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Original Research

Postoperative Pathologies of the Hand Following Shoulder Surgery

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Purpose: Shoulder arthroscopy and arthroplasty are increasingly common procedures used to address shoulder pathologies. This study sought to evaluate the incidence of hand-related pathologies, including carpal tunnel syndrome (CTS), cubital tunnel syndrome (CuTS), trigger finger (TF), de Quervain tenosynovitis, and Dupuytren disease following shoulder arthroscopy and arthroplasty procedures. We hypothesized that patients undergoing shoulder surgery would have a higher incidence of hand-related pathologies within 1 year of surgery compared to controls.

Methods: This was a retrospective analysis of 12,179 patients who underwent shoulder arthroscopy or arthroplasty surgery that were subsequently diagnosed with CTS, CuTS, TF, de Quervain tenosynovitis, or Dupuytren disease within 1 year after surgery. Relative risk of having associated hand pathologies following shoulder surgery was compared to controls.

Results: In total, 10,285 patients underwent shoulder arthroscopy procedures during this period, of whom 815 (7.9%) had an associated hand pathology within 1 year from their shoulder procedure. Arthroscopic surgery was associated with an increased likelihood of having a hand pathology (RR 1.65, 95% CI 1.54–1.76), CTS (RR 1.57, 95% CI 1.42–1.73), CuTS (RR 2.25, 95% CI 1.94–2.61), TF (RR 1.76, 95% CI 1.53–2.03), and Dupuytren disease (RR 2.02, 95% CI 1.54–2.65), but was not associated with a higher likelihood of having de Quervain tenosynovitis. In total, 1,894 patients underwent shoulder arthroplasty procedures during this period, of whom 188 (9.9%) had an associated hand pathology within 1 year. Shoulder arthroplasty was associated with an increased likelihood of having a hand pathology (RR 2.04, 95% CI 1.78–2.34), CTS (RR 2.10, 95% CI 1.72–2.57), CuTS (RR 3.29, 95% CI 2.48–4.39), and TF (RR 1.99, 95% CI 1.47–2.70), but was not associated with an increased likelihood of having de Quervain tenosynovitis or Dupuytren disease.

Conclusions: Shoulder arthroscopy and arthroplasty procedures were associated with an increased likelihood of having a CTS, CuTS, or a TF diagnosis made within 1 year of surgery. Only shoulder arthroscopy procedures were associated with a higher likelihood of having Dupuytren disease. Neither shoulder arthroscopy nor arthroplasty procedures were associated with an increased likelihood of a diagnosis of de Quervain tenosynovitis. These associations, however, do not necessarily imply causation, and further investigation is warranted to delineate this relationship.

Type of study/level of evidence: Differential Diagnosis/Symptom Prevalence Study Level 3.

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Improved technique, implant design, and expanding indications have allowed for increased use of shoulder arthroscopy and arthroplasty in the treatment of various shoulder conditions, such as rotator cuff pathology, end-stage glenohumeral arthritis, and

proximal humerus fractures.^{1–4} Like any surgical intervention, these procedures carry an inherent risk of complications including, but not limited to, infection, vascular or neurologic injury, and implant or repair failure.^{5–9} A previously underappreciated, associated risk, however, is the increased incidence of hand-related pathologies following shoulder surgery.

Previous investigators have noted a link between shoulder surgery and subsequent hand-related conditions including edema, stiffness, numbness, tingling, and the diagnosis of complex regional

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Table 1
Incidence of Hand Pathology and Hand Surgery Following Shoulder Arthroscopy Procedures

