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CURRENT EVIDENCE ON PLATELET-RICH PLASMA (PRP) IN THE MANAGEMENT OF UPPER LIMB TENDINOPATHIES

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ABSTRACT

Platelet-rich plasma (PRP) is an autologous blood derivative enriched in platelets and growth factors, increasingly utilized to enhance tendon healing in upper limb tendinopathies. This review systematically examines current evidence on PRP's biological mechanisms and clinical efficacy in managing tendinopathies affecting the shoulder, elbow, and wrist. PRP exerts multifactorial effects by modulating inflammation, stimulating tenocyte proliferation, angiogenesis, and extracellular matrix remodeling. Clinical studies demonstrate PRP's potential to reduce pain and improve function in rotator cuff tendinopathy, biceps tendinopathy, lateral and medial epicondylitis, and De Quervain's tenosynovitis. Evidence also suggests PRP's role as an adjunct in post-surgical tendon healing, facilitating earlier recovery and functional gains. However, heterogeneity in preparation methods and treatment protocols necessitates further standardized trials to optimize therapeutic outcomes.

KEYWORDS

Platelet-Rich Plasma, PRP, Upper Limb Tendinopathy, Rotator Cuff, Lateral Epicondylitis, Medial Epicondylitis, Biceps Tendinopathy, De Quervain's Tenosynovitis, Tendon Healing, Post-Surgical Recovery

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Introduction

Platelet-rich plasma (PRP) is an autologous blood derivative defined by a supraphysiologic concentration of platelets suspended in plasma and, depending on preparation, variable amounts of leukocytes and fibrinogen. PRP preparations are obtained by centrifugation or apheresis of peripheral blood and are intended to deliver a concentrated pool of platelet-derived growth factors and bioactive proteins to sites of tissue injury to augment physiological repair processes. Clinical adoption of PRP across musculoskeletal indications has been driven by its theoretical potential to provide a localized, patient-derived source of signalling molecules that regulate inflammation, cell recruitment, angiogenesis and extracellular matrix remodelling. At the cellular and molecular level, the therapeutic rationale for PRP derives from the contents of platelet α-granules, which release a repertoire of growth factors and cytokines upon activation. Key mediators identified in PRP include platelet-derived growth factor, transforming growth factor-β, vascular endothelial growth factor, epidermal growth factor and insulin-like growth factor, among others. These factors act on resident tenocytes, progenitor cells and endothelial cells to promote chemotaxis, mitogenesis, angiogenesis and synthesis of collagen and other matrix components, thereby theoretically facilitating tissue repair in degenerative or injured tendons. In addition to growth factors, PRP contains adhesive proteins such as fibronectin and vitronectin, that may provide a provisional matrix, and bioactive peptides with antimicrobial and immunomodulatory properties [1].

Mechanistically, PRP's effects are multifactorial and context dependent. Released growth factors modulate early inflammatory signalling and cellular proliferation. Platelet-derived chemokines influence recruitment and activation of mesenchymal progenitors. Fibrin scaffold that forms after activation can serve as both a delivery vehicle and a structural template for cell ingrowth. The net biological outcome is shaped by interactions among growth factor concentrations, leukocyte content, activation method, and the recipient tissue milieu, which together determine the balance between pro-inflammatory, pro-regenerative and fibrotic responses. Consequently, heterogeneity in preparation protocols and product composition yields variable biological potency and may underlie inconsistent clinical outcomes reported across studies [2].

Contemporary evidence underscores that PRP constitutes a pivotal modality in regenerative medicine, with its therapeutic potential highly dependent on preparation techniques that yield products with variable

compositions of bioactive molecules. While platelets represent the principal functional component, additional constituents - including leukocytes and other plasma-derived factors - contribute to the modulation of immune responses and tissue repair processes. Leukocyte-rich PRP may enhance healing by facilitating microbial clearance and stimulating growth factor release. However, excessive leukocyte concentrations can exert inhibitory effects [3].

PRP has been increasingly explored in recent years for the management of sports-related musculoskeletal injuries. Its content of growth factors and bioactive proteins can modulate the repair and regeneration of tendons, ligaments, muscles, and bone. Emerging research has focused on elucidating both the underlying biological mechanisms and the clinical applications of PRP in the context of tissue healing [1].

