

Complex Region Pain Syndrome Following Shoulder Surgery



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Purpose: To describe the clinical features, treatment, and outcomes in patients with complex region pain syndrome (CRPS) following shoulder surgeries. **Methods:** Three patients were diagnosed with CRPS according to the Budapest criteria. Patients were followed up prospectively at regular intervals for a minimum of 2 years. Demographic data, clinical symptoms, physical examination findings, treatment received, and outcomes were collected and reported. **Results:** The minimum time interval between surgery and diagnosis was 3 weeks (average, 8 weeks). The index procedures included 2 arthroscopic rotator cuff repairs and 1 open Latarjet. Neurologic pain, muscle spasms, hand and wrist swelling, and joint stiffness were seen in the shoulder, wrist, and hand, but the elbow was spared in all patients. Despite the use of multimodal treatment modalities, the symptoms were refractory to treatment for prolonged periods (range, 6-12 months). Hand and wrist symptoms took an average of 4 months longer than shoulder symptoms to improve. At the latest follow-up (range, 24-26 months), varying degrees of residual hand dysfunction, pain, and inability to make a fist or fully extend the fingers were noted in all 3 patients. **Conclusions:** CRPS type 1 following shoulder surgery is a disabling condition with a long-protracted clinical course. CRPS can present as early as few weeks after shoulder surgery, with symptoms of neuropathic pain, spasm, and stiffness affecting the entire upper-extremity joints except the elbow. CRPS symptoms resolve earlier in the shoulder compared with the wrist and hand, with pain improving first, followed by recovery of motion and function. Residual stiffness affecting grip function is last to recover and can present up to 2 years after onset of symptoms. Although prompt recognition and multimodal approach are considered the mainstay of treatment, there is no gold standard treatment modality that can reproducibly alter the natural history of CRPS. **Level of Evidence:** IV, therapeutic case series.

Complex regional pain syndrome (CRPS) was first described by Ambroise Paré and is now referred to by several terms, including causalgia, algodystrophy, reflex sympathetic dystrophy, shoulder-hand

syndrome, and Sudeck syndrome.¹⁻⁴ All aforementioned synonyms describe this painful disease as characterized by erythema, edema, functional impairment, hypersensitivity, and vasomotor disturbance.¹⁻⁴ However, pain and stiffness are the main symptoms of this pathologic process, which is poorly understood.² CRPS has 2 main clinical types; type 1 occurs without a history of peripheral nerve injury, whereas type 2 occurs in response to peripheral nerve injury.

The incidence of CRPS is difficult to estimate, since this disease process is seen across many subspecialties. However, the estimated incidence for CRPS is 5-25/100,000 people/year.¹ CRPS mainly affects the upper extremities in women and is commonly described after distal radius fractures, carpal tunnel surgery, Dupuytren's contracture release, hand trauma, and stroke.¹⁻⁵ However, CRPS following shoulder surgery is less well described, with an estimated prevalence of 1% of patients following anatomic shoulder arthroplasty and 10% of patients following subacromial decompressions with concurrent procedures.^{6,7} The exact clinical presentation of CRPS following shoulder surgeries is not

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Table 1. Patients' Demographics, History, CRPS-Related Symptoms, and Physical Examination Findings

	Case 1	Case 2	Case 3
Surgery	Shoulder arthroscopy Rotator cuff repair (supraspinatus) and open subpectoralis biceps tenodesis	Shoulder arthroscopy Rotator cuff repair (supraspinatus and infraspinatus) and open subpectoralis biceps tenodesis	Open Latarjet procedure Open capsulorrhaphy (bipolar bone loss instability)
Anesthesia	Regional + sedation	Regional + sedation	Regional + sedation
Age, y	56	59	58
Sex	Female	Female	Female
Affected upper limb	Right	Right	Right
Occupation	Occupational therapist	Hospital housekeeper	Dance teacher
Medical history	Obstructive sleep apnea GERD	None	Anxiety Ankylosing spondylitis Osteoporosis Polycystic kidney disease GERD Diverticulitis Asthma COPD (smoking history)
Surgical history	None	None	Cerebral aneurysm (embolization) Cholecystectomy Incontinence (sling) Tubal ligation
Onset of symptoms (postoperative), d	24	112	35
Symptoms	Shoulder to fingers Severe neurologic pain Swelling Muscle spasms	Shoulder and Hand Sharp pain Swelling Stiffness	Hand Severe neurologic pain Swelling Muscle spasms
Physical examination findings	Stiffness (shoulder, hand, and wrist with normal elbow motion) Cutaneous hyperalgesia Warmth and hyperemia Swelling Loss of skin creases Nail changes Poor hand motion Poor grip strength	Stiffness (shoulder, hand, and wrist with normal elbow motion) Cutaneous hyperalgesia Warmth and hyperemia Allodynia Poor hand motion Poor grip strength Pain to passive motion	Stiffness (shoulder, hand, and wrist with normal elbow motion) Cutaneous hyperalgesia Warmth and hyperemia Allodynia Swelling Muscle fasciculations Skin discoloration Excessive sweating Cold intolerance

