RESEARCH PAPER

Current Trends in the Management of Lateral Epicondylitis: From Conservative Therapy to Regenerative Medicine

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ABSTRACT
Lateral epicondylitis (LE), widely known as tennis elbow, is a common musculoskeletal condition marked by pain and reduced function that stems from degenerative change within the extensor carpi radialis brevis tendon. Management approaches for this condition have shifted markedly over the last twenty years, moving from conventional conservative care toward more advanced regenerative options. This review sets out to critically appraise the evidence published between 2005 and 2026 on LE treatment, drawing on data sourced from PubMed, Scopus, the Cochrane Library, and Google Scholar.
A structured search of the literature identified randomized controlled trials, meta-analyses, and systematic reviews addressing conservative care, injection-based approaches, physical therapy modalities, and regenerative options such as platelet-rich plasma (PRP) and stem cell therapy. The evidence indicates that roughly 90% of patients improve with conservative treatment within 12 to 18 months, although cases that fail to respond typically go on to require more advanced intervention.
While corticosteroid injections deliver fast relief of short-term pain, they are linked to poor long-term results and frequent recurrence. PRP, by contrast, has been shown across several meta-analyses to produce better long-term functional gains and pain relief, though the evidence base remains mixed. Newer regenerative options, including stem cell therapy and other biologic approaches, show encouraging early results but still lack agreed-upon protocols.
Taken together, conservative care remains the foundation of treatment, but regenerative medicine appears poised to shape the future direction of LE management. Larger, higher-quality randomized trials are still needed before standardized treatment algorithms can be established.
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INTRODUCTION

Lateral epicondylitis (LE), better known as tennis elbow, ranks among the most common upper-limb musculoskeletal disorders and presents with pain and tenderness localized to the lateral epicondyle of the humerus. The condition tends to develop in people whose work or daily activity involves repeated wrist extension and forearm supination, such as those performing manual or repetitive tasks [1,2]. Population studies put its overall prevalence at around 1–3%, with most cases appearing between the ages of 30 and 60 [3,4]. Despite the popular association with racquet sports, athletic activity accounts for only 5–10% of cases, and the condition is seen far more often in people who are not athletes [5].

LE was long thought to be inflammatory in origin, but histopathological work over the past two decades has reframed it as a degenerative tendinopathy, marked by angiofibroblastic hyperplasia, microtearing, and disorganized collagen within the extensor carpi radialis brevis (ECRB) tendon [6,7]. This shift away from an inflammatory model has reshaped treatment thinking, steering practice away from anti-inflammatory agents and toward strategies aimed at tissue repair and regeneration [8].

Left to run its course, LE tends to be self-limiting: 80–90% of patients recover spontaneously within 12 to 18 months when managed conservatively [9,10]. Initial management typically combines rest, modification of aggravating activity, NSAIDs, physiotherapy, and bracing, with eccentric strengthening exercises in particular producing meaningful gains in tendon structure and function [11,12]. Even so, 10–15% of patients go on to develop chronic symptoms that call for more targeted interventional care [13].

Injectable treatments have drawn considerable interest in LE management. Corticosteroid injections have been a mainstay for decades and offer quick

short-term pain control, but they carry a well-documented risk of high recurrence and disappointing long-term results [14,15]. Autologous blood injections and platelet-rich plasma (PRP), on the other hand, work by delivering growth factors and cytokines directly to the injured tendon to support healing [16]. Of these, PRP has become the most heavily researched regenerative option in LE over the last ten years.

Systematic reviews and meta-analyses published in recent years point to PRP outperforming corticosteroids over the longer term, especially for pain and function at the 3- to 12-month mark [17,18].

The clinical diagnosis of lateral epicondylitis relies primarily on patient history and physical examination, including provocative tests such as Cozen's and Mill's tests. Although imaging is not routinely required, ultrasound and MRI are useful in complex or refractory cases [19] That said, results across studies are inconsistent, largely because PRP preparation methods, platelet concentration, and injection technique vary considerably from one protocol to another [20]. In addition, patient education and accessible resources play a crucial role in promoting treatment adherence. However, studies indicate that current patient education materials often vary in readability and quality, which can hinder patient engagement [21]

Beyond PRP, newer regenerative options — mesenchymal stem cell (MSC) injections, prolotherapy, and biologic scaffolds among them — have produced encouraging early data on tendon healing and regeneration [22,23]. These remain in the early phase of clinical use, however, and will need confirmation through larger randomized trials before their role is settled.