Upper limb tendinopathies are a leading cause of chronic pain and functional impairment, particularly affecting the shoulder, elbow, and wrist. These conditions result in considerable deficits in muscle strength and movement, frequently restricting occupational and recreational activities and negatively impacting quality of life [4]. Their pathophysiology is marked by complex tendon degeneration and failed healing responses, often linked to repetitive upper limb use and mechanical overload. The clinical and societal burden of these disorders includes increased healthcare utilization, long-term disability, and reduced professional productivity [5].

Recent research underscores the need for effective management strategies to restore function and limit disability. These conditions frequently lead to bilateral declines in strength and function, necessitating comprehensive rehabilitation approaches [6, 7].

Accordingly, PRP has emerged as a promising therapeutic option for upper limb tendinopathies, offering potential benefits in pain reduction and functional improvement when conservative treatments are insufficient [8].

Methodology

This review was conducted through a systematic analysis of peer-reviewed scientific literature focusing on PRP in the management of upper limb tendinopathies. Relevant studies were identified using a comprehensive search of the PubMed database and supplemented by manual review of relevant journal articles. Only publications in English and Polish were considered. Articles are available through PubMed database search and through manual search of journals.

Rotator cuff tendinopathy

Rotator cuff tendinopathy represents a prevalent musculoskeletal disorder of the shoulder, characterized by pain, restricted mobility, and functional impairment. It commonly develops in individuals performing repetitive overhead motions, including athletes and manual workers, while in older adults it frequently occurs because of degenerative changes. Epidemiological studies indicate that rotator cuff-related shoulder pain affects a considerable segment of the population, with incidence increasing after the age of 40 due to cumulative microtrauma and age-related tendon degeneration [9, 10]. Conventional therapeutic approaches, such as physiotherapy and corticosteroid injections, often yield variable clinical outcomes. In contrast, PRP therapy has recently gained attention as a regenerative intervention with potential benefits in alleviating pain and enhancing tendon repair [11].

Current evidence indicates that PRP can reduce pain and improve functional impairment in patients with tendinopathy, and its medium-term effects appear to be superior to those of corticosteroid injections, although its long-term effectiveness still requires clinical confirmation [12].

In rotator cuff tendinopathy, PRP has been shown to be a safe treatment that provides better long-term outcomes for shoulder pain and function compared with other therapies, yet further research is needed to standardize PRP preparation, classification, injection protocols, and outcome measures specific to this condition [13].

Another meta-analysis confirms that PRP offers significant short-term benefits by reducing pain and improving shoulder function in rotator cuff tendinopathy, but its long-term effectiveness remains uncertain, with a decline in therapeutic benefit observed beyond one year. PRP significantly reduced pain compared to controls in the short term (3–6 months), with mean Visual Analogue Scale (VAS) scores decreasing by over 20% in some studies. It has also improved shoulder function within 6 months, with gains of 15–20% in some studies. Functional benefits tended to plateau or decline after 12 months. The considerable variability in PRP preparation and treatment protocols further emphasizes the need for standardization in future studies [11].

Biceps tendinopathy

Biceps tendinopathy includes different clinical presentations depending on the anatomical region involved: distal biceps tendinopathy at the elbow and changes affecting the tendon near the shoulder, which may manifest as pain in that area. Both presentations are recognized pain generators whose clinical management prioritizes nonoperative strategies. PRP has been evaluated as a biologically based, minimally invasive adjunct in refractory cases [14, 15].

Distal biceps tendinopathy represents an infrequent source of elbow discomfort. The condition typically manifests as pain in the anterior aspect of the elbow, aggravated by repetitive lifting or forearm-rotation tasks. On physical assessment, the distal biceps tendon remains intact, yet discomfort is elicited during resisted elbow flexion and supination. In contrast to distal biceps tendon rupture, for which operative intervention is generally recommended [16-21]. In a cohort of individuals diagnosed with distal biceps tendinopathy, ultrasound-guided PRP injections were administered to assess therapeutic outcomes. Four patients received a single PRP injection, and at the 6-week follow-up, their symptoms had fully resolved, with distal biceps provocation tests yielding negative results. Two additional patients underwent two PRP injections, including one with a partial tear confirmed on magnetic resonance imaging. At the initial 6-week review, both showed partial symptomatic improvement but continued to exhibit positive provocation tests, prompting a second injection. Six weeks after the repeat procedure, both demonstrated further symptom relief and negative provocation testing. The average modified Mayo Elbow Performance Score increased from 68.3 (range 65–85), indicating fair function prior to injection, to 95 (range 85–100), reflecting excellent function at final follow-up ($P = 0.03125$, Wilcoxon rank test). Resting VAS pain scores decreased from a mean of 2.25 (range 2–5) to 0, while VAS scores during movement declined from an average of 7.25 (range 5–8) to 1.3 (range 0–2). All six participants reported subjective improvement compared with baseline and stated they would consent to repeat the procedure if symptoms reappeared. No adverse events were recorded. Despite the small sample size, these findings suggest that ultrasound-guided PRP injection is a safe and potentially beneficial option for distal biceps tendinopathy, particularly in patients unresponsive to conservative management [14].