Subcategory	Number of Patients (n)	% of Total Patients	% of Patients with Hand Diagnosis	% Patients with the Respective Diagnosis
All patients	10,285	100		
Hand diagnosis within 1 y	815	7.9	100	
CTS	364	3.5	44.7	
CuTS	169	1.6	20.7	
TF	192	1.9	23.6	
de Quervain tenosynovitis	37	0.4	4.5	
Dupuytren disease	53	0.5	6.5	
Underwent hand surgery	160	1.6	19.6	
Carpal tunnel release	75	0.7	9.2	20.6
Cubital tunnel release	30	0.3	3.7	17.8
TF release	42	0.4	5.2	21.9
de Quervain's release	4	0.04	0.5	10.8
Dupuytren's resection	9	0.09	1.1	17.0

pain syndrome (CRPS), carpal tunnel syndrome (CTS), cubital tunnel syndrome (CuTS), and trigger finger (TF).^{5,8,10–15} The exact pathophysiology of these conditions as they relate to shoulder surgery is poorly understood, but it may be in part because of patient positioning and traction, fluid extravasation, compression, prolonged immobilization, and dependent edema following shoulder surgery.^{5,8–16} Additionally, after having established care with an orthopedic provider, patients may be more inclined to voice other underlying symptomologies. Regardless of the cause, patients that develop hand-related conditions can experience considerable discomfort and dysfunction, they often seek further evaluation by hand specialists, and often choose to undergo surgical intervention.^{17–21} There is a paucity of literature regarding the frequency and potential risk of developing these hand pathologies following shoulder surgery, and to our knowledge, no study has compared the incidence of each of these associated hand-related pathologies after shoulder arthroscopy and arthroplasty procedures.

This study sought to evaluate the incidence of CTS, CuTS, TF, de Quervain tenosynovitis, and Dupuytren disease following shoulder arthroscopy and arthroplasty procedures and to determine the relative risks of having each hand-related pathology after surgery. We hypothesized that patients undergoing shoulder surgery would be more likely to have a hand-related pathology diagnosed after surgery, with arthroplasty carrying a greater likelihood than arthroscopy procedures given its more invasive nature and prolonged recovery time. By elucidating the relative patterns of these hand-related pathologies following shoulder surgery at our institution, we aim to better understand the patients that are more likely to develop these conditions.

Materials and Methods

This study was approved by the Institutional Review Board by the Office for Human Subject Protection at the University of Rochester and complied with the Health Insurance Portability and Accountability Act guidelines. Subject informed consent was not required because of the retrospective study design. A retrospective chart review was conducted, analyzing patients who underwent shoulder arthroscopy or arthroplasty and went on to be diagnosed with CTS, CuTS, TF, de Quervain tenosynovitis, or Dupuytren disease within 1 year of surgery. Patients undergoing surgery were identified using Current Procedural Terminology (CPT) codes and those having hand pathologies diagnosed were identified using International Classification of Diseases Tenth Revision (ICD-10) codes.

Inclusion criteria were patients between the ages of 18 and 90 years who underwent shoulder arthroscopy or arthroplasty between April 1, 2010, and April 1, 2020 at a single, large academic institution. Shoulder arthroplasty included both total shoulder arthroplasty (TSA) and reverse total shoulder arthroplasty (rTSA). All subjects had at least one follow-up visit after shoulder surgery with their surgeon, but they were followed for 1 year after surgery for diagnosis of hand pathologies. Subjects were excluded if they had any previously documented diagnosis of CTS, CuTS, TF, de Quervain tenosynovitis, or Dupuytren disease based on ICD-10 codes within the patient's electronic medical record (EMR) indicating the presence of these conditions.

Data were obtained from our institution's EMR and charts were reviewed to determine the presence of CTS, CuTS, TF, de Quervain tenosynovitis, or Dupuytren disease of the ipsilateral, operative extremity within 1 year of the index procedure. A positive diagnosis was considered for all patients diagnosed by a hand surgeon and for which an ICD-10 code was entered. This was verified by chart review. A hand pathology diagnosis was considered to not exist if there was no mention of the condition in chart review and no ICD code entered. Whether the patient underwent surgery within that time was determined by the presence of an operative note detailing the procedure.

The incidence of hand pathologies was compared among those undergoing shoulder arthroplasty or arthroscopy. The control group was age matched and included all patients within the EMR treated at our single, large academic institution for any condition during the study time period (between April 1, 2010, and April 1, 2020), regardless of the presence or absence of shoulder surgery, which represents a sample of the general population in our area for which we have access to their medical records. The surgical group was compared to the comparison group to determine the relative risk of being diagnosed with a hand pathology.