Adjunctive physical modalities, including extracorporeal shock wave therapy (ESWT), therapeutic ultrasound, and laser therapy, have also been investigated. ESWT stands out among these for delivering moderate improvements in pain and function, though the supporting evidence is not entirely consistent from study to study [24,25].

Surgery is generally kept in reserve for patients whose symptoms persist despite six to twelve months of conservative and minimally invasive care. Open and arthroscopic techniques alike report success rates in the 80–90% range [26], though surgery brings its own risks and a longer recovery, which is a strong argument for optimizing non-operative care before resorting to it.

The management landscape for LE has changed substantially over the past two decades as understanding of tendon biology and repair mechanisms has advanced. This move toward regenerative approaches mirrors a wider trend across musculoskeletal medicine, one that prioritizes restoring the tissue itself rather than simply masking symptoms [27].

Treatment strategies for lateral epicondylitis include conservative and surgical approaches. Conservative treatments encompass activity modification, physiotherapy, bracing, and pharmacological options such as NSAIDs. More recently, modalities such as extracorporeal shock wave therapy (ESWT) and platelet-rich plasma (PRP) injections have been explored for their regenerative potential [28].

It is therefore important to recognize that psychological factors can and do play a vital role in the treatment process, and to carefully work to align patient expectations with the notion that nearly all eventually heal without residual disability, and more importantly most nonoperative modalities have no proven long-term benefit.[29]

Debate nonetheless continues over how effective, cost-efficient, and standardizable these therapies actually are.

Because the management landscape keeps shifting, a thorough review of the current evidence is needed to inform both clinical decision-making and future research directions. This review therefore brings together two decades of data, with particular attention to recent developments in regenerative medicine and their impact on patient outcomes [30].

MATERIALS AND METHODS

This paper takes the form of a narrative, evidence-based review of how lateral epicondylitis management has evolved over the last two decades, with a particular emphasis on recent regenerative-medicine developments. A structured search process was used to keep the selection of studies focused on quality and relevance. Searches were run across PubMed/MEDLINE, Google Scholar, Scopus, and the Cochrane Library to capture peer-reviewed articles published from January 2005 through February 2026, and reference lists of key papers and related reviews were hand-screened to fill in any gaps.

Search terms combined relevant MeSH headings with free-text keywords — among them "lateral epicondylitis," "tennis elbow," "tendinopathy," "platelet-rich plasma," "PRP," "corticosteroid injection," "autologous blood injection," "extracorporeal shock wave therapy," "stem cell therapy," "regenerative medicine," and "treatment outcomes" — linked using the Boolean operators AND and OR to sharpen the results. Only human studies published in English were retained.

Eligibility criteria covered RCTs, prospective and retrospective cohort studies, case-control studies, systematic reviews, and meta-analyses evaluating any LE treatment modality. Priority was given to studies reporting

outcomes of direct clinical relevance — pain scores on the Visual Analog Scale (VAS), functional status via validated instruments such as the Disabilities of the Arm, Shoulder and Hand (DASH) score and the Patient-Rated Tennis Elbow Evaluation (PRTEE), recurrence rates, and complications. Animal studies, cadaveric research, editorials, expert opinion pieces, and case reports were excluded to keep the evidence base methodologically sound and clinically applicable.

For each included study, data were extracted on design, sample size, patient demographics, symptom duration, intervention type, follow-up length, and primary and secondary outcomes. Where studies compared treatments head-to-head — corticosteroids against PRP, or conservative care against surgery, for instance — those comparisons were examined closely. Studies from 2024–2026 indexed on PubMed and Google Scholar received particular attention to keep the review current, especially regarding biologic and regenerative interventions.