COPD, chronic obstructive pulmonary disease; GERD, gastrointestinal reflux disease.

completely clear due to the paucity of reported studies. Therefore, it is unclear whether CRPS following shoulder surgeries involves the entire upper extremity uniformly, or perhaps some joints are more severely affected than others. Herein, we describe prospectively followed 3 cases of CRPS that presented after shoulder surgeries: 2 following an arthroscopic rotator cuff repair and one after an open Latarjet shoulder procedure. The patient's demographics, postoperative course, and CRPS treatments and outcomes are presented and discussed. The purpose of this study is to describe the clinical features, treatment, and outcomes in patients with CRPS following shoulder surgeries. Our hypothesis was that CRPS following shoulder surgeries would lead to a global dysfunction of the upper extremity, with some joints being more severely affected than others.

Methods

This is a prospective study approved by our institutional review board (study number – s18-01216). Three patients were diagnosed with CRPS following shoulder surgeries: 2 after arthroscopic rotator cuff repairs and 1 after open Latarjet procedure. All 3 patients were female, and the average age was 57.6 years (range 56-59 years). Patients were treated with multiple treatment modalities, including pain management, physical therapy and rehabilitation, occupational therapy, and hand surgery consults. Visual analog scores (VAS) for pain were documented preoperatively and postoperatively. Patients were followed up for an average of 24.6 months (range 24-26 months) postoperatively.

Table 2. Treatment Modalities, Improvement of Symptoms, Last Follow-Up, and Residual Symptoms.

	Case 1	Case 2	Case 3
Treatment	NSAIDs (meloxicam, ibuprofen) Acetaminophen Gabapentin (did not tolerate) Duloxetine Methocarbamol	NSAIDs (meloxicam, diclofenac) Acetaminophen	NSAIDs (meloxicam, Toradol, ibuprofen, ketorolac) Acetaminophen Gabapentin (did not tolerate) Baclofen Tizanidine Diazepam Cyclobenzaprine Oral steroids
Additional treatments	Therapy Hand Occupational Physical Consultations Pain management Hand surgeon Rehabilitation medicine Acupuncture (improved hand symptoms)	Therapy Hand Occupational Physical Consultations Pain management Hand surgeon Warm soaks (improved swelling and stiffness)	Therapy Hand Occupational Physical (did not tolerate) Consultations Pain management Hand surgeon Stellate ganglion block (no pain relief)
Improvement of symptoms (postoperative)	6 mo Neurogenic symptoms (pain and spasms)	12 mo Hand symptoms (pain)	11 mo Hand symptoms (pain)
Last follow-up	24 months	26 months	24 months
Residual symptoms	Hand stiffness Trophic signs	Minimal shoulder pain Hand stiffness	Mild shoulder pain Moderate hand pain Hand stiffness

NSAIDs, nonsteroidal anti-inflammatory drugs.