When it comes to biceps tendinopathy, it can also affect the shoulder area. Shoulder pain is among the most frequently reported issues in individuals with spinal cord injury (SCI). Research indicates that around 30% to 70% of people with SCI living in the community in the United States experience shoulder pain severe enough to be disabling [22-24]. This pain is believed to result from shoulder tendinopathy, which can lead to impingement syndromes [25]. Current management approaches involve both non-surgical and surgical options, each of which has notable limitations. Considering the critical role of shoulder function in the SCI population and the rising life expectancy, particularly among paraplegics who mainly rely on manual wheelchairs [24], there is a strong demand for alternative therapies for shoulder conditions. One pilot study evaluated the efficacy of PRP injections for biceps tendon pathology in spinal cord injured athletes using manual wheelchairs. Outcomes included the Ultrasound Shoulder Pathology Rating Scale (USPRS), the Physical Examination of the Shoulder Scale (PESS), and the VAS. Eight participants with chronic shoulder pain, ASIA Impairment Scale scores A–D, and at least one year of wheelchair use were enrolled. Baseline assessments were performed, followed by a unilateral PRP injection to the biceps tendon sheath. Participants were monitored biweekly for VAS scores and adverse events, with final assessments at 8 weeks.

Wilcoxon signed-rank tests revealed significant improvements in the noninjected shoulder for USPRS ($Z = 2.207$, $P = .027$), PESS ($Z = 2.120$, $P = .034$), and VAS scores ($Z = 2.041$, $P = .041$). Repeated measures analysis showed a trend toward decreased VAS pain scores in the injected arm over five time points ($F = 6.68$, $P = .061$). No adverse events were reported. These preliminary findings indicate that PRP injections are safe and may positively affect biceps tendinopathy in the SCI population, warranting further investigation in larger, controlled studies [26].

Lateral epicondylitis (tennis elbow)

Lateral epicondylitis is the most frequently diagnosed disorder of the elbow, with an estimated prevalence of 1–3% in the general population. Although the precise etiology is often indeterminate, it is commonly attributed to repetitive overuse of the wrist extensor and supinator muscle groups, most frequently involving the extensor carpi radialis brevis. Characteristic features are persistent lateral elbow pain, impaired function, and reduced grip strength, which may interfere with activities of daily living and occupational performance. The condition is typically observed in middle-aged adults and is associated with repetitive stress from sports such as tennis and golf or from physically demanding occupations [27, 28].

Lateral epicondylitis is among the chronic tendinopathies for which PRP therapy has garnered attention as a biologically based intervention [29].

Two systematic reviews investigated the clinical effectiveness of platelet-rich plasma (PRP) in the management of lateral epicondylitis, with particular attention to outcomes measured through validated patient-reported instruments and differences between leukocyte-rich PRP (LR-PRP) and leukocyte-poor PRP (LP-PRP) [30, 31].

In the first review, conducted according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, studies indexed in Medline and Scopus were screened for the use of PRP in lateral epicondylitis with outcomes assessed by the VAS, Disabilities of the Arm, Shoulder and Hand (DASH), Patient-Rated Tennis Elbow Evaluation (PRTEE), and Mayo Clinic Performance Index. Weighted mean scores were calculated at baseline and at multiple follow-up intervals up to 104 weeks, and changes in outcomes were compared with the established minimal clinically important difference (MCID). Twenty-six studies met the inclusion criteria, and all outcome measures showed progressive improvement over time following PRP injection. Apart from PRTEE in weeks 12 and 52, all scores improved significantly relative to baseline ($P < .0001$), and the mean change surpassed the MCID threshold for most assessments across follow-up periods. Both LR-PRP and LP-PRP preparations consistently exceeded MCID values, suggesting comparable clinical efficacy [31].

