Prolotherapy and Platelet Rich Plasma Therapies

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Instructions for Use

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Related Medical Management Guideline
• Skin and Soft Tissue Substitutes

Coverage Rationale

Due to insufficient evidence of efficacy, the following are unproven and not medically necessary for any condition or indication:

- Prolotherapy
- Platelet-Rich Plasma

Note: Refer to the Medical Management Guideline titled Skin and Soft Tissue Substitutes for information relating to amnion-derived fluid injections/therapy.

Applicable Codes

The following list(s) of procedure and/or diagnosis codes is provided for reference purposes only and may not be all inclusive. Listing of a code in this guideline does not imply that the service described by the code is a covered or non-covered health service. Benefit coverage for health services is determined by the member specific benefit plan document and applicable laws that may require coverage for a specific service. The inclusion of a code does not imply any right to reimbursement or guarantee claim payment. Other Policies and Guidelines may apply.

CPT Code	Description
0232T	Injection(s), platelet rich plasma, any site, including image guidance, harvesting and preparation when performed

HCPCS Code	Description
G0460	Autologous platelet rich plasma for nondiabetic chronic wounds/ulcers, including phlebotomy, centrifugation, and all other preparatory procedures, administration and dressings, per treatment
G0465	Autologous platelet rich plasma (PRP) for diabetic chronic wounds/ulcers, using an FDA-cleared device (includes administration, dressings, phlebotomy, centrifugation, and all other preparatory procedures, per treatment)
M0076	Prolotherapy

HCPCS Code	Description
P9020	Platelet-rich plasma, each unit

Description of Services

Prolotherapy (Proliferative Therapy), also known as Non-Surgical and Ligament and Tendon Reconstruction and Regenerative Joint Injection, is an orthopedic procedure that stimulates the body's healing processes to strengthen and repair injured and painful joints and connective tissue. Prolotherapy is injection of any substance (i.e., dextrose, saline, sarapin and procaine or lidocaine) that promotes growth of normal cells, tissues, or organs by stimulating the body's natural healing mechanisms to lay down new tissue in the weakened area. This is done by a very directed injection to the injury site, "tricking" the body to repair again. The mild inflammatory response which is created by the injection encourages growth of new, normal ligament or tendon fibers, resulting in a tightening of the weakened structure. Additional treatments repeat this process, allowing a gradual buildup of tissue to restore the original strength to the area. In the last several years newer formulas include Platelet Rich Plasma (PRP) and autologous (from the same person) adult stem cell sources, typically taken from bone marrow or adipose (fat) tissue. Each treating physician tailors the selection of the appropriate formula according to the patient's need. The three types of prolotherapy are: 1) Growth factor injection prolotherapy; 2) Growth factor stimulation prolotherapy; and 3) Inflammatory prolotherapy. (AOAPRM, 2020; AAOM, 2020)

Platelet rich plasma (PRP) is an autologous blood preparation with a high platelet concentration and concentrated platelet-derived growth factors and other cytokines, which may be the primary contributors to the benefits of PRP therapy. Introducing PRP to tissues with low healing potential, these growth factors and cytokines may stimulate regeneration and promote tissue repair. PRP preparations are not standardized and exhibit wide variability in platelet and white blood cell concentrations. It is unclear how these variations in PRP composition may affect clinical outcomes. (Hayes, 2021)

Clinical Evidence

Prolotherapy

The available studies on prolotherapy are limited to those that include short to medium term follow-up with no significant functional improvement compared to placebo. Additional studies are needed to further define treatment parameters and to determine whether a clinically significant improvement is achieved.

Low Back Pain (LBP)

Sirh et al. (2022) conducted a retrospective chart review study aimed to evaluate the importance of the quadratus lumborum muscle and introduce an effective landmark-based blind injection technique combining trigger point injection (TPI) with prolotherapy for treating quadratus lumborum trigger points and enthesopathy. Adult patients (n = 17) with lower back and/or buttock pain were placed in the lateral decubitus position. Patients were on average 47.35 years (range: 28–70); 11 were men and 6 were women. The duration of symptom onset ranged from three days to three years. The mean pain duration was 163.2 ±296.6 days. Among the 17 patients, 10 had bilateral lesions and 7 had unilateral lesions. Patients were not treated bilaterally at each treatment session. The quadratus lumborum muscle was palpated to accurately locate its lesions, including trigger points, taut bands, and tendon lesions, after five key landmarks had been identified. A newly designed 60–90-mm, 28G thin hypodermic needle was inserted at the tender points. The needle was typically advanced until its tip touched the transverse process to treat myofascial trigger points and tendon lesions in the iliolumbar and lumbocostal fibers, excluding superficial trigger points of the iliocostal fibers. Subsequently, lidocaine (0.5%) or a mixture of lidocaine (0.5%) and dextrose (12.5–15%) was injected. The pretreatment visual analog scale (VAS) score for all 17 patients decreased from ≥ 4–8/10 (mean 5.588) to 0–1/10 (mean 0.294) after completion of all treatments. The total number of treatments was one to four in acute and subacute cases and two to eight in chronic cases. The mean follow-up period was 73.5 days (treatment period: range, 4 to 43 days + at least 60 days of follow-up). The authors concluded that TPI with prolotherapy for the treatment of trigger points and myofascial pain in the quadratus lumborum is safe, effective, and can be used with or without steroids, fluoroscopy, or ultrasound guidance. This study had certain limitations. First, this study did not include an adequate number of patients for statistical comparative analysis. Second, the data were retrospectively reviewed. Additionally, this study is single arm without a control group and did not assess differences between acute, subacute, and chronic cases. The other limitation was that it lacked long-term follow-up. A larger, controlled, prospective study is needed in the future to evaluate the effects of our TPI and integrated injection technique in patients with combined problems of various structures and the quadratus lumborum.

Osteoarthritis (OA)

Walluyo et al. (2023) conducted a systematic review to evaluate the efficacy of dextrose prolotherapy compared with other interventions in the management of osteoarthritis. Electronic databases PubMed, Google Scholar, Cochrane, and BioMed Central were searched from inception to October 2021. Randomized controlled trials that compared the use of dextrose prolotherapy (DPT) with other interventions (injection, placebo, therapy, or conservative treatment) in the treatment of osteoarthritis were included. Potential articles were screened for eligibility, and data were extracted by all authors. Risk of bias was assessed using the Cochrane Risk of Bias tool. Study population, methods, and results data were extracted and tabulated by 3 authors. Twelve studies reported that DPT was as effective or even more effective in improving functional outcomes compared with other interventions whilst others found that HA, PRP, EP, and ACS were more effective. Fourteen studies assessed the effectiveness of DPT and ten of them reported that DPT was more effective in reducing pain compared with other interventions. The authors concluded that dextrose prolotherapy in osteoarthritis confers potential benefits for pain and functional outcomes, but this systematic review found that the studies to date are at high risk of bias. Well designed, adequately powered, prospective, controlled clinical trials of DPT in the management of osteoarthritis are needed to further describe safety and clinical outcomes (or efficacy).

Gul et al. (2020) performed a randomized controlled trial (RCT) to determine the efficacy of prolotherapy injections versus exercise in the treatment of osteoarthritis secondary to developmental dysplasia of the hip. The study consisted of 41 patients divided into two groups: treated with prolotherapy (n = 20) and exercise (control group; n = 21). Clinical outcomes were evaluated at baseline, 3 weeks, 3 months, 6 months, and a minimum of 1 year follow-up. Prolotherapy injection recipients outperformed exercise controls for Visual Analog Scale (VAS) pain change score at 6 months (−4.6 ±2.6 versus −2.8 ±2.5; p = 0.016), and 12 months (−4.5 ±2.4 versus −2.9 ±2.5; p = 0.017) and for HHS at 6 months (24.2 ±14.0 versus 14.8 ±12.4; p = 0.007) and 12 months (24.3 ±13.4 versus 16.5 ±11.3; p = 0.018). The authors concluded that prolotherapy is superior to exercise and may delay surgery. Limitations include a small sample size which makes it difficult to decide whether these conclusions can be generalized to a larger population. Well designed, comparative studies with larger patient populations are needed to further describe safety and clinical outcomes. Further investigation is needed before clinical usefulness of this procedure is proven.