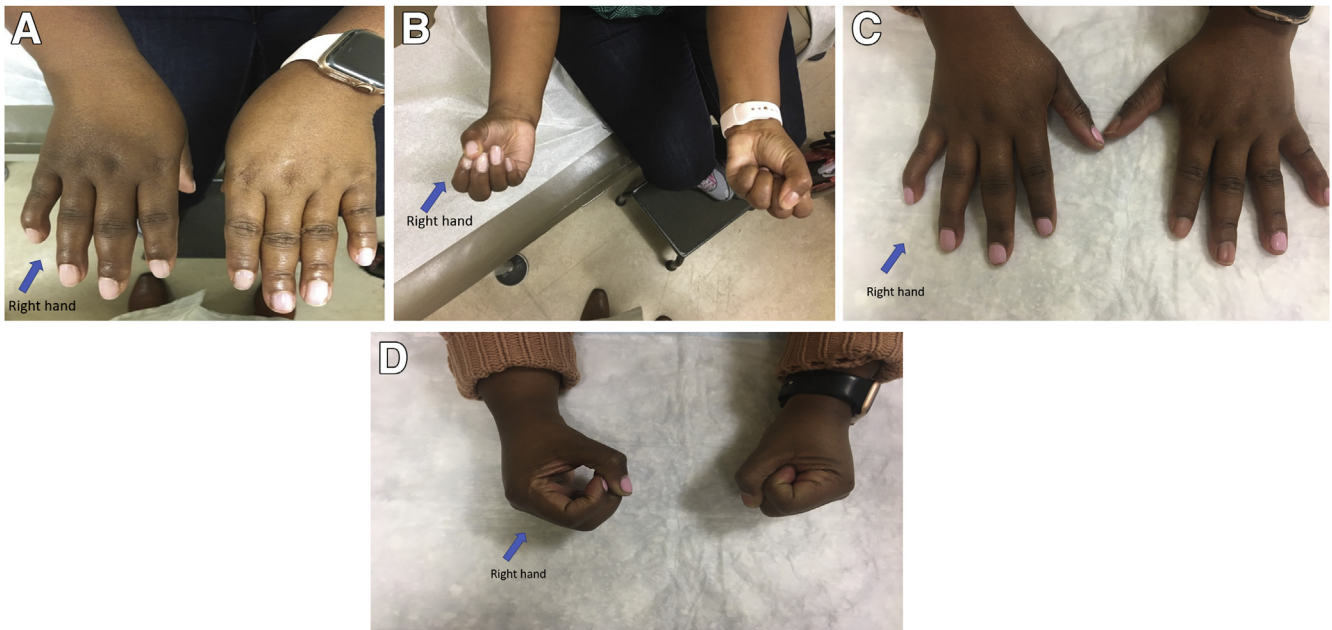


Fig 1. Postoperative images of patient 1 at 24 days following arthroscopic rotator cuff repair. Note right-hand changes (arrows)—diffused hand swelling, loss of dorsal digital skin creases, especially over the distal interphalangeal joints (A), and inability to make a full fist (B). In her last follow-up visit, 24 months postoperatively, swelling around the right hand resolved (C), but the patient is still unable to make a full fist. (D)