Study quality was judged qualitatively according to the standard evidence hierarchy, with RCTs and meta-analyses treated as carrying the greatest weight. Because this is a narrative rather than systematic review, no single risk-of-bias instrument was applied uniformly; instead, synthesis leaned more heavily on studies with sound methodology, adequate sample sizes, and longer follow-up. Differences between studies in intervention protocols — PRP preparation, injection technique, rehabilitation regimens, and so on — were factored into how the results were interpreted.

Given how much study designs and outcome measures varied, no quantitative meta-analysis was attempted; findings were instead pulled together descriptively, comparing outcomes across treatment types. Particular attention was paid to how outcomes have trended over time, especially the move from conventional to regenerative therapy, and to emerging themes such as personalized medicine, biologic augmentation, and combination treatment approaches.

Analysis of the studies spanning 2005 to 2026 revealed wide variation in treatment approach, outcome measures, and follow-up length across the LE literature. Even so, a number of consistent, clinically meaningful patterns emerged across conservative, interventional, and regenerative treatment categories.

Most studies looking at conservative management — rest, activity modification, NSAIDs, physiotherapy, and bracing — reported good outcomes, especially in early or mild disease. Across the RCTs and cohort studies reviewed, roughly 80–90% of patients showed meaningful improvement in pain and function within 12 to 18 months of starting conservative treatment. Eccentric strengthening exercises featured prominently in physiotherapy protocols, with several studies recording statistically significant drops in VAS pain scores (reductions of 30–60%) alongside gains on functional measures like DASH and PRTEE. Counterforce bracing was found to offload the extensor tendon and ease symptoms in the short term, although its longer-term benefit was less certain.

Injectable treatments performed quite differently from one another. Corticosteroids reliably brought fast, marked pain relief — typically within 2 to 6 weeks and with VAS reductions above 50% in several trials — but that benefit tended to fade. Longer-term data and meta-analyses point to recurrence rates of 40–72% by 6 to 12 months, with some trials showing corticosteroids doing worse than placebo or physiotherapy over time. Repeated injections also carry risks, including weakening of the tendon and possible rupture, which further limits their usefulness beyond the short term.

PRP followed a different trajectory — slower to take effect but more durable in its benefit. Multiple RCTs and recent meta-analyses link PRP injections to significant pain relief and functional gains at both the 3- to 6-month and 6- to 12-month marks. Data from 2024–2026 reinforced this pattern, with PRP outperforming corticosteroids on both VAS and DASH measures; pain reduction at 6 months ranged from 40% to 70%, and gains continued out to 12 months. Protocols varied considerably, though, in platelet concentration, leukocyte content, number of injections given, and use of imaging guidance. Recent meta-analyses have also cast doubt on whether platelet concentration itself drives outcomes, pointing instead to injection technique and post-injection rehabilitation as likely more important factors.

Autologous blood injection showed moderate benefit — comparable to PRP in some studies, though less reliably so overall. Most patients experienced some reduction in pain and improvement in function, though typically to a smaller degree than with PRP. Its lower cost and simpler preparation still make it a reasonable option where resources are limited.

Physical modalities — ESWT, therapeutic ultrasound, and low-level laser therapy — produced mixed results overall. ESWT showed the most consistent benefit, with several meta-analyses finding statistically significant improvement over placebo in pain and function, though smaller in magnitude than what injections achieved; outcomes here depended on factors like energy dosing, treatment frequency, and patient selection. Ultrasound and laser therapy were less consistent still, with some studies reporting modest gains and others finding no real difference from control.

Newer regenerative options — MSC injections and biologic scaffolds — have delivered encouraging early data for chronic, treatment-resistant LE, with preliminary studies showing imaging-confirmed improvements in tendon structure alongside meaningful gains in pain and function scores. The evidence base here is thin, however: small samples, short follow-up, and inconsistent protocols mean firm conclusions about efficacy aren't yet possible.

Combined treatment regimens — PRP paired with ESWT or physiotherapy, for example — have also drawn interest. Early findings hint at a synergistic effect, with better pain and function outcomes than single-modality treatment alone, but solid comparative evidence is still scarce, and more research is needed to pin down which combinations work best.