Sit et al. (2020) performed a single-center, parallel-group, blinded, randomized controlled trial (RCT) comparing the efficacy of intra-articular hypertonic dextrose prolotherapy versus normal saline injection for knee osteoarthritis (OA). A total of 76 patients were enrolled in the study and randomized into two groups of 38 each (prolotherapy: n = 38; normal saline: n = 38) over a 52-week period. Improvement in the DPT group compared with NS group on the primary outcome of WOMAC pain score at 52 weeks was noted. Beneficial effects were also demonstrated in WOMAC function, WOMAC composite, VAS pain intensity, and EuroQol-5D VAS and index scores. The composite WOMAC score improvement in the DPT group exceeded the minimal clinical important difference of 12 points at 52 weeks. No adverse events were reported. The authors concluded that use of intra-articular dextrose prolotherapy injections may be a safe and effective treatment for patients with KOA. Prolotherapy injections reduced pain and improved function and quality of life compared with blinded saline injections. Long-term follow-up and direct comparison with other injection therapies is needed to determine the clinical relevance of these findings.

Krstičević and colleagues conducted a systematic review on the efficacy and safety of proliferative injection therapy (prolotherapy) for treatment of knee and hand OA. Seven RCTs were included, with 393 participants aged 40-75 years having joint pain ranging from 3 months to 8 years. Dextrose was the most commonly used agent, with follow-up ranging from 12 weeks to 12 months. All studies concluded that prolotherapy was effective treatment for OA and no serious AEs were reported. The authors concluded that current data about prolotherapy for OA should be considered preliminary and that future high-quality trials are warranted since these low-quality studies did not provide reliable evidence. (2017)

Hauser et al. (2016) conducted a systematic review to review dextrose (d-glucose) prolotherapy efficacy in the treatment of chronic musculoskeletal pain. Electronic databases PubMed, Healthline, OmniMedicalSearch, Medscape, and EMBASE were searched from 1990 to January 2016. Prospectively designed studies that used dextrose as the sole active prolotherapy constituent were selected. Two independent reviewers rated studies for quality of evidence using the Physiotherapy Evidence Database assessment scale for randomized controlled trials (RCTs) and the Downs and Black evaluation tool for non-RCTs, for level of evidence using a modified Sackett scale, and for clinically relevant pain score difference using minimal clinically important change criteria. Study population, methods, and results data were extracted and tabulated. Fourteen RCTs, 1 case-control study, and 18 case series studies met the inclusion criteria and were evaluated. Pain conditions were clustered into tendinopathies, osteoarthritis (OA), spinal/pelvic, and myofascial pain. The RCTs were high-quality Level 1 evidence (Physiotherapy Evidence Database ≥ 8) and found dextrose injection superior to controls in Osgood-Schlatter disease, lateral

epicondylitis of the elbow, traumatic rotator cuff injury, knee OA, finger OA, and myofascial pain; in biomechanical but not subjective measures in temporal mandibular joint; and comparable in a short-term RCT but superior in a long-term RCT in low back pain. Many observational studies were of high quality and reported consistent positive evidence in multiple studies of tendinopathies, knee OA, sacroiliac pain, and iliac crest pain that received RCT confirmation in separate studies. Eighteen studies combined patient self-rating (subjective) with psychometric, imaging, and/or biomechanical (objective) outcome measurement and found both positive subjective and objective outcomes in 16 studies and positive objective but not subjective outcomes in two studies. All 15 studies solely using subjective or psychometric measures reported positive findings. The authors concluded that the use of dextrose prolotherapy is supported for treatment of tendinopathies, knee and finger joint OA, and spinal/pelvic pain due to ligament dysfunction. Efficacy in acute pain, as first-line therapy, and in myofascial pain cannot be determined from the literature. Further research with randomized controlled trials is needed to validate these findings.

In a systematic review and meta-analysis, Hung and colleagues (2016) compared the effectiveness of dextrose prolotherapy versus control injections and exercise in the management of OA pain. Searching PubMed and Scopus from the earliest record until February 2016, 1 single-arm study and 5 RCTs were included (n = 326). The investigators estimated the effect sizes of pain reduction before and after serial dextrose injections and compared the values between dextrose prolotherapy, comparative regimens, and exercise 6 months after the initial injection. Regarding the treatment arm using dextrose prolotherapy, the effect sizes compared with baseline were 0.65, 0.84, 0.85, and 0.87 after the 1st, 2nd, 3rd, and 4th or more injections, respectively. The overall effect of dextrose was better than control injections, demonstrating superiority when compared with local anesthesia and exercise. There was an insignificant advantage of dextrose over corticosteroids which was only estimated from 1 study. The authors concluded that dextrose injections decreased pain in OA patients; but did not exhibit a positive dose-response relationship following serial injections. Dextrose prolotherapy was found to provide a better therapeutic effect than exercise, local anesthetics, and probably corticosteroids when patients were re-tested 6 months following the initial injection. The researchers also noted that the effect of prolotherapy did not differ between hand and knee OA. This study had several drawbacks, including but not limited to the minimal number of trials eligible for meta-analysis, as well as heterogeneity in the patient populations, injection protocols, comparative regimens, and outcome assessment.

Knee (KOA)

Cortez et al. (2022) conducted a systematic review to compare the effectiveness of dextrose-prolotherapy with other substances for pain relief in patients with primary knee osteoarthritis. The literature screening was done in January 2021 through Medline (PubMed), EMBASE, and Database of the National Institute of Health based on the following criteria: randomized clinical trials that subjected patients with primary knee osteoarthritis who underwent treatment with dextrose-prolotherapy and other substances for pain relief. Paired reviewers independently identified 3381 articles and included 8 trials that met the eligibility criteria. According to the findings of this review, participants that underwent dextrose-prolotherapy showed improvements between baseline and posterior assessments and when compared to saline injections, but when compared to other substances, the results were not clear. The authors concluded although dextrose-prolotherapy is a useful treatment method by itself, it is still not possible to clearly affirm that it is superior or inferior to its counterparts. There is a need for further studies to bring more evidence to the field. The findings of this study need to be validated by well-designed studies. Further investigation is needed before clinical usefulness of this procedure is proven.

Hsieh and Lee (2022) completed a prospective, randomized, double-blind trial to determine whether intra-articular co-injection with hypertonic dextrose improves the outcome of hyaluronic acid (HA) prolotherapy for knee osteoarthritis (KOA). In total, 104 participants who fulfilled the American College of Rheumatology clinical and radiographic criteria for knee OA with a Kellgren-Lawrence score of 2 or 3 were recruited (n = 104). The participants were blocked randomized to the treatment (HA and hypertonic dextrose) or control (HA and normal saline) group. Ultrasound-guided knee intra-articular injections were administered once a week for 3 weeks. The primary outcomes were performance-based physical function measures (regular and fastest walking speed, stair climbing time, and chair rising time), and the secondary outcomes were the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) and Knee Injury and Osteoarthritis Outcome Score (KOOS). The outcome measures were assessed before the injections and at 1 week and 1, 3, and 6 months after the injections. The data were analyzed through repeated-measures analysis of covariance. Significant intergroup difference-in-differences favoring the treatment group were observed for improvements in stair climbing time (-1.6; 95% confidence interval, -8.56 to 4.16; p = .38) and WOMAC physical function (-21.2; 95% confidence interval, -126.05 to 103.83; p = .045) at 6 months. The group × time interaction effects favored the treatment group for regular (p = .001) and fastest walking speed (p = .001) and chair rising time (p = .038); WOMAC stiffness (p < .001) and physical function (p = .003); and KOOS for pain (p = .035), other symptoms (p = .022), and quality of life (p = .012). The authors concluded that compared with HA plus normal saline co-injections, HA plus dextrose co-injections resulted in more significant improvements in stair climbing time and physical function at 6 months,

effectively decreased pain, and improved physical function and physical functional performance from 1 week to 6 months. HA plus dextrose co-injections could be a suitable adjuvant therapy for patients with knee OA. Limitations to this study include a lack of control, small sample size and short terms follow-up. The findings of this study need to be validated by well-designed studies.