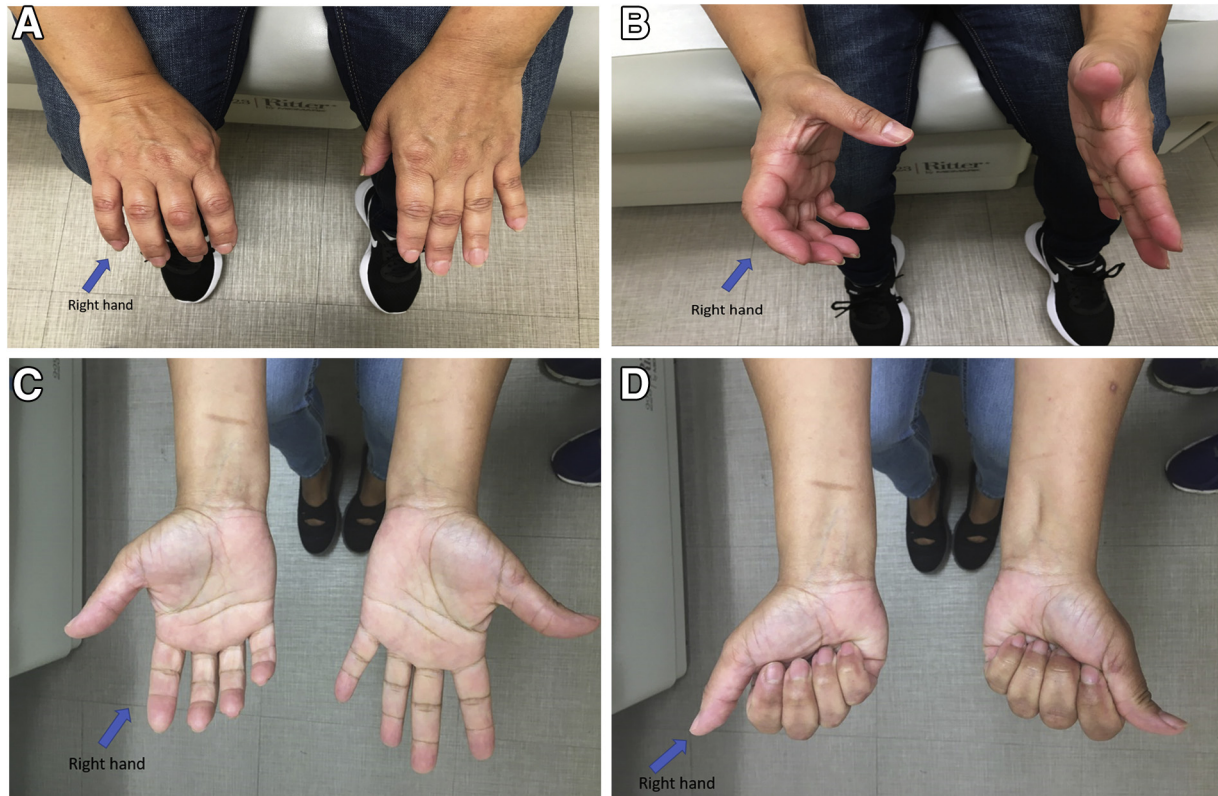


Fig 2. Postoperative images of patient 2 at 112 days images following arthroscopic rotator cuff repair. Note right-hand changes (arrows)—diffused hand swelling (A) and inability to extend the fingers. (B) In her last follow-up visit 26 months postoperatively, swelling around the right hand resolved. However, the patient is still unable to fully extend her fingers (C) or to make a full fist. (D)

Case Presentations

Case 1

Patient Demographics and Medical History

The patient is a 56-year-old right-hand dominant female occupational therapist. Her medical history included obstructive sleep apnea and gastroesophageal reflux disease.

Surgery Details

The patient underwent right arthroscopic supraspinatus tendon repair (double row) with subacromial decompression and open subpectoralis biceps tenodesis (Tables 1 and 2). The patient had regional anesthesia (interscalene nerve block with bupivacaine 0.5%) and sedation for surgery.

Postoperative Symptoms

The patient reported sudden onset of severe pain in her right arm and hand associated with hand swelling 24 days after the index arthroscopic surgery. The patient graded her pain as VAS 9. There was no antecedent trauma before this new onset of right arm pain. Her postoperative pain had recovered considerably, and she had started a supervised physical therapy program.

Her new symptoms included a neurologic type of pain traveling from the shoulder into all her fingers, along with spontaneous spasms in her arm and hand.

The patient's postoperative physical examination findings included shoulder, hand, and wrist stiffness. She had no symptoms in the region of the elbow and had a normal elbow range of motion. She had cutaneous hyperalgesia, mild diffuse swelling, increased warmth, and hyperemia in her wrist and hand with loss of dorsal digital skin creases, especially over the distal interphalangeal joints, and presence of nail changes that developed over a period of few months. Her hand function was minimal at the time of presentation, with poor motion and inability to make a full grip (Fig 1A and B).

Treatment

Various treatment modalities were used during the course of her treatment. Pain management, physical medicine and rehabilitation, and hand surgery consults were obtained. Nonsteroidal anti-inflammatory drugs (NSAIDs) included meloxicam (15 mg once daily for 3 months), ibuprofen (overall 10 trials, each treatment included 800 mg 3 times a day for 14 days, the patient reported this treatment helped her the maximum), and