Surgical outcomes were assessed mainly in patients with chronic, refractory symptoms who had already tried at least 6 to 12 months of conservative and minimally invasive treatment without success. Both open and arthroscopic surgery achieved high success rates, in the 80–90% range, with substantial gains in pain and function. Arthroscopic surgery offered a shorter recovery and quicker return to activity, though long-term results were similar between the two techniques. Complications were uncommon overall but did include infection, nerve injury, and persistent pain.

Taken together, these findings point to a clear trend toward greater use of biologic and regenerative therapy in LE management, particularly for patients with chronic or treatment-resistant disease. Conservative care remains highly effective for most patients, but therapies like PRP are gaining ground for their capacity to support tendon healing and deliver benefits that last. The variability seen across study methods and treatment protocols, though, makes a strong case for standardized guidelines and better-quality randomized trials going forward.

DISCUSSION

This review pulls together two decades of evolving evidence on LE management and points to a clear move away from purely symptomatic treatment toward biologically driven, regenerative approaches. That shift traces back to a better understanding of LE as a degenerative tendinopathy rather than an inflammatory process — a reframing first proposed by Kraushaar and Nirschl, whose histopathological work found angiofibroblastic degeneration rather than inflammatory cell infiltrate [6,7]. This conceptual change has had a real influence on treatment strategy, reducing reliance on anti-inflammatory agents in favor of approaches aimed at healing and regenerating the tendon itself.

Conservative management remains foundational, and the evidence for its favorable natural history and high spontaneous-recovery rate is strong. Systematic reviews and RCTs consistently put non-operative improvement rates at 80–90% within 12–18 months [9,10]. Bisset et al. and Smidt et al. both found that structured physiotherapy — especially programs built around eccentric strengthening — produces significant gains in pain and function [9,10], and Stasinopoulos et al. underscored how exercise-based rehabilitation supports tendon remodeling and restores biomechanical function [11]. Still, 10–15% of patients go on to develop chronic symptoms requiring more advanced care [13].

Corticosteroid injection has long been a go-to option for LE because of how quickly it relieves pain. Several strong studies, RCTs and meta-analyses among them, confirm its short-term edge over placebo, especially in the first 4–6 weeks [14,15]. Longer follow-up tells a different story, though, with consistently higher recurrence and worse outcomes than physiotherapy or placebo. Coombes et al.'s landmark trial found that despite the immediate relief, corticosteroids were linked to worse one-year outcomes and a greater chance of symptoms returning [14], a finding echoed by Krogh et al., who reported higher recurrence and poorer functional recovery at long-term follow-up in corticosteroid-treated patients [15]. The consensus emerging from this body of work is that corticosteroids are better suited to short-term symptom control than to definitive treatment.

PRP therapy, by contrast, has built a growing evidence base supporting its long-term value as a regenerative option. Gosens et al.'s RCT found that PRP produced more durable improvements in pain and function than corticosteroids at two years [17], and later systematic reviews and meta-analyses have backed this up, showing PRP's advantage becomes clearer past the 3- to 6-month mark [18,19]. Studies from 2024–2025 add further support, reporting significant VAS and DASH improvements with PRP relative to conventional treatments [19]. The picture isn't entirely consistent, though — some studies find no real difference between PRP and placebo, a discrepancy likely explained by differences in how PRP is prepared, including platelet concentration, leukocyte content, and activation method [20].

Recent meta-analyses have also called into question the assumption that a higher platelet count means a better outcome. Averell et al. found no meaningful link between platelet concentration and clinical improvement, suggesting that injection technique and patient selection may matter more [21] — a finding that reinforces the case for standardized PRP

protocols and illustrates just how complex biologic therapy in musculoskeletal medicine can be.

Autologous blood injection offers a simpler, cheaper biologic alternative to PRP. Edwards et al.'s early work reported meaningful improvement in pain and function among patients with refractory LE [16]. Epidemiological data suggest that lateral epicondylitis affects approximately 1–3% of the general population annually, peaking in individuals aged 30 to 50 [18].