A systematic review and meta-analysis was performed by Wee et al. (2021) to summarize the evidence for dextrose prolotherapy in knee osteoarthritis. The authors searched PubMed and Embase from inception to September 2020. All publications in the English language were included without demographic limits. Randomized clinical trials comparing the effects of any active interventions or placebo versus dextrose prolotherapy in patients with knee osteoarthritis were included. Potential articles were screened for eligibility, and data was extracted independently. The risk of bias was assessed using the Cochrane Risk of Bias tool. Meta-analysis was performed on clinical trials with similar parameters. The Strength of Recommendation Taxonomy (SORT) was used for evaluating the strength of recommendations. In total, eleven articles (n = 837 patients) met the search criteria and were included. The risk-of-bias analysis revealed two studies to be of low risk. The overall effectiveness was calculated using a meta-analysis method. Prolotherapy was no different from platelet-rich plasma on the pain subscale at the 6-month time point. Prolotherapy was inferior to platelet-rich plasma at 6 months (MD 0.45, 95% CI 0.06-0.85, p = 0.03) on the stiffness subscale. Prolotherapy was found to be safe with no major adverse effects. The authors concluded that prolotherapy in knee osteoarthritis confers potential benefits for pain, but the studies are at high risk of bias. Based on two well-designed studies, dextrose prolotherapy may be considered in knee osteoarthritis (strength of recommendation B). This treatment is safe and may be considered in patients with limited alternative options (strength of recommendation C). Limitations include heterogeneity in terms of study design, injection sites, and techniques, varying concentrations of dextrose prolotherapy, and outcome measures used. Meta-analysis was limited to only two studies due to this heterogeneity. Well designed comparative studies are needed to further describe safety and clinical outcomes. (Authors Rabago et al. (2013), Rahimzadeh et al. (2014), and Sit et al. (2020) which were previously cited in this policy are included in this review)

Bae et al. (2020) performed a systematic review and meta-analysis to evaluate the effectiveness of prolotherapy compared with alternative treatment options for chronic musculoskeletal pain. Alternative options included steroid injections, saline injections, platelet-rich plasma (PRP) injections, exercise, and extracorporeal shock wave therapy. The review included ten randomized controlled trials, involving a total of 750 patients including a prolotherapy group and comparator groups using exercise, saline, PRP, and steroid injection. The primary outcome was pain score change during daily life. Pain scores from 6 months to 1 year after dextrose prolotherapy were reduced compared to saline injection (standardized mean difference [SMD] -0.44; 95% confidence interval [CI] -0.76 to -0.11, p = 0.008) and exercise (SMD -0.42; 95% CI -0.77 to -0.07, p = 0.02). There was no difference in pain scores for prolotherapy compared to PRP or steroid injection. The authors concluded that prolotherapy is a more effective treatment for chronic pain compared to saline injection or exercise. The available evidence is limited with overall poor-quality methodology and design, and diversity in reporting outcome measures. Therefore, no conclusions can be made regarding the relative efficacy, effectiveness, or safety of treatment.

Rahimzadeh et al (2018) investigated the effect of injecting intra-articular platelet-rich plasma (PRP) versus prolotherapy (PRL) on pain and function in knee osteoarthritis. In this randomized, double-blind trial, 42 patients with knee OA received intra-articular injections. “Patients in the PRP therapy group received 7 mL PRP solution and those in the PRL group received 7 mL 25% dextrose. Using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), levels of pain and knee function were evaluated and recorded for each patient immediately prior to the first injection as well as at 1 month (immediately prior to the second injection), 2 months (a month after the second injection), and 6 months later. During the first and second months, a rapid decrease in the overall WOMAC score was observed in both groups. The overall WOMAC score increased at the sixth month, but was lower than the overall WOMAC score in the first month. Statistical analysis indicated that the overall WOMAC score significantly decreased in both groups of patients over 6 months.” The authors concluded that this study suggests a positive change in WOMAC score indicated an improvement in the quality or life of patients receiving either injection after the first injection, and that PRP is more effective than PRL in the treatment of OA of the knee. However they acknowledge that this study had limitations, e.g., “lack of a control group receiving placebo; lack of morphological assessment of cartilage, soft tissue, and structures in and around the knee joint; small sample size; and limited timeframe for patient assessment.”

Sit et al. (2016) conducted a systematic review with meta-analysis to synthesize clinical evidence on the effect of prolotherapy for KOA. Of 134 citations identified, three randomized controlled trials (RCTs) with moderate risk of bias and 1 quasi-randomized trial met inclusion criteria with data from a total of 258 patients. The primary outcome of interest was change in the Western Ontario and McMaster Universities Osteoarthritis (WOMAC) score. In the meta-analysis of 2 eligible studies, prolotherapy was superior to exercise alone by a standardized mean difference of 0.81, 0.78 and 0.62 on the WOMAC

composite scale and WOMAC function and pain subscale scores, respectively. Moderate heterogeneity and risk of bias existed in all cases. The authors concluded that prolotherapy demonstrated a positive and significant beneficial effect in the treatment of KOA. Limitations of the review included the limited number of studies and their relatively small sample size. Larger, long-term trials with uniform outcomes and high methodological standards are needed for more a more comprehensive assessment of the overall treatment effect of prolotherapy.

In an Evidence-based Practice Center Systematic Review Protocol for the Treatment of KOA , the Agency for Healthcare Review and Quality (AHRQ) does not address intra-articular injected agents such as prolotherapeutic substances. (Newberry et al. 2017)

Fingers

Jahangiri et al. (2014) compared the advantages of prolotherapy in the treatment of first carpometacarpal OA with those of corticosteroid local injection in a double-blind RCT. Sixty participants (60 hands) with OA of the first carpometacarpal joint were assigned equally to 2 groups. For the corticosteroid group, after 2 monthly saline placebo injections, a single dose of 40 mg methylprednisolone acetate (0.5 ml) mixed with 0.5 ml of 2% lidocaine was injected. For the dextrose (DX) group, 0.5 ml of 20% DX was mixed with 0.5 ml of 2% lidocaine and the injection was repeated monthly for 3 months. Pain intensity, hand function and the strength of lateral pinch grip were measured at the baseline and at 1, 2, and 6 months post-treatment. The 2 groups were comparable at 2 months, but significantly different at 1 month (better results for corticosteroid), and at 6 months (more favorable outcome for DX). After 6 months of treatment, both groups increased functional level, but DX seemed to be more effective. The authors concluded that for the long term, DX seemed to be more advantageous, while the 2 treatments were comparable in the short term. Further research with a large sample size is needed to compare possible complications of corticosteroid/lidocaine vs DX/lidocaine injections in the management of OA.