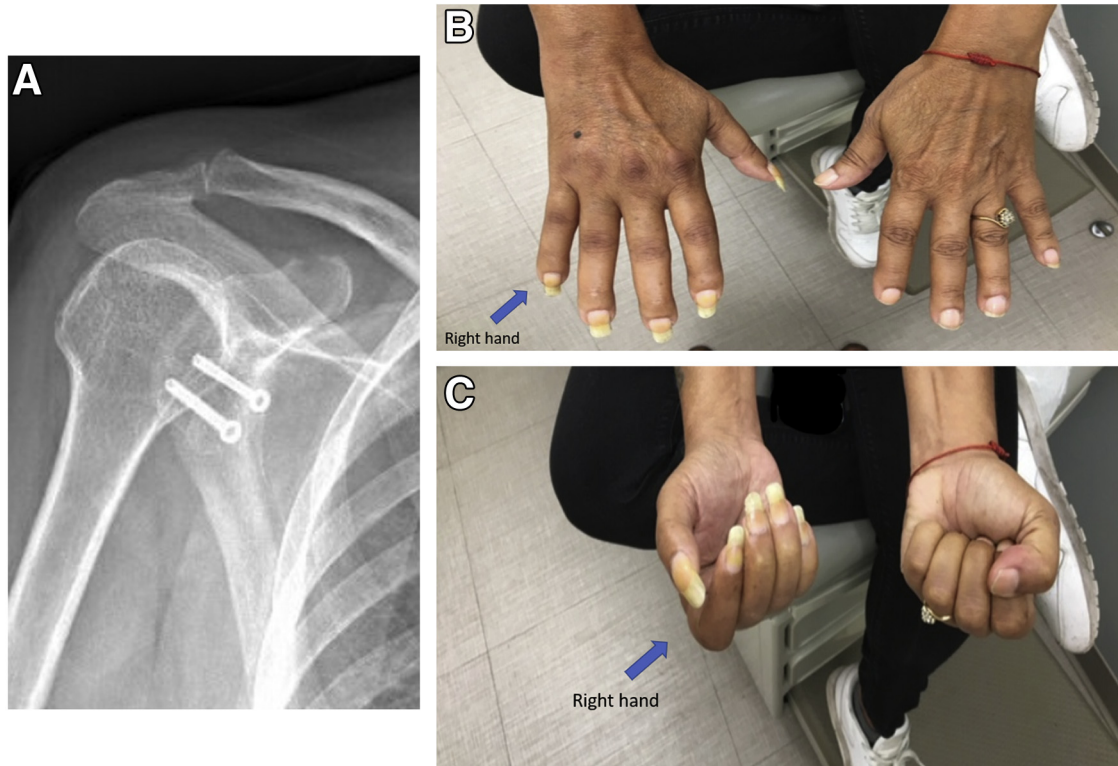


Fig 3. Postoperative images of patient 3 at 35 days following open Latarjet procedure. (A) Postoperative radiographs depict a healed bone graft fixated with 2 cannulated screws. (B) Note right-hand changes (arrows)—diffused hand swelling and loss of dorsal digital skin creases, especially over the distal interphalangeal joints, as well as (C) inability to make a full fist implying poor hand grip strength.

acetaminophen (as needed, maximal dosage—650 mg 4 times a day for 24 months) gabapentin (100 mg 3 times a day for 3 months, the patient did not tolerate the medication after first few doses), duloxetine (20 mg once daily for 30 days, the patient did not tolerate the medication after first few doses), and methocarbamol (for muscle spasms, 500 mg once daily for 3 weeks). The patient was offered a stellate ganglion block, but she refused. She underwent occupational and hand therapy throughout her treatment. The patient had acupuncture and believed that this helped her more with the recovery of hand symptoms.

Case 2

Patient Demographics and Medical History

The second patient is a 59-year-old right-hand dominant female hospital housekeeper. The patient did not have any medical history or previous surgeries on her right shoulder.

Surgery Details

The patient underwent right arthroscopic rotator cuff (supraspinatus and infraspinatus) tendon repair (double row) with subacromial decompression, and open subpectoralis biceps tenodesis. The patient had regional anesthesia (interscalene nerve block with

bupivacaine 0.5%) and sedation for the surgical procedure.

Postoperative Symptoms

Similar to case 1, the patient reported sudden onset severe pain and stiffness in her right shoulder and arm pain that started 112 days after the arthroscopic surgery. The patient graded her pain as on a VAS as 7. She reported hand and wrist stiffness and swelling following the onset of arm pain and was observed at a subsequent follow-up visit. According to the patient, this new-onset pain was different from her initial postsurgical pain, which was already improved, and she was progressing well with the ongoing physical therapy. The patient denied any rest or night pain before this new onset of symptoms. The patient's new onset of symptoms included an intense, sharp pain in her forearm and hand.

Postoperative Physical Examination Findings

The patient's physical examination demonstrated stiffness of the shoulder, hand, and wrist with the normal motion of the elbow. She did not have any muscle spasms. The patient had cutaneous hyperalgesia, swelling, increased warmth and erythema at the dorsum of the hand, and hypersensitivity to light

Table 3. Clinical Diagnostic Criteria (Budapest Criteria) for Complex Regional Pain Syndrome

	Case 1*	Case 2*	Case 3*
A: Disproportionate pain	Yes	Yes	Yes
B: 1 symptom in 3 of the 4 categories			
Category 1: Sensory—hyperesthesia and/or allodynia	Yes	Yes	Yes
Category 2: Vasomotor—temperature asymmetry and/or skin color changes and/or skin color asymmetry	Yes	Yes	Yes
Category 3: Sudomotor/edema—edema and/or sweating changes and/or sweating asymmetry	Yes	Yes	Yes
Category 4: Motor/trophic—decreased range of motion and/or motor dysfunction (weakness, tremor, dystonia) and/or trophic changes (hair, nail, skin)	Yes	Yes	Yes
C: 1 symptom in 3 of the 4 categories			
Category 1: Sensory—evidence of hyperesthesia and/or allodynia	Yes	Yes	Yes
Category 2: Vasomotor—evidence of Temperature asymmetry and/or skin color changes and/or skin color asymmetry	Yes	Yes	Yes
Category 3: Sudomotor/edema—evidence of edema and/or sweating changes and/or sweating asymmetry	Yes	Yes	Yes
Category 4: Motor/trophic—evidence of decreased range of motion and/or motor dysfunction (weakness, tremor, dystonia) and/or trophic changes (hair, nail, skin)	Yes	Yes	Yes
D: No other diagnosis that explains CRPS	Yes	Yes	Yes

NOTE. To confirm the diagnosis of CRPS, A and B and C and D must apply.
CRPS, complex region pain syndrome.