The second review synthesized data from 33 studies identified through multiple major databases, encompassing 2420 patients treated with either LR-PRP or LP-PRP. Across both groups, statistically significant reductions in pain and functional disability were reported from baseline to short- and long-term follow-up. VAS scores in the LR-PRP cohort decreased from pre-treatment ranges of 6.1–8.0 to 1.5–4.0 in the short term and 0.6–3.3 in the long term, with similar improvements observed in the LP-PRP cohort. DASH scores likewise demonstrated substantial functional recovery over time. Reported success rates varied widely but were high in both groups, and no meaningful differences in therapeutic effectiveness were detected between LR-PRP and LP-PRP. However, adverse events, primarily transient post-injection pain, were more common in the LR-PRP group (6.4%) than the LP-PRP group (3.9%) [30].

Collectively, the findings from both reviews indicate that PRP therapy produces clinically meaningful improvements in pain and upper-limb function in patients with lateral epicondylitis, with no clear superiority of leukocyte-rich over leukocyte-poor formulations, although LR-PRP may be associated with a slightly higher rate of minor, self-limiting complications [30, 31].

Medial epicondylitis (golfer's elbow)

Medial epicondylitis, commonly termed "golfer's elbow," arises from pathological alteration of the musculotendinous origin of the common flexor tendon at the medial epicondyle due to overuse. Like its lateral counterpart, medial epicondylitis most frequently presents in the fourth and fifth decades of life but manifests at a considerably lower incidence [32-34]. It has been demonstrated to be more strongly associated with occupational activities than with sports, with forceful manual work representing a greater risk factor than repetitive activity alone [33-36]. Classification into type 1 and type 2 is essential: type 1, in which the ulnar nerve is not involved, demonstrates superior outcomes with nonoperative management, whereas type 2 more commonly requires surgical intervention [37].

One retrospective case series compared PRP injections with open surgical debridement for type 1 medial epicondylitis. Between 2006 and 2016, 33 patients who failed at least 3 months of nonoperative treatment were included and offered either PRP or surgery. Fifteen patients received two leukocyte-rich PRP injections 2–3 weeks apart, and eighteen underwent open surgical debridement with tendon repair. PRP was prepared from autologous blood using a dual-spin centrifugation system and injected under ultrasound guidance, while surgical treatment involved open debridement and suture anchor repair followed by structured rehabilitation. Outcomes were assessed using VAS, Mayo Elbow Performance Score, Oxford Elbow Score, and Nirschl grading system, with follow-up averaging 3.9 years. Successful outcomes were achieved in 80% of the PRP group and 94% of the surgical group, with no statistically significant differences in pain or function. Both treatments improved symptoms, but PRP provided a shorter recovery period, making it a viable alternative to surgery in managing type 1 medial epicondylitis [37].

PRP therapy has also been evaluated against extracorporeal shock wave therapy (ESWT). One randomized controlled trial investigated the efficacy of ultrasound-guided PRP injection compared with ESWT in improving pain and function among patients with medial epicondylitis of the elbow. Fifty-four patients diagnosed with medial epicondylitis and treated at a sports medicine outpatient department were randomly

assigned to receive either PRP injections or ESWT. Clinical outcomes were assessed using VAS for pain and the Mayo Elbow Performance Score for functional evaluation. Both groups demonstrated significant improvement in pain and function at 12 and 24 weeks compared with baseline. However, the degree of improvement was significantly greater in the PRP group. Baseline characteristics between groups were not statistically different. The study concluded that ultrasound-guided PRP injection is more effective than extracorporeal shock wave therapy in reducing pain and enhancing elbow function in medial epicondylitis after six months of treatment [38].

De Quervain's tenosynovitis

De Quervain's disease is a form of stenosing tenosynovitis affecting the tendons within the first extensor compartment of the forearm. Although multiple hypotheses have been proposed regarding its etiology, the prevailing explanation attributes the condition to repetitive microtrauma resulting from the continuous gliding of the abductor pollicis longus and extensor pollicis brevis tendons over the radial styloid, leading to thickening and inflammation of the extensor retinaculum [39, 40]. The dominant perspective in the literature suggests that such tendon microtrauma induces degeneration of individual tendon fibrils due to cumulative mechanical stress, which progressively results in chronic degeneration and tendinopathy [41]. The disorder is frequently observed in pregnant and lactating women and demonstrates higher prevalence among individuals in their fifth and sixth decades of life [42].