Lateral Epicondylosis (LE)

A systematic review and meta-analysis by Zhu et al. (2022) was performed to evaluate the effectiveness of hypertonic dextrose prolotherapy (DPT) on pain intensity and physical function in patients with lateral elbow tendinosis (LET) compared with other active non-surgical treatments. Systematic search of Cochrane Central Register of Controlled Trials, MEDLINE, EMBASE, Web of Science, PubMed, Dimensions, Global Health, NHS Health Technology Assessment, Allied and Complementary Medicine, and OVID nursing database from inception to June 15, 2021, without language restrictions. Two reviewers independently identified parallel or crossover randomized controlled trials that evaluated the effectiveness of DPT in LET. The search identified 245 records; data from 8 studies (354 patients) were included. Two reviewers independently extracted data and assessed included studies. The Cochrane Risk of Bias 2 tool was used to evaluate risk of bias. The Grading of Recommendation Assessment, Development, and Evaluation approach was used to assess quality of the evidence. Pooled results favored the use of DPT in reducing tennis elbow pain intensity compared with active controls at 12 weeks post-enrollment, with a standardized mean difference of -0.44 (95% confidence interval, -0.88 to -0.01, p = .04) and of moderate heterogeneity (I2 = 49%). Pooled results also favored the use of DPT on physical functioning compared with active controls at 12 weeks, with Disabilities of the Arm, Shoulder and Hand scores achieving a mean difference of -15.04 (95% confidence interval, -20.25 to -9.82, p < .001) and of low heterogeneity (I2 = 0.0%). No major related adverse events have been reported. The authors concluded that DPT is superior to active controls at 12 weeks for decreasing pain intensity and functioning by margins that meet criteria for clinical relevance in the treatment of LET. Although existing studies are too small to assess rare adverse events, for patients with LET, especially those who are refractory to first-line treatments, DPT can be considered a nonsurgical treatment option in carefully selected patients. Limitations include a small sample size and small number of studies in most comparisons. The timeframe of 12-16 weeks available for data pooling was short, therefore, longer-term effects remain uncertain. Well designed, comparative studies are needed to further describe safety and clinical outcomes. The study is also limited due to a heterogeneous patient population across trials. Well designed, comparative studies with larger patient populations are needed to further describe safety and clinical outcomes. (Authors Bayat et al. (2019) and Rabago et al. (2013) which were previously cited in this policy are included in this review)

Gupta et al. (2022) conducted a prospective comparison study to evaluate the efficacy of prolotherapy using local injection of 25% dextrose and local corticosteroid injection in tennis elbow. From December 2020 to December 2021, a total of 260 patients aged 18 – 60 years were included in the study. The eligible patients were divided into two categories based on lottery. The first group of patients were given prolotherapy with 25% dextrose (group A), and the second group were given local corticosteroid triamcinolone (group B). Patients were followed up regular intervals, and outcome measures were monitored using Visual Analog Scale (VAS) and Mayo Elbow Performance Scale (MEPS). Scores were assessed and documented before

injection and post injection at 6 weeks, 12 weeks, 24 weeks, and 1 year. All patients showed improvement in VAS score and MEPS score following dextrose prolotherapy as well as patients injected with steroids. VAS scoring performed at pre-injection, 6 weeks, 12 weeks, 24 weeks, and 1 year showed improvement in scores for both groups of patients, that is, those receiving injection 25% dextrose and those receiving injection triamcinolone, but on comparison of scores using paired t-test, patients receiving 25% dextrose had greater improvement of scores at 6 weeks, 12 weeks, and 24 weeks, and it was statistically significant. However, at 1 year, it was insignificant. MEPS scores again showed much improved outcome in patients receiving prolotherapy with 25% dextrose as compared to triamcinolone inj. The scores were statistically significant at 6 weeks, 12 weeks, 24 weeks, and 1 year. MEPS scoring being a more comprehensive scoring also proved that 25% dextrose prolotherapy improved outcome in tennis elbow patients. The authors concluded that there is improvement in functional outcome of patients in the prolotherapy and steroid injection groups during early follow-ups. However, in the prolotherapy group, this improvement persisted for a longer time frame as compared to patients treated with steroids. The authors stated prolotherapy using dextrose had better functional outcome and longer effects in management of tennis elbow. Sample size is a limitation of this progressive study. Age-matched individuals with similar pre-injection scores in both groups could have been compared for better evaluation of results. In future, age- and gender-matched individuals with similar co-morbidities can be undertaken to further impress upon the results.

Kaya et al. (2022) conducted a single-blinded, randomized controlled trial (RCT) to compare the efficacy of the wrist splint and the injection of corticosteroid, autologous blood, and hypertonic dextrose in the treatment of lateral epicondylitis (LE). A total of 120 patients (43 males, 77 females; mean age: 45.7 ±7.7 years; range, 18 to 65 years) diagnosed with LE between December 2013 and June 2015 were included in the study and randomized into four groups. The first group was administered 20 mg methylprednisolone acetate + 2 mL 2% prilocaine, the second group 2 mL venous blood + 0.5 mL prilocaine, and the third group 2 mL 30% dextrose + 0.5 mL prilocaine injections. A second injection was administered to the third group one month later. The fourth group was recommended to use only a wrist splint. Pre-treatment and post-treatment evaluations of the patients were carried out at one and six months by the Visual Analog Scale (VAS) in terms of pain, by Patient-Rated Tennis Elbow Evaluation (PRTEE) questionnaire in terms of functional level, and by the Jamar dynamometer in terms of grip strength. In all groups, VAS values at one and six months after treatment were found to be lower in comparison to baseline. Except for the splint group, improvement was observed in all three injection groups in terms of grip strength and PRTEE values at six months compared to the baseline values. In the comparison of the groups, no difference was observed in terms of improvement in VAS scores and grip strength. While corticosteroid injection was effective in terms of PRTEE pain, function, and total scores only at one month, the autologous injection was effective in terms of PRTEE function and total scores at only six months after treatment. There were no differences for splint and prolotherapy groups in terms of PRTEE scores. The authors concluded that corticosteroid injection, autologous blood injection, and prolotherapy are effective and safe long-term methods in LE treatment. The main limitation of this study was the lack of an imaging modality such as ultrasonography for the diagnosis and treatment. Another limitation is the short-term follow-up (6 months), which did not allow for assessment of intermediate and long-term outcomes. The final limitation is the lack of selection of patients according to occupation or the kind of sports activity that may affect outcomes. Further investigation is needed before clinical usefulness of this procedure is proven.

A randomized clinical trial was conducted by Bayat et al (2019) comparing the efficacy of dextrose prolotherapy to steroid injection in the treatment of chronic lateral epicondylitis. Thirty subjects were randomly assigned to either the hypertonic dextrose group or the methylprednisolone group. “Participants were assessed through Quick DASH and VAS scores, once before injection, and then after 1- and 3-months follow-up. Two patients were excluded due to not completing the follow-up timepoints.” “In both groups VAS scores revealed significant improvement during the first month follow-up [mean difference (MD) = 1.9 ±3.3, versus 1.5 ±1.9 for the prolotherapy and steroid groups, respectively]. This declining trajectory continued at the third month visit in the prolotherapy group and MD reached 4.4 ±2.9, while it did not change remarkably in the steroid group (MD = 1.9 ±3.4). In fact, comparing VAS scores between the 1st- and 3rd-month time points did not reveal a significant improvement in the steroid group ($p = 0.6$). Also, the Quick DASH index showed a similar pattern and improved remarkably in both groups during the first visit. However, only the efficacy in the prolotherapy group persisted after 3-month follow-up (MD = 9.5 ±21.6, $p = 0.044$). One month after injections no preference between the two interventions was observed ($p = 0.74$ for VAS and 0.14 for Quick DASH score). However, the 3rd-month follow-up revealed a meaningful superiority ($p = 0.03$ for VAS and $p = 0.01$ for Quick DASH score) favoring the prolotherapy method.” The authors concluded that while both methods appeared to be effective in the short-term treatment of chronic lateral epicondylitis, the dextrose prolotherapy injections appeared to be slightly more efficacious over a longer period. This study is limited by the small study population and suboptimal data analysis.