Statistical analysis was performed using standard statistical software. Response variable statistical calculations were conducted using chi-squared analysis. Relative risk (RR) was calculated with a 95% confidence interval (CI) to determine significance.

Results

In total, 10,285 patients underwent shoulder arthroscopy procedures during this period, of whom 815 (7.9%) were diagnosed with a hand pathology within 1 year. The breakdown for each specific diagnosis was as follows: 364 patients (3.5%) carried a diagnosis of CTS, 75 of whom underwent carpal tunnel release; 169 patients (1.6%) with CuTS, 30 of whom underwent cubital tunnel release; 192 patients (1.9%) with TF, 42 of whom underwent TF

Table 2
Incidence of Hand Pathology and Hand Surgery Following Shoulder Arthroplasty Procedures

Subcategory	Number of Patients (n)	% of Total Patients	% of Patients with Hand Diagnosis	% Patients with Respective Diagnosis
All patients	1894	100		
Hand diagnosis within 1 y	188	9.9	100	
CTS	91	4.8	48.4	
CuTS	46	2.4	24.5	
TF	40	2.1	21.3	
de Quervain tenosynovitis	5	0.3	2.7	
Dupuytren disease	6	0.3	3.2	
Underwent hand surgery	47	2.5	25.0	
Carpal tunnel release	27	1.4	14.4	29.7
Cubital tunnel release	12	0.6	6.4	26.1
TF release	6	0.3	3.2	15.0
de Quervain's release	1	0.1	0.5	20.0
Dupuytren's resection	1	0.1	0.5	16.7

Table 3
Relative Risk of Hand Pathology Following Shoulder Arthroscopy or Arthroplasty Versus Controls

Subcategory	Hand Diagnosis	RR	95% Confidence Interval
Shoulder arthroscopy	All included hand diagnoses	1.65	[1.54–1.76]
	CTS	1.57	[1.42–1.73]
	CuTS	2.25	[1.94–2.61]
	TF	1.76	[1.53–2.03]
	de Quervain tenosynovitis	0.88	[0.64–1.21]
	Dupuytren disease	2.02	[1.54–2.65]
Shoulder arthroplasty	All included hand diagnoses	2.04	[1.78–2.34]
	CTS	2.10	[1.72–2.57]
	CuTS	3.29	[2.48–4.39]
	TF	1.99	[1.47–2.70]
	de Quervain tenosynovitis	0.64	[0.27–1.54]
	Dupuytren disease	1.24	[0.56–2.77]

release; 37 patients (0.4%) with de Quervain tenosynovitis, 4 of whom underwent de Quervain release; and 53 patients (0.5%) with Dupuytren disease, 9 of whom underwent Dupuytren resection. For all hand pathologies, 160 patients (1.6% of total patients or 19.6% of the patients with a hand diagnosis) underwent hand surgery (Table 1).

In total, 1,894 patients underwent shoulder arthroplasty procedures during this period, of whom 188 (9.9%) were diagnosed with a hand pathology within 1 year. The breakdown for each specific diagnosis was as follows: 91 patients (4.8%) carried a diagnosis of CTS, 27 of whom underwent cubital tunnel release; 46 patients (2.4%) with CuTS, 12 of whom underwent cubital tunnel release; 40 patients (2.1%) with TF, six of whom underwent TF release; 5 patients (0.3%) with de Quervain tenosynovitis, one of whom underwent de Quervain release; and six patients (0.3%) with Dupuytren disease, one of whom underwent Dupuytren resection. For all hand pathologies, 47 patients (2.5% of total patients or 25.0% of patients with a hand diagnosis) underwent hand surgery (Table 2).

