

COMPLEX REGIONAL PAIN SYNDROME OF THE SHOULDER: A COMPREHENSIVE REVIEW OF CLINICAL FEATURES, DIAGNOSIS, AND PHYSIOTHERAPY MANAGEMENT

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ABSTRACT

Background: Complex Regional Pain Syndrome (CRPS) is a painful and disabling condition characterized by persistent pain, stiffness, sensory disturbances, swelling, and changes in skin color or temperature. When the shoulder is affected, these manifestations can substantially restrict movement and interfere with daily activities.

Objective: To review the available literature on CRPS of the shoulder joint, focusing on its clinical characteristics, diagnostic approaches, treatment strategies, and reported outcomes, with particular emphasis on physiotherapy management.

Methods: A literature review was conducted using PubMed, Scopus, and Google Scholar. Studies published between 2010 and 2026 were identified using the keywords "Complex Regional Pain Syndrome," "CRPS," and "shoulder." English-language human studies involving adults were considered. Studies addressing diagnosis, treatment, or outcomes of shoulder CRPS were included, whereas non-English studies, animal studies, and studies focusing on CRPS in other body regions without shoulder involvement were excluded. Two reviewers independently screened the studies, and relevant information regarding study design, patient characteristics, diagnostic criteria, treatment approaches, and outcome measures was extracted. Findings were synthesized qualitatively.

Results: Twenty-five studies met the inclusion criteria. Most participants were adults aged 30–60 years, and the Budapest Criteria were commonly used for diagnosis. Physiotherapy was the most frequently reported intervention, primarily targeting pain reduction and maintenance of shoulder mobility. Pharmacological treatment, nerve blocks, injections, and psychological support were also reported. Combined physiotherapy and medical management generally demonstrated improvement in pain and shoulder movement, although some patients experienced persistent stiffness or residual pain.

Conclusion: Early diagnosis and multidisciplinary management are important in shoulder CRPS. Physiotherapy appears to have an important role in reducing pain, maintaining mobility, and improving functional recovery. Further research is required to establish standardized rehabilitation protocols and long-term outcomes.

KEYWORDS: Complex Regional Pain Syndrome; Shoulder; Physiotherapy; Rehabilitation; Pain; Budapest Criteria.

INTRODUCTION

The shoulder joint, anatomically designated as the glenohumeral joint, represents the most mobile multi-axial ball-and-socket joint in the human body, situated at the junction of the upper extremity and the axial skeleton [1]. The osseous framework of the shoulder girdle comprises three distinct structural elements: the proximal humerus, the scapula, and the supporting clavicle [1, 2]. The rounded head of the humerus articulates with the relatively small, shallow glenoid cavity of the scapula. Because these bony articular surfaces do not form a tight congruent mechanical fit, the glenohumeral joint inherent structural stability is minimal, requiring extensive reliance on surrounding capsuloligamentous and muscular soft tissue networks for dynamic stabilization [2, 3].

The primary dynamic stabilizers of the shoulder consist of the rotator cuff muscular complex, comprising four specific muscles: the supraspinatus, infraspinatus, teres minor, and subscapularis [3]. Three of these musculo-tendinous units envelop the humeral head to keep the ball centered accurately within the glenoid fossa throughout dynamic movement [3]. Static restraint is provided by the capsular apparatus and the glenohumeral ligaments (superior, middle, and

inferior portions), which form a protective hammock mechanism to prevent anterior and inferior subluxation [4]. Accessory ligamentous structures, including the coracoacromial and coracoclavicular ligaments, anchor the scapula to the clavicle, maintaining architectural alignment [5]. Small fluid-filled synovial bursae—most notably the subacromial-subdeltoid bursa—act as low-friction cushions between moving tendinous structures and bone [5]. This specialized anatomy enables an extraordinary range of motion across multiple kinematic planes, including flexion (180°), extension (45°–60°), abduction (150°–180°), adduction (30°–50°), internal rotation (70°–90°), external rotation (90°), and multi-planar circumduction [4].