*All 3 cases had presented in this series positive symptoms in each one of the A, B, C, D categories for diagnosis of CRPS.

touch. Her hand function was minimal at the time of presentation as she could not make a full fist, her grip strength was poor, and she was unable to completely extend her 2-5th proximal interphalangeal joints (Fig 2 A and B). Passive extension of the fingers resulted in severe pain. Moreover, elevation of her arm exacerbated her hand and wrist pain symptoms.

Treatment

Multimodal treatment modalities were used for the treatment of pain, swelling, and stiffness. Pain management and hand surgery consultations were obtained. NSAIDs; meloxicam (15 mg once daily for 3 months), acetaminophen (as needed, maximal dosage—650 mg 4 times a day for a period of 26 months), diclofenac (2 trials of 75 mg twice a day did not relieve pain symptoms), and ibuprofen (overall 12 trials during a period of 24 months, each treatment 600 mg 3 times a day, this treatment worked best for pain control) were used. She underwent occupational and hand therapy during her treatment course. The patient reported that modalities used during occupational therapy and warm soaks were most effective in reducing swelling and stiffness in her right hand.

Case 3

Patient Demographics and Medical History

The third patient is a 58-year-old right-hand dominant female dance teacher. The patient has a medical history significant for anxiety, osteoporosis, polycystic kidney disease, gastroesophageal reflux disease, diverticulitis, asthma, chronic obstructive pulmonary disease

(smoking history), and ankylosing spondylitis. Her surgical history includes a cerebral aneurysm embolization, cholecystectomy, incontinence (sling) surgery, and tubal ligation. The patient did not have any previous shoulder surgeries despite her recurrent instability symptoms.

Surgery Details

The patient underwent a right open Latarjet and capsulorrhaphy procedure for bipolar bone loss (glenoid and humeral head) and recurrent instability. The patient had regional anesthesia (interscalene nerve block with bupivacaine 0.5%) and sedation for the operation.

Postoperative Symptoms

The patient reported sudden, sharp, increased ipsilateral hand pain, muscle spasms, and swelling, and decreased sensation in her forearm 35 days following the open procedure. Her postoperative pain had improved significantly prior to the new onset of hand pain and swelling. Also, the patient was progressing well with physical therapy after the index procedure (Latarjet). The patient's symptoms included a severe neurologic type of pain in her ipsilateral hand and arm. According to VAS for pain, she graded her pain as VAS 8.

Postoperative Physical Examination Findings

The patient's physical examination findings included limited motion of her shoulder, hand, and wrist but normal motion of her elbow. She complained of muscle spasms and had intermittent visible muscle

fasciculations in her biceps and triceps. She had cutaneous hyperalgesia, generalized hand swelling, and loss of dorsal digital skin creases, especially over the distal interphalangeal joints. The patient also had increased warmth and hyperemia, skin discoloration, excessive sweating, and hypersensitivity to light touch (tactile allodynia) in her fingers, hand, and wrist. Her hand and wrist symptoms were worse with exposure to cold temperature. Similar to the previous cases, her hand function was minimal at the time of presentation with poor motion and grip strength. The radiographic examination demonstrated a healed bone graft, and she also underwent upper-extremity ultrasound Doppler, electromyography, and nerve conduction test, which were unremarkable (Fig 3A).

Treatment

A multimodal treatment plan was used for pain and spasm control. Pain management and hand surgery consultations were obtained. NSAIDs, including meloxicam (15 mg once a day for 30 days), Toradol (a total of 7 trials were given to the patient, each treatment included an intravenous injection of 15 mg), ibuprofen (overall 12 trials were given to the patient, each treatment included 600 mg 3 times a day for 14 days), acetaminophen (as needed, maximal dosage—650 mg up to 6 times a day for a period of 24 months), gabapentin (300 mg a day for 6 months, improved muscle spasm but the patient had poor tolerance), baclofen (10 mg once a day for 1 month, the patient had poor tolerance), tizanidine (2 mg once a night for 8 months), diazepam (2 mg once a day for 1 month), cyclobenzaprine (one trial of 10 mg once a day for 1 week), and oral steroids (hydrocodone, 5 mg up to 4 times a day for 3 months) were prescribed at some point, with varying response during the course of treatment under the supervision of pain management physician. The patient also underwent a stellate ganglion block with no relief at 12 months after the onset of symptoms. She also had occupational and hand therapy during her treatment course.

