistent with previously published literature, which reports a range of rates of acute CTS following DRF to be from 5.4% to 8.6%, and the rates of delayed carpal tunnel to be from 0.5% to 22%.[8,9]

In addition, patients treated surgically for a DRF were at a greater risk for developing CTS requiring surgical intervention than those managed conservatively. This finding aligns with prior literature suggesting that CTS is significantly associated with ORIF for DRFs within 9 months after the fracture.[10] The incidence of CTS development in the surgical DRF cohort was 19.8%, with 67.3% of these patients progressing to CTR. Notably, 18.5% of patients who underwent ORIF of their DRF required a CTR within 6 months. This delay represents a missed opportunity to concurrently address both pathologies by performing the CTR with the DRF.

The etiology of CTS following a DRF is likely multifactorial and has been hypothesized to be related to the change in the carpal tunnel anatomy after the traumatic event.[3,11,12] Dyer et al[7] investigated variables associated with acute CTS following DRF. They found that DRF translation was the most important risk factor in predicting which patients would develop acute CTS in patients with surgically treated DRFs. Similarly, Kim et al[13] found that an increasing Gustilo and Anderson grade and Orthopaedic Trauma Association fracture type C were predictors for requiring a CTR in open DRFs. Similarly, Earp et al[14] found that in patients with DRF undergoing ORIF, those with open fractures, AO fracture type C, and any intervening surgical procedure are at risk for developing acute CTS. It is not surprising that our study demonstrated that patients with DRF requiring surgical intervention had a higher rate of CTS and CTR. It is likely that those DRFs that required surgical intervention had greater severity of bony and soft tissue injury than those distal radius fractures treated nonsurgically.

The use of prophylactic CTR in patients with a DRF is unclear.[15-18] Fuller et al[15] measured the carpal tunnel pressure in 10 patients after volar plate fixation of a DRF and found a decrease in pressure over the first 24 hours after surgery. These authors concluded, “routine prophylactic carpal tunnel release is not recommended after volar plating of distal radius fractures.”[15] However, this recommendation is based on a small series. Our large retrospective study suggests that some patients may benefit from prophylactic CTR on the same day of index surgery for DRF; the incidence of CTS increases significantly in DRFs that require surgery, with 67% of patients diagnosed with CTS developing symptoms severe enough to warrant surgical CTR. Thus, a larger prospective clinical trial may help further characterize patients requiring ORIF after DRF, who may benefit from anticipatory CTR. Notably, roughly 3% of patients in both the surgically and conservatively managed groups of our study developed CTS in the unaffected extremity during the study period. As such, it is important to realize that CTS development in the DRF extremity, to some degree, also has to do with the patient’s underlying preinjury risk factors for CTS.

There are limitations to this study. Foremost, our data came from a large, administrative database, which precluded analysis of fracture or CTS severity, standardization of surgical indications, the impact of plate position, or technique for DRF and CTR. In addition, the information available in the database does not allow for the evaluation of clinical function or patient outcome scores. Furthermore, our analysis relies on the accurate coding of clinical information. Differences in CTS diagnosis between the conservative and surgical DRF groups may also be biased by the specialty of the physician treating the fracture as it may include a diversity of specialists, including nonsurgical physicians, orthopedic trauma surgeons, and hand surgeons who may have varying thresholds to diagnose CTS. As other studies have described, we could not accurately distinguish acute from delayed CTS within the dataset and characterize the fracture characteristics that may predispose patients to develop CTS.[7,10,13,19,20] Finally, we were limited by our follow-up period. We acknowledge that the 6-month timeframe is not based on consensus evidence. However, it represents our best effort to assess the realistic timeframe over which patients with DRF are consistently followed and assessed for ongoing issues following DRF.

In conclusion, we found the overall incidence of CTS within the first 6 months following DRF to be 9.1%, significantly greater than the incidence in the unaffected limb. Furthermore, the incidence of CTS was greater in patients who required surgical fixation of their DRF, suggesting that patients with a higher energy injury or unstable fracture are more likely to develop CTS and require CTR. Importantly, nearly 20% of patients who required a CTR following a surgically treated DRF had the release in a second surgical intervention rather than at the time of the DRF surgical fixation. Based on these data, surgeons should maintain vigilance for symptoms of CTS in patients with DRFs, particularly in those patients with DRFs indicated for surgical intervention who have other risk factors for CTS (female sex, age >50, diabetes, hypothyroidism). Future investigations may help further identify patients undergoing DRF fixation who may benefit from concomitant CTR.

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