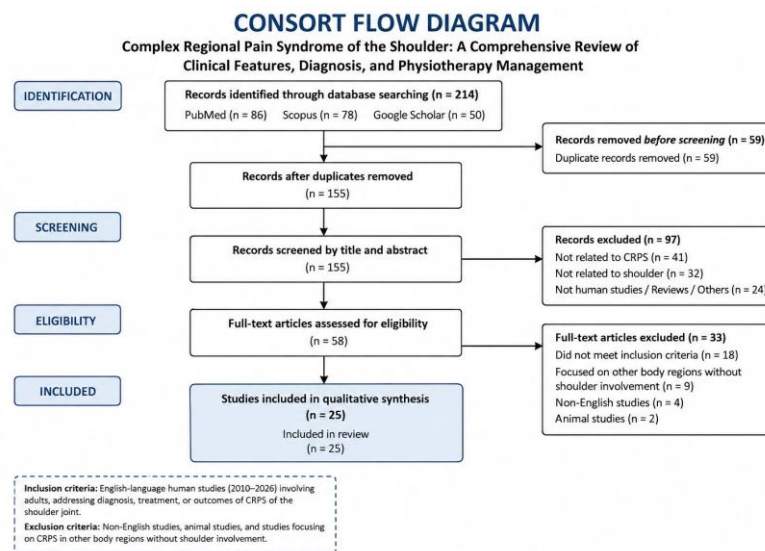
However, this extreme functional mobility renders the shoulder girdle highly vulnerable to acute musculoskeletal injuries and chronic overload wear-and-tear conditions [6]. Common acute traumatic pathologies include traumatic shoulder dislocations, acute rotator cuff tendinous tears, labral cartilage disruptions (such as SLAP or Bankart lesions), fractures of the humerus, scapula, or clavicle, and severe ligamentous sprains [7]. Overuse or chronic microtraumatic mechanical conditions frequently involve degenerative rotator cuff tears, biceps tendinopathy, and rare deltoid muscular tears [8].

Following acute trauma, surgical intervention (e.g., rotator cuff repair or open reduction and internal fixation), or central neurological events (such as cerebrovascular accidents resulting in hemiplegia), a subset of patients develop a disproportionate, severely debilitating neuro-inflammatory condition known as Complex Regional Pain Syndrome (CRPS) [9, 10]. When affecting the shoulder joint—often in continuity with the distal hand as Shoulder-Hand Syndrome (SHS)—CRPS manifests as severe unremitting burning pain, marked joint stiffness, hyperalgesia, cutaneous temperature and color asymmetry, localized edema, and profound motor dysfunction [9, 11]. The disease etiology stems from a complex breakdown across peripheral and central sensory pathways [10, 11].

Pathophysiologically, localized musculoskeletal tissue damage initiates excessive neurogenic inflammation driven by sustained peripheral nociceptor activation and the local release of pro-inflammatory neuropeptides, including substance P and calcitonin gene-related peptide (CGRP), along with pro-inflammatory cytokines such as TNF- α and IL-6 [12, 13]. Concurrently, autonomic sympathetic dysregulation induces abnormal vascular responsiveness, producing thermal fluctuations and sudomotor disturbances in the affected limb [14]. As nociceptive signaling persists, profound central sensitization occurs within the spinal cord and higher cerebral centers [15, 16]. Functional neuroimaging reveals reorganization and representation blurring within the primary somatosensory cortex (S1) and motor cortex (M1), leading to motor neglect, body schema distortion, and severe kinesiophobia [15, 17].

Given the substantial risk of secondary adhesive capsulitis (frozen shoulder), permanent articular contracture, muscle atrophy, and long-term functional loss, prompt clinical recognition and evidence-based management are essential [11, 18].

MATERIAL & METHODOLOGY



Complex Regional Pain Syndrome (CRPS) is predominantly diagnosed in adults aged 40 to 60 years, though it also presents in individuals older than 65 years, particularly following surgical procedures, joint manipulation, or direct limb trauma. To review this condition, a systematic electronic literature search was conducted using PubMed, Scopus, and Google Scholar for studies published between 2010 and 2026, utilizing keyword combinations including "Complex Regional Pain Syndrome," "CRPS," "Shoulder," "Shoulder-Hand Syndrome," and "Physiotherapy Rehabilitation". Studies were included if they addressed diagnostic methods, physical therapy protocols, pharmacological treatments, or functional clinical outcomes of CRPS involving the shoulder among adult human

subjects (18–65+ years) across clinical trials, observational cohort studies, and systematic review syntheses. Conversely, research was excluded if it comprised case series with fewer than 5 patients, evaluated CRPS exclusively in isolated lower extremities or the distal hand/wrist without shoulder involvement, consisted of animal or in-vitro models, or was published in languages other than English. Two reviewers independently screened titles, abstracts, and full texts for eligibility, resolving any disagreements through structured consensus. Extracted data encompassed study design, patient demographics, diagnostic protocols, therapeutic modalities such as physiotherapy, nerve blocks, and pharmacotherapy, as well as standardized clinical outcome measures including the pain visual analog scale (VAS), shoulder active range of motion (AROM), and overall functional status.