Results

Case 1

The neurogenic symptoms (pain and spasms) took at least 6 months before the patient could tolerate them without need for any medication. At the latest follow-up of 24 months after surgery, the patient's pain symptoms improved, and VAS for pain decreased from VAS 9 before treatment to VAS 4 at the last follow-up. Moreover, her neurogenic symptoms are minimal, and she has recovered her shoulder motion and rotator cuff strength. However, she continues to have residual hand stiffness, which prevents her from making a full fist. The trophic signs in her hand are resolving but have not

returned to baseline. The patient graded her pain as VAS 4 (Fig 1 C and D).

Case 2

Resolution of the patient's forearm and hand pain took at least 12 months before becoming tolerable while her hand stiffness did not start to improve until 19 months. According to VAS for pain, her symptoms decreased from VAS 7 before treatment to VAS 1-3 after treatment. She was still unable to return to work due to hand stiffness. At the latest follow up of 26 months, she has minimal shoulder pain and has recovered most of her shoulder motion and function. However, although the patient does not have any hand swelling, residual hand pain and stiffness exists, causing inability to make a full fist or fully extend her fingers (Fig 2 C and D).

Case 3

Resolution of patient's intense hand pain took at least 11 months before becoming tolerable wherein the patient did not require scheduled use of analgesics, muscle relaxants or nerve modulating medications. At the latest follow up of 24 months, the patient reports mild shoulder pain with recovery of her shoulder motion. Her VAS score decreased from VAS 8 before treatment to VAS 1-3 after treatment. However, wrist and hand pain still persist, and she is unable to make a full fist (Fig 3 B and C).

Discussion

In this case series of 3 patients with CRPS following shoulder surgeries, shoulder symptoms and stiffness resolved earlier than hand and wrist symptoms, and the elbow joint was spared in all 3 patients. Shoulder pain and stiffness resolved on an average of 8 months following index surgery (range 3-16 months). The hand pain and stiffness improved considerably, with some residual motor symptoms on an average of 12 months following the index operation (range 5-19 months). Hand and wrist symptoms took an average of 4 months longer than the shoulder symptoms to improve or become more tolerable. Inability to form a full fist and grip weakness were the most disabling residual symptoms at the last follow-up visit.

The incidence of CRPS is difficult to estimate, as multiple diagnostic criteria have been used in the past for the CRPS and may have led to overdiagnosis.^{1,8} In 2010, a European task force solidified a new International Association for the Study of Pain or Budapest Criteria to be used for diagnosis of CRPS, which will make comparing of prior studies and reporting of new studies more meaningful.^{9,10} Accordingly, all patients in this series fulfilled the criteria for the diagnosis of CRPS type 1 (Table 3).

Although CRPS is a clinical diagnosis, patients were worked up for alternate diagnoses of cervical radiculopathy, deep vein thrombosis, and compression neuropathy at the wrist, which were all ruled out. Moreover, case #3 had an electromyography done as recommended by the pain management team and was normal, and case #2 was offered an electromyography, but the patient declined.

The etiology and pathophysiology of CRPS type 1 are not fully understood.¹⁻⁴ CRPS type 1 can present with a variety of symptoms and typically has an identifiable, inciting event.^{1-4,9} In the upper extremity, the most common described etiology is distal radius fractures, which represent 42 % of the cases.^{1,2} Furthermore, surgery and crush injuries combined (32% of the time) as the next most common inciting event for CRPS type 1.⁹ Complex regional pain syndrome has been reported to affect 1% of anatomic shoulder arthroplasties, 10% of subacromial decompressions, either open or arthroscopic and 24 % of arthroscopic rotator cuff repairs.^{6-8,11} In this case series, 2 of 3 patients had arthroscopic rotator cuff repair with subacromial decompression and open sub-pectoralis biceps tenodesis, and the third patient had an open Latarjet with capsulorrhaphy. Interscalene blocks and other regional anesthesia have been questioned as a cause for CRPS type 1 as well.^{9,10} All patients in this case series underwent regional anesthesia (interscalene block) and sedation for the operation, which is standard for shoulder surgeries at our institution. Psychologic factors such as stress, anxiety, and depression disorders also have been described as risk factors, but they did not seem to contribute to our patients.¹²

Symptoms of CRPS typically present within 3 months in the upper extremity limb, ipsilateral to the site of surgery.^{8,10,11} The most frequent symptoms noticed are around the hand and wrist irrespective of the site of surgery. Symptoms include edema (93%), decreased finger motion (83%), hyperalgesia (30%), paridrosis (20%), and atrophic changes (12%).^{1,2,8,10}