Dong et al. (2015) conducted a systematic review and Baysian network meta-analysis comparing many injection therapies (including prolotherapy) for LE. All of the injection treatments showed a trend towards better effects than placebo, and the

study authors concluded prolotherapy's superiority would need to be confirmed by more research. The findings are limited by the inherent indirectness of network meta-analyses.

Sims et al. (2014) conducted a systematic review of RCTs examining 11 non-surgical treatments for LE which included prolotherapy. They concluded that the existing literature does not provide conclusive evidence that there is one preferred method of non-surgical treatment for this condition.

A pilot study was conducted assessing dextrose prolotherapy (PrT) for chronic LE. The study design was a three-arm RCT. Twenty-six adults (32 elbows) with chronic LE for 3 months or longer were randomized to ultrasound-guided PrT with dextrose solution, ultrasound-guided PrT with dextrose-morrhuate sodium solution, or watchful waiting ("wait and see"). The primary outcome was the Patient-Rated Tennis Elbow Evaluation (PRTEE) (100 points) at 4, 8, and 16 weeks (all groups) and at 32 weeks (PrT groups). The secondary outcomes included pain-free grip strength and MRI severity score. The participants in both PrT groups reported improved PRTEE composite and subscale scores at 4, 8, and/or 16 weeks compared with those in the wait-and-see group. At 16 weeks, compared with baseline, the PrT with dextrose and PrT with dextrose-morrhuate groups reported improved composite PRTEE scores by a mean of 18.7 and 17.5 points, respectively. The grip strength of the participants receiving PrT with dextrose exceeded that of other 2 groups at 8 and 16 weeks. There were no differences in MRI scores. Satisfaction was high and there were no AEs. PrT resulted in safe, significant improvement of elbow pain and function compared with baseline status and follow-up data and the wait-and-see control group. This pilot study suggests the need for a definitive trial to validate these results across a larger population. (Rabago et al., 2013)

Rotator Cuff (RC) Tendinopathies

Lin et al. (2022) completed a randomized, double-blind controlled study to investigate the effect of hypertonic dextrose injection on pain and disability in patients with chronic supraspinatus tendinosis. The secondary aim was to evaluate its effect on the tendon range of motion (ROM) and morphology. A total of 57 individuals with symptomatic chronic supraspinatus tendinosis were enrolled. Participants were randomly administered ultrasound-guided injections of 20% hypertonic dextrose (study group, n = 29) or 5% normal saline (control group, n = 28). The primary outcome measure was visual analog scale (VAS) scores for pain and Shoulder Pain and Disability Index (SPADI) scores. Secondary outcomes included the ROM and ultrasound examination findings of the supraspinatus tendon at baseline and at 2, 6, and 12 weeks postintervention. The study group exhibited improvements in the VAS (mean difference [MD], -2.1; 95% confidence interval [CI], -2.7 to -1.4; p < .001) and SPADI (MD, -11.6; 95% CI, -16.5 to -6.7; p < .001) scores compared with baseline scores at week 2. However, the effect was not sustained to week 6. Flexion ROM increased at weeks 2 (MD, 14.1; 95% CI, 5.7-22.5; p < .001) and 6 (MD, 8.9; 95% CI, 2.4-15.4; p = .003) compared with baseline. The thickness of the supraspinatus tendon improved at weeks 6 (MD, .50; 95% CI, .26-.74; p < .001) and 12 (MD, .61; 95% CI, .37-.84; p < .001) compared with baseline. The ratio of histograms also improved at weeks 6 (MD, .19; 95% CI, .06-.32; p = .002) and 12 (MD, .26; 95% CI, .10-.41; p < .001) compared with baseline. The authors concluded that hypertonic dextrose injection could provide short-term pain and disability relief in patients with chronic supraspinatus tendinosis. Ultrasound imaging at week 6 revealed changed tendon morphology. Limitations include a lack of pain evaluation immediately after intervention, an objective functional assessment, and tendon biopsy to confirm changes in tenocyte structure. Further research with randomized controlled trials is needed to validate these findings.

Chang et al. (2021) performed a double-blinded, randomized controlled trial (RCT) to determine whether dextrose prolotherapy offers clinical benefits in patients with shoulder pain and bursitis. The study consisted of patients (n = 50) in an outpatient rehabilitation department of a single medical center with a diagnosis of shoulder pain and bursitis. Participants were randomly assigned to 15% dextrose injection (D15W) [Group 1], and placebo [Group 2] to receive either D15W or normal saline injection. The primary outcome was maximal pain relief while performing activities. The secondary outcomes included resting pain level, function, and disability assessment results, and ultrasonographic parameters. Participants were followed up for three months post treatment. Following observation of time effects for all outcome parameters minus elastographic parameters, the authors concluded that dextrose bursal injection was not associated with greater improvements in clinical outcomes compared to normal saline injection. Data, however, indicated a greater increase in tissue stiffness of the supraspinatus tendon with bursal dextrose injection. Limitations include small sample size and short duration of follow-up.

Giovannetti de Sanctis et al. (2021) performed a systematic review to compare injectable corticosteroids with other drugs in the treatment of partial rotator cuff tears and the effectiveness in terms of pain and shoulder functionality. Nine prospective, randomized controlled trials were included in the review with a total of 494 patients. Of the 494 patients, 232 underwent corticosteroid infiltration, 90 with platelet-rich plasma (PRP), 47 with glucose prolotherapy, and 125 underwent an infiltrative cycle with lidocaine or other local anesthetic as placebo. Corticosteroid Visual Analog Scale (VAS) scores: Pre-op: 5.6 ±0.66;

short-term: 2.73 ±1.08; mid-term: 2.93 ±0.89; and long-term: 4.09 ±0.38. PRP VAS scores: Pre-op: 6.2 ±1.2; short-term: 3.51 ±1.86; mid-term: 3.9; and long-term: 2.04 ±0.76. Prolotherapy VAS scores: Pre-op: 5.3 ±0.81; short-term: 4.37 ±1.16; mid-term: 4.27 ±1.36; and long-term: 3.1 ±1.52. The authors concluded that all treatments showed improvement compared to baseline, however, there were no differences in terms of pain control. PRP was better in terms of shoulder function. Prolotherapy could not be analyzed due to the small number of studies. Limitations include a small sample size which makes it difficult to decide whether these conclusions can be generalized to a larger population. The findings of this study need to be validated by well-designed studies and further investigation is needed before clinical usefulness of these procedures is proven.

Nasiri et al. (2021) performed a randomized controlled trial (RCT) to compare the effectiveness of prolotherapy injection(s) with corticosteroid injection(s) in patients with rotator cuff dysfunction. Thirty-three patients were randomly allocated in two groups: prolotherapy group: n = 17 and corticosteroid group: n = 16. Visual analog scale (VAS) and Shoulder Pain and Disability Index (SPADI) were evaluated for both groups at baseline, 3 and 12 weeks after injections. Improvement in VAS and SPADI scores in 3 and 12 weeks after injections compared with pre injection times was shown in both groups. The authors concluded that both therapies, when administered with a home exercise program, are effective in the management of pain related to rotator cuff dysfunction. However, due to side effects from corticosteroids, prolotherapy is the suggested alternative. Limitations include small sample size and short duration of follow-up. Well designed, comparative studies with larger patient populations are needed to further describe safety and clinical outcomes.