RESULTS

The literature search identified studies addressing the clinical presentation, diagnosis, management, physiotherapy rehabilitation, and outcomes associated with Complex Regional Pain Syndrome (CRPS) involving the shoulder. Following screening of titles, abstracts, and full-text articles according to the predefined eligibility criteria, 25 studies were considered eligible for inclusion in the qualitative synthesis. The included literature comprised clinical trials, observational studies, and review-based evidence addressing diagnostic approaches, rehabilitation strategies, pharmacological management, interventional procedures, and functional outcomes.

The majority of the included studies were published between 2012 and 2025, reflecting the increasing clinical and research interest in contemporary approaches to CRPS management. The reviewed evidence predominantly concerned adult populations, with most patients falling within the 30–60-year age range. A secondary group consisted of older adults, particularly individuals above 65 years of age who developed shoulder-hand manifestations following neurological events, especially stroke.

Table 1. General Characteristics of the Included Literature

Characteristic	Findings from the reviewed literature
Total studies included	25 studies
Publication period represented in the synthesis	Majority published between 2012 and 2025
Population	Adult human participants
Predominant age group	30–60 years
Additional population identified	Adults >65 years, particularly post-stroke patients
Clinical presentation	Shoulder CRPS and shoulder-hand manifestations
Common clinical contexts	Trauma, surgery, and neurological conditions including stroke
Study approaches represented	Clinical trials, observational studies, and review-based evidence
Main areas investigated	Diagnosis, physiotherapy, pharmacological management, interventional procedures, and clinical outcomes
Main outcome domains	Pain, shoulder range of motion, stiffness, and functional status

The synthesis demonstrated that shoulder CRPS predominantly affected adults and was reported in different clinical contexts, including following trauma, surgical procedures, and neurological impairment. The most frequently represented age group was 30–60 years. However, the reviewed literature also identified an important subgroup of older adults, particularly those with post-stroke hemiplegia and associated shoulder-hand manifestations.

Clinically, the condition was characterized by a combination of persistent or disproportionate pain, sensory abnormalities, swelling, alterations in skin temperature and color, stiffness, and motor dysfunction. These manifestations were not restricted to the glenohumeral joint and could extend distally into the hand, particularly in presentations described as Shoulder-Hand Syndrome.

The reviewed evidence indicated that the combination of pain, edema, autonomic alterations, and progressive restriction of movement can substantially interfere with upper-limb function. Persistent symptoms were also associated with reduced participation in active movement and increased fear of movement, potentially contributing to secondary stiffness and functional decline.

Diagnostic Findings

Across the contemporary literature, the IASP Budapest Criteria emerged as the principal diagnostic framework for establishing the clinical diagnosis of CRPS. The criteria organize the clinical manifestations into four major categories: sensory, vasomotor, sudomotor/edema, and motor/trophic abnormalities.

The use of these categories is particularly relevant in shoulder CRPS because symptoms may overlap with other common causes of shoulder pain and stiffness, including adhesive capsulitis, post-surgical capsular restriction, and

post-stroke shoulder-hand manifestations. The reviewed literature emphasized the importance of identifying the characteristic combination of autonomic, sensory, and motor findings rather than interpreting shoulder stiffness as an isolated mechanical problem.

The diagnostic findings identified from the reviewed studies are presented in Table 3.

Table 3. Diagnostic Characteristics of Shoulder CRPS Reported in the Literature

Budapest category	diagnostic	Principal findings reported
Sensory		Hyperalgesia, altered pain perception, and sensory disturbances
Vasomotor		Temperature asymmetry and skin-color changes
Sudomotor/edema		Localized edema and altered sweating/sudomotor responses
Motor/trophic		Reduced ROM, stiffness, motor dysfunction, and trophic changes
Clinical examination		Identification of disproportionate pain combined with autonomic and motor abnormalities
Differential diagnosis		Differentiation from adhesive capsulitis, post-surgical stiffness, and post-stroke shoulder disorders
Standard framework	diagnostic	IASP Budapest Criteria
Imaging/other investigations		Used as supportive or differential diagnostic approaches rather than replacing clinical diagnostic criteria

Physiotherapy Interventions

Physiotherapy represented the core rehabilitation intervention across the reviewed literature. The principal objective of rehabilitation was to reduce pain-related disability while maintaining or progressively restoring shoulder mobility and upper-limb function.

The physiotherapy approaches most frequently emphasized in the reviewed evidence were active pacing exercises, Graded Motor Imagery (GMI), mirror therapy, and desensitization techniques. Rather than relying exclusively on mechanical restoration of range of motion, contemporary rehabilitation approaches increasingly incorporated strategies directed toward altered sensory processing, movement-related fear, and cortical reorganization.