ESWT has been studied extensively among the physical modalities. Systematic reviews and meta-analyses generally credit it with moderate benefit for pain and function, though less than what injectable treatments achieve [24,25]. Speed proposed that its effect may work through stimulating neovascularization and tissue regeneration [24], though inconsistent protocols — differing energy levels and treatment frequency, in particular — have produced uneven results across the literature [25].

MSC injections represent one of the more forward-looking regenerative options for LE. Preclinical and early clinical evidence suggests MSCs support tendon repair through both direct differentiation and paracrine signaling, encouraging collagen synthesis while limiting fibrosis [22,23]. Chen et al. and Kim et al. both reported favorable outcomes for tendon structure and functional recovery [22,23], but routine clinical use is still held back by cost, regulatory hurdles, and a lack of long-term safety data.

Surgery remains a last resort, reserved for patients whose symptoms persist after exhausting conservative and interventional options. Both open and arthroscopic surgery report favorable outcomes in 80–90% of cases [26], with arthroscopy offering the added benefits of a less invasive approach, quicker recovery, and earlier return to activity — though its long-term results are on par with open surgery [26]. Surgical risks such as nerve injury and persistent pain are a reminder of why optimizing non-operative care matters so much.

The last twenty years have also seen movement toward more personalized, multimodal treatment. Recent studies combining PRP with physiotherapy or ESWT hint at synergistic benefit, and improvements in imaging and ultrasound guidance have made interventional treatments more precise and, likely, more effective.

Research output in this area has grown substantially, particularly since 2021, mirroring rising interest in regenerative medicine's potential to change how tendinopathies are treated. Bibliometric data confirm a sharp rise in publications on PRP and biologic therapy, evidence of their expanding footprint in clinical practice [28,29]. Real challenges remain, however — inconsistent study designs, the absence of standardized protocols, and variation in how outcomes are measured all continue to complicate the picture.

In short, LE management has moved a long way from simple symptom relief toward biologically restoring the tendon itself. Conservative therapy still works well for most patients, but regenerative options like PRP offer real promise for those with chronic or resistant disease. What's still missing is a strong enough base of standardized, high-quality randomized trials to turn this progress into firm treatment guidelines [30].

CONCLUSION

Lateral epicondylitis continues to be both common and clinically difficult to manage, with real consequences for function and quality of life. Understanding of its underlying pathophysiology has advanced substantially over the last twenty years, moving the field from an inflammatory model to a degenerative-tendinopathy one — a conceptual shift that has, in turn, driven treatment away from purely symptomatic care and toward biologically oriented, regenerative strategies.

This review confirms that conservative management — activity changes, physiotherapy, bracing — remains the backbone of treatment and works well for most patients. For those whose symptoms persist or resist first-line care, interventional therapy has an important role to play. Corticosteroid injection offers fast short-term relief but its weak long-term performance and high recurrence rate limit its usefulness as a lasting solution.

Regenerative options, PRP chief among them, have emerged as attractive alternatives, with several recent studies showing better long-term pain and function outcomes than older interventions. Preparation methods still vary too much, though, and results are inconsistent enough to make standardized protocols a clear priority. Stem cell therapy and combination biologic approaches look promising for the future but don't yet have the high-quality evidence base needed for routine clinical use.

On the whole, LE management is heading toward a more personalized, evidence-based model that blends conventional rehabilitation with advanced biologic therapy. Larger, well-designed randomized trials should be the priority for future research, with the goal of setting standardized treatment algorithms and improving outcomes for patients.

LIMITATIONS

This review is not without limitations. The included studies varied considerably in design, sample size, and treatment protocol, PRP preparation being a particularly inconsistent area. Many of the more recent regenerative-therapy studies were also limited by small samples and short follow-up. Because this is

a narrative rather than systematic review, selection and publication bias cannot be ruled out, and inconsistency in outcome measures (VAS, DASH, PRTEE) combined with the absence of standardized treatment guidelines may limit how comparable or generalizable the findings are.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest related to this study.

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