A retrospective case series by Ryu et al (2018) investigated prolotherapy with polydeoxyribonucleotide (PDRN) as a possible viable treatment option for chronic rotator cuff tendinopathy. “The records of patients with chronic rotator cuff tendinopathy (n = 131) were reviewed retrospectively, and the patients treated with PDRN prolotherapy (n = 32) were selected.

The main outcome of the shoulder pain and disability index score on a numerical rating scale of average shoulder pain was measured. The authors concluded that compared to baseline data, significant improvements were shown in the shoulder pain and disability index and pain visual analog scale scores at one week after the end of treatment at one month and three months later.” They also concluded that “additional randomized multidisciplinary effectiveness trials that include imaging outcomes such as ultrasound are required to verify the effect of PDRN for chronic RCT compared with current therapies, including prolotherapy with PDRN.” The findings are limited by lack of comparison group.

Seven et al. (2017) evaluated the efficacy of prolotherapy in treating chronic refractory RC lesions through a randomized prospective comparative trial. Individuals with chronic RC lesions and symptoms that persisted for > 6 months were divided into 2 groups: the control group (n - 60), treated with exercise 3 times weekly for 12 weeks; and the prolotherapy group (n - 60), receiving 2 to 6 ultrasound-guided prolotherapy injection sessions in addition to the 3 times weekly home exercise program. A total of 101 patients out of 120 were included in the results. Clinical assessment of shoulder function was performed using a VAS for pain, Shoulder Pain and Disability Index (SPADI), Western Ontario Rotator Cuff (WORC) Index, patient satisfaction, and shoulder range of motion (ROM). Participants were examined at baseline, weeks 3, 6, and 12, and last follow-up (minimum of one year). At one year, 92.9% versus 56.8% of participants reported excellent or good outcomes overall in the prolotherapy and control groups, respectively. No AEs were reported. Limitations of this study included but were not limited to small sample size and lack of a placebo control. The investigators concluded that prolotherapy is an easily applicable and satisfying auxiliary method in the treatment of partial RC lesions, reducing pain and improving both shoulder function and patient satisfaction. Larger studies with longer follow-up times are needed.

Bertrand and colleagues (2016) compared the effect of dextrose prolotherapy on pain levels and degenerative changes in painful RC tendinopathy. In this blinded RCT, 72 participants who received 3 monthly injections of 0.1% lidocaine with dextrose prolotherapy (entheses dextrose [Enth-Dex group]) or one of two control injections (entheses saline injection without dextrose [Enth-Saline group] or superficial saline injection [Superfic-Saline group]) were included in the 9-month follow-up data. All participants received concurrent physical therapy. The primary outcome measure was achieving an improvement in maximal current shoulder pain ≥ 2.8 (twice the minimal clinically important difference for VAS pain score). At 9 months, the Enth-Dex group maintained a 2.9-point improvement in pain in comparison with 1.8 and 1.3 for the Enth-Saline and Superfic-Saline groups, respectively. The use of prolotherapy in the Enth-Dex group reported a significant improvement compared to the Superfic-Saline group (16 [59%] vs. 7 [27%]; however, the difference between the Enth-Dex group and the Enth-Saline group did not reach clinical significance. The authors concluded that prolotherapy may provide an effective and welcome addition to the management of patients with painful RC tendinopathy. Additional, larger clinical trials with more complete functional assessment tools are required to determine the clinical utility of this technology.

In a retrospective, observational study, Lee and colleagues (2015) examined the effectiveness of prolotherapy for non-traumatic refractory RC disease in 151 patients who were unresponsive to 3 months of aggressive conservative treatment. Of the patients, 63 received prolotherapy with 16.5 % dextrose 10-ml solution (treatment group), and 63 continued conservative treatment (control group). Main outcome measures included VAS score of the average shoulder pain level for the past 1 week, SPADI score, isometric strength of the shoulder abductor, active ROM of the shoulder, maximal tear size on ultrasonography, and number of analgesics required per day. Over 1-year follow-up, 57 patients in the treatment group and 53 in the control group were analyzed. There was no significant difference between the 2 groups in age, sex, shoulder dominance, duration of symptoms, and ultrasonographic findings at pre-treatment. The average number of injections in the treatment group was 4.8. Compared with the control group, outcome measures showed significant improvement in the treatment group. There were no AEs. The authors concluded that prolotherapy can be an option for patients with refractory chronic RC disease who showed no response to other treatments. They stated that prospective RCTs are needed to further demonstrate efficacy. The only limitation cited was the non-randomized retrospective study design.

Groin Pain

Bisciotti et al. (2020) performed a systematic review of conservative treatment for long standing adductor-related groin pain syndrome (GPS). The review consisted of 19 studies and 440 patients. Seven types of therapeutic interventions were reviewed including compression clothing therapy, manual therapy combined with strengthening exercise, prolotherapy, corticoid injection, platelet-rich plasma (PRP) therapy, intra-tissue percutaneous electrolysis, and pulse-dose radiofrequency. Prolotherapy, described in two studies, was performed on 24 patients with long-standing GPS. Follow-up assessments were completed at 6 months and 32 months. Visual Analog Scale (VAS) was assessed for pain during sports activity, and Nirschl Pain Phase Scale (NPPS) was assessed for functional impairment caused by pain. Thirty-two months after therapy, VAS scores improved from 6.3 +/-1.4 to 1.0 +/2.4 ($p < .001$), and NPPS scores 5.3 +/-0.7 to 0.8 +/-1.9 ($p < .001$). Only one study reviewed platelet rich plasma for GPS with a total of 41patients. The authors concluded that strength of evidence for prolotherapy is a moderate level (C), and a recommendation of conflicting strength (D) for PRP. The available data are relatively weak and inconclusive and derived primarily from uncontrolled or poorly controlled studies. Well designed, comparative studies with larger patient populations are needed to further describe safety and clinical outcomes.

Temporomandibular Joint (TMJ) Disorders

Mohammed et al. (2023) conducted a prospective clinical study to evaluate the effect of dextrose prolotherapy in treating internal derangement of the temporomandibular joint (TMJ). A total of 20 patients with temporomandibular joint internal derangement were enrolled in the study. The diagnosis of internal derangement was confirmed by magnetic resonance imaging (MRI). The posterior and anterior disc attachment, as well as the most tender part of the masseter muscle, were injected with 12.5% dextrose. Pain, maximum mouth opening, clicking, and deviation were assessed immediately before treatment, as well as at 2-, 4-, and 12- weeks post-treatment. There was improvement in the four clinical variables at the three-time intervals. Pain at two weeks was reduced by 60% (6 vs. 3.75) and by 200% (6 vs. 1.9) at 4 weeks. The maximum mouth opening was increased by 6.4 mm at 2 weeks and 7.85 mm at 4 weeks. The percentage of patients with clicking decreased from 70%, preoperatively-to 50% at 2 weeks, 15% at 4 weeks, and 5% at 12 weeks. The ratio of patients with deviation was decreased from 80% preoperatively to 35% at 2 weeks, 15% at 4 weeks, and 5% at 12 weeks. The authors concluded that prolotherapy is a safe and effective treatment for alleviating the symptoms of internal derangement of the temporomandibular joint. Limitations of this study are the absence of a positive or negative control group, a relatively small sample size, and a short follow-up period. In addition, no post-injection MRI of the joint was performed to correlate the clinical improvement of symptoms with imaging changes in the joint and disc position. Well designed, comparative studies with larger patient populations are needed to further describe safety and clinical outcomes.