Active pacing was used to encourage controlled participation in movement while minimizing symptom exacerbation. Desensitization approaches were directed toward reducing abnormal sensory responses and improving tolerance to tactile and movement-related stimuli. GMI and mirror therapy provided graded exposure to movement-related cortical activity while attempting to minimize excessive peripheral nociceptive stimulation.

GMI was particularly relevant because it provides a sequential approach involving laterality recognition, explicit motor imagery, and mirror therapy. This approach was discussed in the literature as a means of addressing altered cortical representation, movement-related fear, and central sensitization. Although physiotherapy represented the central rehabilitation component, the reviewed literature demonstrated that medical and interventional approaches were frequently used as adjuncts, particularly in patients with severe pain that limited participation in rehabilitation. Reported pharmacological approaches included bisphosphonates, gabapentinoids, and short courses of corticosteroids. Bisphosphonates were discussed particularly in relation to CRPS-associated skeletal and inflammatory changes, whereas gabapentinoids were used to address neuropathic pain and abnormal sensory processing. Interventional procedures, including stellate ganglion blocks, were reported for selected patients with severe sympathetically maintained pain. Neuromodulation approaches, including dorsal root ganglion-related interventions, were also identified within the contemporary literature. Importantly, these approaches were generally described as components of a multidisciplinary management strategy rather than substitutes for rehabilitation. Reduction of severe pain through medical or interventional treatment may provide a therapeutic window in which patients can participate more effectively in active physiotherapy.

Table 5. Medical and Interventional Approaches Reported in the Reviewed Literature

Treatment category	Intervention reported	Main clinical purpose
Pharmacological	Bisphosphonates	Management of CRPS-related pain and skeletal/inflammatory changes

Treatment category	Intervention reported	Main clinical purpose
Pharmacological	Gabapentin/pregabalin	Modulation of neuropathic and abnormal sensory pain
Pharmacological	Short-course corticosteroids	Management of selected inflammatory presentations
Interventional	Stellate ganglion block	Management of severe sympathetically maintained pain
Interventional	Neuromodulation/DRG-related approaches	Considered for persistent or severe CRPS
Rehabilitation	Physiotherapy	Pain management, mobility, and functional restoration
Psychological	Psychological support/CBT or ACT approaches	Address fear-avoidance, catastrophizing, coping, and self-efficacy
Multidisciplinary	Combined treatment	Integrates rehabilitation with medical, interventional, and psychological management

The principal outcome domains identified across the reviewed literature were pain intensity, shoulder range of motion, stiffness, and functional recovery. Overall, the evidence suggested that patients receiving early and coordinated multidisciplinary care demonstrated better clinical improvement than patients managed using isolated treatment approaches.

Pain reduction was an important therapeutic outcome, particularly because severe pain may prevent active shoulder movement and contribute to avoidance behavior. Improvements in shoulder mobility were also consistently emphasized because persistent stiffness may progress to secondary adhesive capsulitis and fixed restriction of movement.

Functional improvement was closely related to improvements in pain and mobility. Rehabilitation strategies that incorporated active pacing, graded movement, desensitization, GMI, and mirror therapy were intended not only to improve physical capacity but also to reduce fear of movement and facilitate functional use of the affected limb.

However, the reviewed evidence also demonstrated variability in treatment response. Some patients continued to experience residual pain, stiffness, or functional limitation despite treatment. This finding highlights the multifactorial nature of CRPS and the importance of early diagnosis and individualized management.

Table 6. Outcome Domains and Overall Findings

Outcome domain	Findings from the literature
Pain	Reduction reported with appropriate multidisciplinary management
Shoulder ROM	Improvement reported following rehabilitation and symptom control
Shoulder stiffness	Reduction possible with early and graded rehabilitation; persistent stiffness may remain in some patients
Upper-limb function	Improvement associated with reduction in pain and restoration of mobility
Movement-related fear	GMI, mirror therapy, education, and graded activity may help address Kinesio phobia
Sensory symptoms	Desensitization and graded rehabilitation may improve tolerance
Edema/autonomic symptoms	May improve with overall disease management
Functional independence	Improved with restoration of movement and progressive functional activity
Long-term outcome	Variable; some patients experience persistent pain or stiffness
Overall treatment finding	Early multidisciplinary treatment generally provides better clinical recovery than isolated management

DISCUSSION

The clinical presentation and management of Complex Regional Pain Syndrome affecting the glenohumeral joint represent a major challenge in orthopedic and neurological rehabilitation [9, 11]. Over the past decade (2015–2026), translational pain neuroscience has advanced our understanding of shoulder CRPS, shifting the paradigm from a historical model of localized autonomic hyper-reactivity to a complex, multi-system neuro-inflammatory and neuroplastic pathology [10, 12, 15].