When compared to a control group of all patients during the same time period, patients undergoing shoulder arthroscopy procedures were associated with an increased likelihood of being diagnosed with a hand pathology (RR 1.65, 95% CI 1.54–1.76), CTS (RR 1.57, 95% CI 1.42–1.73), CuTS (RR 2.25, 95% CI 1.94–2.61), TF (RR 1.76, 95% CI 1.53–2.03), and Dupuytren disease (RR 2.02, 95% CI 1.54–2.65) but were not associated with an increased likelihood of being diagnosed with de Quervain tenosynovitis (RR 0.88 95% CI 0.64–1.21) (Table 3). Similarly, patients undergoing shoulder arthroplasty procedures were associated with an increased likelihood of being diagnosed with a hand pathology (RR 2.04, 95% CI 1.78–2.34), CTS (RR 2.10, 95% CI 1.72–2.57), CuTS (RR 3.29, 95% CI 2.48–4.39), and TF (RR 1.99, 95% CI 1.47–2.70) but were not

Table 4
Mean Time From Index Procedure Until Surgery to Address Hand Pathology

Hand Diagnosis	Procedure	Mean Time Until Surgery (Mo)
CTS	Carpal tunnel release	5.9
CuTS	Cubital tunnel release	7.4
TF	TF release	6.9
de Quervain tenosynovitis	de Quervain release	4.5
Dupuytren disease	Dupuytren resection	8.3

associated with an increased likelihood of being diagnosed with de Quervain tenosynovitis (RR 0.64, 95% CI 0.27–1.54) or Dupuytren disease (RR 1.24, 95% CI 0.56–2.77) (Table 3).

The mean time from the index procedure to the surgical intervention to address each hand pathology was as follows: 5.9 months until carpal tunnel release, 7.4 months until cubital tunnel release, 6.9 months until TF release, 4.5 months until de Quervain release, and 8.3 months until Dupuytren's resection (Table 4).

Discussion

Many complications after shoulder surgeries are well documented, but most pertain to localized postoperative problems such as infection or shoulder pain.^{5–9} However, greater attention has recently been directed toward the development of hand-related pathologies. Postoperative edema, stiffness, paresthesias, CRPS, CTS, CuTS, and TF have been previously identified, but the mechanisms behind their development remain poorly understood.^{5,8,10–15}

The most common postoperative hand pathologies in our cohorts were CTS and CuTS. The risk of neurologic symptoms following shoulder surgery, although rare, is a recognized

complication and has been hypothesized to occur secondary to traction of proximal neurologic structures at the level of the brachial plexus and shoulder, rather than affecting distal, terminal nerve branches.^{6–9} Nevertheless, previous studies have also documented the development of distal peripheral neuropathies, namely CTS and CuTS, after shoulder surgery, which is in agreement with our findings.^{5,8,10–12,14,15} The development of these pathologies after surgery is poorly understood and is unlikely to be the result of a direct “injury” related to the performance of the shoulder procedures themselves. In a large retrospective review, Thomasson et al¹⁵ noted high incidences of distal peripheral neuropathies after TSA, rTSA, and arthroscopic rotator cuff repair (ARCR), affecting 7.1%, 12.3%, and 2.8% of patients, respectively. They found that CTS was more common after ARCR, whereas CuTS was more common after TSA and rTSA.¹⁵ Instances of ulnar neuropathy, consistent with CuTS, occurring after rTSA have also been illustrated.^{8,14} In a retrospective study over a 6-year period, Shields et al¹⁴ identified 18 cases of CuTS in rTSA patients, 14 of whom (78%) underwent surgical intervention at a mean of 6.8 months after the index procedure.¹⁴ Moreover, retrospective and prospective reports by Harada et al^{10–12} have further demonstrated development of postoperative CTS and CuTS after ARCR. In each of their studies, they noted a high percentage of patients experiencing hand-related symptoms of numbness, pain, edema, and stiffness. However, rather than CTS or CuTS, TF was the most frequent pathology, even though many of these patients did not demonstrate triggering of the fingers. The authors suggest that if patients develop hand-related symptoms after surgery that may imitate a CRPS-like phenotype, it is important to explore other possible primary hand diagnoses, before making a diagnosis of CRPS.^{10–12}