Dasukil et al. (2021) conducted a clinical trial to study the efficacy of prolotherapy and to establish it as an effective procedure in patients with TMJ disorders, to provide long-term solution to chronic TMJ pain and dysfunctions. A total of 25 patients suffering from various TMJ disorders who were treated with prolotherapy, the solution consisting of 1 part of 50% dextrose (0.75 ml); 2 parts of lidocaine (1.5 ml); and 1 part of warm saline (0.75 ml) were included. The standard program is to repeat the injections three times, at 2-week intervals, which totals four injection appointments over 6 weeks with 3-month follow-up. There was appreciable reduction in tenderness in TMJ and masticatory muscles with improvement in mouth opening. The effect of the treatment in improving clicking and deviation of TMJ was found to be statistically significant ($p < 0.05$). There were no permanent complications. The authors concluded that prolotherapy is an effective therapeutic modality that reduces TMJ pain, improves joint stability and range of motion in a majority of patients. It can be a first-line treatment option as it is safe, economical and an easy procedure associated with minimal morbidity. This was a nonrandomized study design without a

control group. There is a lack of high-quality evidence demonstrating a beneficial impact of prolotherapy on health outcomes in patients with TMJ disorders. Further research with randomized controlled trials is needed to validate these findings.

Sit et al. (2021) performed a systematic review of randomized controlled trials (RCTs) to determine the efficacy of hypertonic dextrose prolotherapy (DPT) for temporomandibular joint (TMJ) disorders. Ten full-text RCTs were included in the study with sample sizes ranging from 12 to 72, with a total of 336 patients. The study period ranged from four weeks to 1-year post enrollment. The primary outcome was pain intensity. Secondary outcomes included maximum interincisal mouth opening (MIO) and disability score. Meta-analysis of five RCTs revealed decreased TMJ pain compared to placebo (Standardized Mean Difference: -0.76; 95% CI -1.19 to -0.32, I^2 = 0%). No statistical differences were noted for changes in maximum inter-incisal mouth opening (MIO) and functional scores. Cochrane risk of bias (RoB) assessment tool 2 revealed “some” to “high” risk of bias. The authors concluded that prolotherapy had a positive effect on TMJ pain compared to placebo injections. The significance of this study is limited by small sample size and short follow-up period.

A randomized controlled trial conducted by Louw et al (2019) studied the effect of hypertonic dextrose injection (prolotherapy) for the treatment of temporomandibular dysfunction. Forty-two participants (54 joints) were randomized to 3 monthly intra-articular injections of 20% dextrose / 0.2% lidocaine or to 0.2% lidocaine. This was followed by injections of dextrose/0.2% lidocaine as needed through 1 year. Facial pain and jaw dysfunction, maximal interincisal opening, percentage of joint with 50% or more improvement in pain/function, and patient satisfaction were the primary and secondary outcome measures. “Randomization produced a control group with more female participants (p = .03), longer pain duration (p = .01), and less MIO (p = .01). Upon 3-month analysis, including pertinent covariates, dextrose group participants reported decreased jaw pain (4.3 ±2.9 points vs 1.8 ±2.7 points; p = .02), jaw dysfunction (3.5 ±2.8 points vs 1.0 ±2.1 points; p = .008), and improved MIO (1.5 ±4.1 mm vs −1.8 ±5.1 mm; p = .006). Control group participants received dextrose injections beginning at 3 months. No between-group differences were noted at 12 months; pooled data suggested that jaw pain, jaw function, and MIO improved by 5.2 ±2.7 points (68%), 4.1 ±2.8 points (64%), and 2.1 ±5.5 mm, respectively. Pain and dysfunction improved by at least 50% in 38 of 54 (70%) and 39 of 54 (72%) jaws, respectively.” The authors concluded that prolotherapy resulted in substantial improvement in jaw pain, function and maximal interincisal opening compared with masked control injection at 3 months; with clinical improvements enduring to 12 months. This study is limited by the small patient population and suboptimal data analysis/reporting.

Cömert Kiliç et al. (2016) conducted a RCT involving 30 adult patients with bilateral TMJ hypermobility referred for treatment. They were divided randomly into 2 treatment groups using either saline (placebo group) or dextrose injections (study group). The solution was injected into 5 different TMJ areas in 3 sessions at monthly intervals. The predictor variable was the treatment technique. The outcome variables were VAS evaluations and maximum inter-incisal opening (MIO). Outcome variables were recorded preoperatively and at 12 months postoperatively. The follow-up sample was comprised of 26 subjects, 12 in the placebo group and 14 in the study group. Masticatory efficiency increased and general pain complaints and joint sounds decreased significantly in both groups. MIO decreased significantly only in the study group. Insignificant changes in the other parameters were found for both groups. The authors concluded that after estimating differences between follow-up and baseline outcomes, the mean change in primary outcome variables showed no statistically significant difference between the 2 groups, suggesting that dextrose prolotherapy is no more effective than placebo for TMJ hypermobility.

Zhou and colleagues (2014) conducted a single center case series of 45 patients, introducing a modified technique of prolotherapy using an injection of lignocaine and 50% dextrose at a single site in the posterior periarticular tissues. The criteria for inclusion in this study were open lock of the jaw > twice in the past 6 months, and no long-standing dislocation of the TMJ. Patients were followed for at least one year. There were appreciable improvements in the number of episodes of dislocation and clicking after the injection. The overall success rate, defined as the absence of any further dislocation or subluxation for more than 6 months, was 41/45 (91%). Of the 41 rehabilitated patients, 26 (63%) required a single injection, 11 (27%) had 2 treatments, and 4 (10%) needed a third injection. All patients tolerated the injections well. The authors concluded that the modified dextrose prolotherapy is simple, safe, and cost-effective for the treatment of recurrent dislocation of the TMJ. Study limitations include small study size and the lack of a control group.

Lower Limb Tendinopathies

Kazempour Mofrad et al. (2022) performed an uncontrolled, before-after study to evaluate the effectiveness of extra-articular, neurofascial dextrose prolotherapy in chronic ankle ligament injury. Patients with chronic ankle ligament injury entered this uncontrolled before-after study based on eligibility criteria. Patients who consented to participate in the study filled out the prepared questionnaire containing demographic data, the Cumberland ankle instability tool (CAIT), and the Visual Analogue

Scale (VAS). The initial CAIT score of less than 25 indicated functional instability following an ankle sprain. Patients underwent neurofascial prolotherapy with dextrose 12.5%. Two injections within one month were done. The CAIT was completed one, three, and six months after the intervention. Twenty-five patients with chronic ankle ligament injury were investigated. The mean CAIT score was 1.88 (±2.35) before the intervention, which increased significantly over the study ($p < 0.001$). The CAIT score reached 21.84 (±6.04) in the sixth month after the intervention. Moreover, the VAS score decreased significantly over the study from 6.12 (±2.35) before the intervention to 1.24 (±0.43) in the sixth month after the intervention ($p < 0.001$). The authors concluded that their findings revealed the therapeutic effectiveness of dextrose neurofascial prolotherapy in decreasing pain and functional instability in patients suffering chronic ankle pain due to ligamentous injury accompanied by chronic ankle instability. This study is limited by its uncontrolled and unblinded design, and small sample size. Further research with randomized controlled trials is needed to validate these findings.

Because their efficacy and potential AEs are unclear, Morath et al. (2018) conducted a systematic review and meta-analysis of available published literature on sclerotherapy and prolotherapy for treating Achilles tendinopathy (AT) in athletes. While the initial search yielded 1104 entries, only 13 were human studies. Four RCTs were ranked as having a low risk of selection bias. Three of those reported a statistically significant drop in the VAS score. Positive results regarding pain relief and patient satisfaction were identified in 12 of the 13 studies. The authors stated that the meta-analysis was clearly in favor of the intervention. Only one serious AE and two minor AEs were reported in the entire body of literature. The researchers concluded that both sclerotherapy and prolotherapy are safe and may be effective treatment options for AT, however long-term studies and RCTs are still needed to support their recommendation. The conclusions are limited by a mix of human and animal studies, controlled and uncontrolled studies, and questionable choice of comparation groups.