A crucial diagnostic hurdle in clinical practice is differentiating early-stage shoulder CRPS Type I from severe hyperalgesic secondary adhesive capsulitis (frozen shoulder) or post-surgical capsular tightness following rotator cuff repair or fracture fixation [8, 18, 19]. Misdiagnosing early shoulder CRPS as simple mechanical joint stiffness

frequently leads to the premature prescription of aggressive passive joint stretching, forceful manual mobilization, or high-intensity exercise [18, 20]. Clinical and physiological evidence confirms that applying forceful mechanical force in the presence of active neurogenic inflammation and central sensitization provokes severe nociceptive flares [13, 21]. This mechanical irritation stimulates perivascular sensory nerve endings to release substance P and CGRP, intensifying tissue extravasation, expanding localized edema, and driving secondary sympathetic outflow [12, 14]. Consequently, early diagnostic screening via the validated Budapest Criteria is imperative before initiating physical therapy [22]. Neuroimaging studies utilizing functional MRI and magnetoencephalography have established that prolonged pain and limb disuse in shoulder CRPS cause functional shrinkage and spatial degradation of the primary somatosensory cortex (S1) and motor cortex (M1) representations corresponding to the affected upper limb [15, 17, 23]. Patients frequently experience motor neglect, body schema distortion, and severe kinesiophobia, perceiving the affected shoulder and hand as 'alien' or structurally altered [17, 24]. Therefore, traditional biomechanical rehabilitation targeting only peripheral shoulder range of motion is insufficient unless coupled with brain-targeted central cortical re-mapping [21, 25]. Graded Motor Imagery (GMI) has emerged as a key evidence-based neuro-rehabilitative approach for upper limb CRPS [25, 26]. GMI consists of three sequential stages: (1) implicit left/right limb judgment training, (2) explicit motor imagery, and (3) mirror therapy [25]. By systematically engaging premotor and motor cortical areas without generating peripheral nociceptive signaling, GMI helps reorganize somatosensory networks, reduce central hyperexcitability, and decrease movement-related fear, providing a safe transition toward sub-threshold functional active exercise [25, 27]. Optimal therapeutic outcomes require a synchronized interdisciplinary model integrating physical therapy, pharmacological agents, interventional pain management, and psychological support [11, 28]. In acute and subacute phases, bisphosphonates (e.g., neridronate, pamidronate) show efficacy in resolving periarticular bone marrow edema and microvascular pain [28]. Concurrently, gabapentinoids (gabapentin, pregabalin) help modulate central sensory processing [11]. When severe sympathetically maintained pain limits active exercise, targeted stellate ganglion blocks (SGB) or dorsal root ganglion (DRG) stimulation can afford temporary pain relief, opening a critical therapeutic window for active neuro-rehabilitation [29, 30]. Prognostically, early intervention remains the single most important predictor of functional recovery in shoulder CRPS [18, 22]. Diagnostic delays exceeding 3 to 6 months markedly increase the risk of fixed glenohumeral capsular contracture, permanent muscular atrophy, myofascial pain syndrome, and chronic disability [11, 18]. Furthermore, psychological factors such as pain catastrophizing, fear-avoidance beliefs, and depression strongly influence disease trajectory [24]. Incorporating Cognitive Behavioral Therapy (CBT) or Acceptance and Commitment Therapy (ACT) addresses maladaptive coping strategies, improves self-efficacy, and supports long-term functional autonomy [24, 28]. In conclusion, managing CRPS of the shoulder requires moving beyond mechanical stretching toward a comprehensive, brain-targeted neuro-rehabilitation approach. Combining precise Budapest-based early diagnosis, gentle pacing-based physical therapy, central cortical retraining via GMI, targeted interventional pain management, and interdisciplinary psychological care represents the gold standard for reducing pain and optimizing upper extremity functional recovery [11, 22, 25, 28].

CONCLUSION

This review highlights that CRPS affecting the shoulder joint is a complex, highly disabling condition requiring early diagnostic identification and structured multidisciplinary care. Early assessment using the validated Budapest Criteria is essential to avoid misdiagnosis and prevent inappropriate, aggressive mechanical interventions. The literature demonstrates that combined multidisciplinary treatment—integrating brain-targeted physical rehabilitation (such as Graded Motor Imagery and active pacing exercises) with pharmacological and interventional pain strategies—yields superior outcomes compared to monotherapy. Future prospective clinical trials with standardized rehabilitation protocols are needed to optimize long-term functional recovery for patients with shoulder CRPS.

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