The cause of these hand-related pathologies after shoulder surgery is not known. As suggested previously, patient positioning and traction, fluid extravasation, compression, prolonged immobilization, and dependent edema are all reasonable hypotheses.^{5,8–12,14–16} For instance, excessive wrist and elbow flexion from prolonged or improper sling usage after surgery could contribute to development of CTS and CuTS by increasing pressures within the carpal and cubital tunnels, respectively.¹⁵ However, the underlying causes are likely multifactorial and inter-related. For example, there have been previous reports of an association between CTS and TF as well as between TF and Dupuytren disease.^{22,23} If these associations truly exist, it may suggest that the pathophysiology of these hand conditions potentially overlap to an extent. Wessel et al²² suggest that the thickening of the A1 pulley sheath and flexor retinaculum occurs as a result of a common underlying pathway, contributing to development of TF and CTS. Additionally, the associated shoulder pathology itself may create an overall inflammatory state of the operative extremity, predisposing patients to development of more distal hand-related pathologies. In fact, in two separate studies, Latif et al^{24,25} noted that patients undergoing ARCR or arthroscopic labral repairs presented with paresthesias in addition to shoulder pain before surgery. Similarly, Horneff et al¹⁶ noted a high incidence of patients exhibiting symptoms of distal peripheral neuropathy even before undergoing ARCR. Harada et al^{10–12} argue that a portion of patients developing postoperative hand pathologies may have underlying subclinical disease that evades diagnosis before surgery and becomes exacerbated by surgery. Overall, it is likely that patients who are diagnosed with hand pathologies after shoulder surgery fall into three categories: patients who had pre-existing pathologies that were only diagnosed after surgery, patients who developed pathologies after their shoulder surgery, and patients with subclinical disease that was exacerbated by surgery.

Neither shoulder arthroscopy or arthroplasty procedures were associated with an increased likelihood of de Quervain tenosynovitis, which was not unexpected. de Quervain tenosynovitis is

primarily the result of repeated friction within the first extensor compartment, and often times splinting is the first line of treatment.²⁰ With prolonged immobilization of the operative extremity, it is unlikely that patients would be at an increased risk for this condition. However, with regards to Dupuytren disease, it remains unclear as to why an elevated likelihood was observed in the arthroscopy group, but not the arthroplasty group, an interesting association that warrants further investigation.

Our study has several limitations. Being retrospective in nature, we were unable to analyze whether patients were adequately screened for these conditions or whether they experienced any signs or symptoms of these conditions before surgery, although we did exclude patients with a previously documented diagnosis of CTS, CuTS, TF, de Quervain tenosynovitis, or Dupuytren disease. Similarly, we did not have the means to capture any procedures performed outside of our institution, which is an inherent limitation of the retrospective design. Additionally, our comparison group included all patients within the EMR during the study time period, rather than patients with an associated shoulder diagnosis, and as noted previously, it is possible that having an associated shoulder pathology in and of itself may predispose patients to the associated hand pathologies. Despite not being completely matched, the comparison group was age matched and the incidence of the hand pathologies considered in this population was in line with that previously reported in the literature.^{17,19,21,26–29} Therefore, the comparison group is taken to represent a sample of the aged-matched population in our area for which we have access to their diagnosis.

Our results, in agreement with previously published data, suggest that patients undergoing shoulder surgery have an associated increased likelihood of being diagnosed with hand-related pathologies after surgery.^{10–12,15} In particular, shoulder arthroscopy and arthroplasty procedures were associated with an increased likelihood of carrying a diagnosis of CTS, CuTS, and TF, with a trend toward a higher likelihood in the arthroplasty patients. Even though association does not necessarily imply causation, hand surgeons performing shoulder surgery should still avoid unnecessary traction or excessive compressive wrapping of the operative extremity and be mindful when positioning patients intraoperatively. Moreover, improved screening for these pathologies should be undertaken after surgery to accelerate diagnosis and treatment. Harada et al^{10–12} noted that swift recognition and treatment of TF and CTS with corticosteroid injection, for example, resulted in improved symptoms and could prevent development of CRPS. Additionally, our findings provide a large data set to aid providers when counseling patients of the risks of developing these associated hand-related pathologies when undergoing shoulder arthroscopy or arthroplasty.

Conflicts of Interest

No benefits in any form have been received or will be received related directly to this article.

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