The average age of patients in this study was 58 years (range 56-59 years), and all patients were female. The mean duration of onset of symptoms was 57 days (range, 24-112 days) following index surgery. All 3 patients presented with hand and wrist symptoms that were more disabling than postoperative shoulder symptoms. Our findings are consistent with the literature reported following shoulder surgery with regards to the timing of symptoms, sex, age, extremity, and dominant symptoms that are presented.^{1-4,9,13}

A multidisciplinary approach is recommended in the literature for treatment of CRPS in the upper extremity and includes hand and physical therapy, NSAIDs, steroids, dry needling, vitamin C supplementation, mirror therapy, stellate ganglion blocks, antidepressants, anticonvulsants, calcium channel blockers, and adrenergic

agents.^{13,14} Majority of these treatments have been described following fracture, stroke resulting in hemiplegia, hand injuries, and hand surgeries.^{1-4,9,13-15} Fewer reports have described CRPS treatment following shoulder surgery. A multidisciplinary treatment approach, as described in the literature, was used in all 3 patients. Pain management physicians, physical medicine and rehabilitation specialist, hand surgeon, and occupational and hand therapists were all involved in the care of the patients early in the course of treatment. Early rehabilitation and therapy are postulated to prevent CRPS and/or reduce the duration of symptoms after upper extremity injuries, and accordingly, hand therapy and occupational therapy was initiated at the time of diagnosis in all three patients.^{9,12} Anti-inflammatory medications (oral steroids, NSAIDs, and acetaminophen), anticonvulsant analgesics (gabapentin), antidepressants (duloxetine), and muscle relaxants (methocarbamol, diazepam, tizanidine, baclofen, cyclobenzaprine, and diazepam) were used for symptom control. Alternate treatment modalities like acupuncture therapy also were part of the treatment for 1 patient. A stellate ganglion block was given to 1 patient, and the other 2 declined. Opioids were not used for pain control except in the immediate postoperative period in all 3 patients. Despite following the multimodal protocols previously described in the literature, the hand, wrist, and shoulder symptoms persisted for a prolonged period of time after diagnosis (at least 8-12 months). Although we found that greater-dose NSAID therapy was the most effective treatment for controlling the pain symptoms, it does not seem to be a standard gold treatment that can be recommended on the basis of 3 cases or a review of available literature. Due to the long duration of NSAID therapy, patients were kept on gastrointestinal prophylaxis (Pepcid) during the treatment course. Patient perception regarding successful treatment was variable, with 1 patient reporting acupuncture as the most effective treatment modality, and 1 patient reported warm soaks and occupational therapy as the most effective treatment modality for her hand swelling and stiffness. The aforementioned observations highlight our limited understanding regarding CRPS etiology, absence of a current gold standard treatment modality that can reliably and reproducibly alter the natural history of CRPS.

At the latest follow up (range 24-26 months), all 3 patients have varying degrees of residual hand pain. However, the most recognizable residual symptom is hand stiffness with inability to make a full fist (2 patients) or inability to fully extend the fingers (1 patient). The recovery process for a patient with CRPS following shoulder surgery is long, and residual hand dysfunction can persist for more than 24 months at the very least, which is consistent with literature.^{2,4} This is important

information to share with a newly diagnosed patient with CRPS regarding the duration of symptoms, and overall prognosis with CRPS.

Limitations

Our study has several limitations. First, due to the rarity of this condition, the sample size of our study is small and includes only 3 patients. Second, the treatment regimens were similar but not identical for all patients. However, these variations in treatment protocols are probably related to the recommended multidisciplinary approach and the relatively high number of physicians who treated the patients. Finally, although all 3 patients underwent shoulder surgeries, there were differences in the type of surgeries and the surgical approach (arthroscopic vs open). We acknowledge that these drawbacks make the external applicability of our findings is limited. However, we do believe our study's results contribute to the current literature, especially with regards to the timeline of resolutions of symptoms and sparing of the elbow joint.

Conclusions

CRPS type 1 following shoulder surgery is a disabling condition with a long-protracted clinical course. CRPS can present as early as few weeks after shoulder surgery, with symptoms of neuropathic pain, spasm, and stiffness affecting the entire upper extremity joints except the elbow. CRPS symptoms resolve earlier in the shoulder compared to the wrist and hand, with pain improving first, followed by recovery of motion and function. Residual stiffness affecting grip function is the last to recover and can present up to 2 years after onset of symptoms. Although prompt recognition and multimodal approach are considered the mainstay of treatment, there is no gold standard treatment modality that can reproducibly alter the natural history of CRPS.

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