When it comes to treatment of this condition, most patients respond well to non-surgical management [43]. Steroid injections are commonly utilized as an injectable therapeutic approach for the management of De Quervain's disease, with studies reporting up to 83% pain reduction following a single corticosteroid administration [44, 45]. Nevertheless, local corticosteroid injections may be associated with skin-related adverse effects in approximately 20% of cases, including depigmentation, cutaneous atrophy, and thinning [46]. Moreover, recurrence rates ranging from 32% to 48% within one year have been documented following corticosteroid monotherapy for De Quervain's disease [46, 47]. Although corticosteroid injections are often recommended following the failure of conservative treatments, their limitations and uncertain mechanisms of action highlight the need to explore alternative therapies such PRP [48].

A prospective, randomized, open-label trial conducted at a tertiary hospital in India compared ultrasound-guided triamcinolone acetonide injections with autologous PRP in patients aged 18–60 years diagnosed with De Quervain's tenosynovitis. Both treatments significantly reduced pain and improved function at 1, 4, and 12 weeks. The corticosteroid group showed greater improvement in pain and hand function at 1 and 4 weeks, but by week 12, outcomes were comparable between groups. The study concluded that PRP is as effective and safe as corticosteroid injections in managing De Quervain's tenosynovitis [48].

A systematic review following the Cochrane Handbook and PRISMA guidelines included 12 studies out of 275 identified. Meta-analysis of two studies involving 194 patients showed that PRP produced greater reductions in pain and improvements in wrist function compared with conservative therapy at one and six months. The authors suggested that PRP may serve as an effective non-surgical option, especially when guided by ultrasound, and highlighted the need for standardization of PRP preparation and injection techniques [43].

Another systematic review conducted according to PRISMA guidelines evaluated the efficacy of PRP in treating De Quervain's tenosynovitis, including eight studies published between 2013 and 2023. The results indicated that PRP provides outcomes comparable to corticosteroid injections but with fewer adverse effects. The authors concluded that PRP is a promising and safe alternative to corticosteroid therapy, though larger studies are necessary to confirm its effectiveness [49].

Post-surgical tendon healing

PRP is increasingly being investigated as a therapeutic agent to enhance tendon regeneration following surgical interventions in the upper limb. Due to the limited intrinsic healing capacity of tendons and unpredictable outcomes of surgery, PRP offers potential benefits by delivering concentrated growth factors that may improve tissue repair and reduce recovery time [50, 51].

A prospective, randomized, double-blind trial investigated whether intraoperative application of PRP combined with autologous thrombin improved tendon healing after arthroscopic repair of complete rotator cuff tears. Fifty-three patients were randomized into PRP and control groups, with all undergoing the same rehabilitation protocol. The PRP group reported significantly lower pain levels and better functional outcomes, demonstrated by higher scores on the Simple Shoulder Test, University of California, and Constant score, particularly at early follow-up intervals, with the most notable improvement at three months. However, no

long-term differences were found between the groups in Magnetic Resonance Imaging healing rates or overall functional outcomes, except in patients with smaller tears, where PRP yielded better results over 24 months. The study concluded that PRP may accelerate early postoperative recovery and reduce pain after rotator cuff repair [50].

There is also a prospective, randomized, triple-blind controlled trial which investigated the use of PRP as an adjuvant treatment following open carpal ligament release in patients with carpal tunnel syndrome. Fifty participants were randomized to receive intraoperative irrigation with either PRP or platelet-poor plasma. At six weeks postoperatively, both groups showed improvements in pain, symptom severity, and functional scores. However, only the PRP group regained preoperative hand grip strength levels. The study indicated that PRP may serve as an effective adjunct in enhancing functional recovery following carpal tunnel release surgery [51].

Conclusions

Current evidence supports the clinical utility of PRP as a regenerative treatment modality for various upper limb tendinopathies, offering benefits in pain reduction and functional improvement, particularly in cases refractory to conventional therapies. PRP's mechanistic actions encompass modulation of inflammation, promotion of cellular proliferation, and enhanced matrix synthesis. Its application in post-surgical tendon healing shows promise in accelerating early recovery, although long-term outcomes require further investigation. Variability in PRP preparation, leukocyte content, and administration protocols underscores the need for standardized methodologies and high-quality randomized controlled trials. Incorporation of ultrasound guidance and individualized treatment plans may enhance efficacy. Overall, PRP represents a valuable adjunctive option in the management of upper limb tendon disorders, but further research is essential to define optimal clinical indications and protocols.

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