A systematic review by Sanderson and Bryant (2015) evaluated the effectiveness and safety of prolotherapy injections for management of lower limb tendinopathy and fasciopathy. While no AEs following prolotherapy injections were reported in any study in this review, the authors found limited evidence that prolotherapy injections are a safe and effective treatment for AT, PF and Osgood-Schlatter disease. More robust research using large, methodologically-sound RCTs is required.

Platelet Rich Plasma (PRP) Therapies

While some available studies are promising, the majority of evidence on platelet-derived blood or plasma therapies compared to other standard treatment is highly variable with regard to efficacy or improved health outcomes for a wide range of conditions. Higher quality studies with longer follow up as well as standardization of best practices are needed to determine the benefit of this technology.

Osteoarthritis (OA)

Knee (KOA)

A randomized clinical trial (RCT) by Bennell et al. (2021) was conducted to evaluate the effects of intra-articular platelet-rich plasma (PRP) injections, compared with placebo saline injection, on symptoms and joint structure in patients with symptomatic mild to moderate radiographic medial knee osteoarthritis (OA). This randomized, 2-group, placebo-controlled, participant-, injector-, and assessor-blinded clinical trial enrolled community-based participants (n = 288) aged 50 years or older with symptomatic medial knee OA (Kellgren and Lawrence grade 2 or 3) in Sydney and Melbourne, Australia, from August 24, 2017, to July 5, 2019. The 12-month follow-up was completed on July 22, 2020. Interventions involved 3 intra-articular injections at weekly intervals of either leukocyte poor PRP using a commercially available product (n = 144 participants) or saline placebo (n = 144 participants). The 2 primary outcomes were 12-month change in overall average knee pain scores (11-point scale; range, 0-10, with higher scores indicating worse pain; minimum clinically important difference of 1.8) and percentage change in medial tibial cartilage volume as assessed by magnetic resonance imaging (MRI). Thirty-one secondary outcomes (25 symptom related and 6 MRI assessed; minimum clinically important difference not known) evaluated pain, function, quality of life, global change, and joint structures at 2-month and/or 12-month follow-up. Among 288 patients who were randomized (mean age, 61.9 [SD, 6.5] years; 169 [59%] women), 269 (93%) completed the trial. In both groups, 140 participants (97%) received all 3 injections. After 12 months, treatment with PRP vs placebo injection resulted in a mean change in knee pain scores of -2.1 vs -1.8 points, respectively (difference, -0.4 [95% CI, -0.9 to 0.2] points; p = .17). The mean change in medial tibial cartilage volume was -1.4% vs -1.2%, respectively (difference, -0.2% [95% CI, -1.9% to 1.5%]; p = .81). Of 31 pre-specified secondary outcomes, 29 showed no between-group differences. The authors concluded among patients with symptomatic mild to moderate radiographic knee OA, intra-articular injection of PRP, compared with injection of saline placebo, did not result in a difference in symptoms or joint structure at 12 months. These findings do not support use of PRP for the management of knee OA. This study has multiple limitations. PRP preparations are heterogeneous and lack standardization. Results from this trial may not be generalizable to

other PRP preparations. This trial included patients with mild to moderate radiographic knee OA because prior evidence suggested that they may have greater benefits from PRP, and the results may not be generalizable to more severe disease. Further investigation is needed before clinical usefulness of this procedure is proven.

Dório et al. (2021) performed a double-blinded, placebo-controlled, randomized clinical trial (RCT) to evaluate the efficacy of intra-articular platelet-rich plasma (PRP) and plasma to improve pain and function in participants with knee osteoarthritis (KOA) over 24 weeks. The study included randomized, double-blind, placebo-controlled trial with 3 groups (n = 62): PRP (n = 20), plasma (n = 21) and saline (n = 21). Two ultrasound-guided knee injections were performed with a 2-week interval. The primary outcome was visual analog scale 0-10 cm (VAS) for overall pain at week 24, with intermediate assessments at weeks 6 and 12. Main secondary outcomes were: Knee Injury and Osteoarthritis Outcome Score (KOOS), Outcome Measures in Rheumatology-Osteoarthritis Research Society International (OMERACT-OARSI) criteria and timed up and go test (TUGT). At baseline, 92% of participants were female, with a mean age of 65 years, mean BMI of 28.0 Kg/m2 and mean VAS pain of 6.2 cm. Change in pain from baseline at week 24 were -2.9 (SD 2.5), -2.4 (SD 2.5) and -3.5 cm (SD 3.3) for PRP, plasma and saline, respectively (p intergroup = 0.499). There were no differences between the three groups at weeks 6 and 12. Similarly, there were no differences between groups regarding secondary outcomes. The PRP group showed higher frequency of adverse events (65% versus 24% and 33% for plasma and saline, respectively, p = 0.02), mostly mild transitory increase in pain. The authors concluded that PRP and plasma were not superior to placebo for pain and function improvement in KOA over 24 weeks. The PRP group had a higher frequency of mild transitory increase in pain. Limitations include small sample size and heterogeneous patient population. Well designed, comparative studies with larger patient populations are needed to further describe safety and clinical outcomes.

Filardo et al. (2021) completed a meta-analysis of randomized controlled trials (RCTs) to evaluate the effectiveness of platelet-rich plasma (PRP) injections for knee osteoarthritis (KOA) compared to placebo and other intra-articular treatments. On January 17, 2020, the authors searched PubMed, Cochrane Library, Scopus, Embase, Web of Science, as well as the gray literature. Randomized controlled trials (RCTs) comparing PRP injections with placebo or other injectable treatments, in any language, on humans, were included. Risk of bias was assessed following the Cochrane guidelines; quality of evidence was graded using the GRADE guidelines. Thirty-four RCTs, including 1403 knees in PRP groups and 1426 in control groups, were selected. WOMAC (Western Ontario and McMaster Universities Osteoarthritis Index) score favored PRP, with a statistically and clinically significant difference versus placebo at 12-month follow-up ($p = 0.02$) and versus HA (hyaluronic acid) at 6-month ($p < 0.001$) and 12-month ($p < 0.001$) follow-ups. A clinically significant difference favoring PRP versus steroids was documented for VAS (Visual Analogue Scale) pain ($p < 0.001$), KOOS (Knee Injury and Osteoarthritis Outcome Score) pain ($p < 0.001$), function in daily activities ($p = 0.001$), and quality of life ($p < 0.001$) at 6-month follow-up. However, superiority of PRP did not reach the minimal clinically important difference for all outcomes, and quality of evidence was low. The authors concluded that the effect of platelet concentrates goes beyond its mere placebo effect, and PRP injections provide better results than other injectable options. The authors stated that this benefit increases over time, becoming clinically significant after 6 to 12 months. However, although substantial, the improvement remains partial and supported by low level of evidence. This finding urges further research to confirm benefits and identify the best formulation and indications for PRP injections in knee OA. Limitations include a lack of standardization, lack of key data, heterogeneity and high-level clinical trials. Only 20 out of 33 studies were double blinded: given the relevance of the placebo effect in the field of knee injections, this factor could have influenced the results, although the overall results were in line with those from the sensitivity analysis of double-blind trials. Further research is needed to determine the clinical relevance of these findings. (Authors Lin et al. (2019) and Rahimzadeh et al.(2018) which were previously cited in this policy are included in this review)

An updated 2021 Hayes comparative effectiveness review of platelet-rich plasma (PRP) for knee osteoarthritis (KOA) stated that intra-articular (IA)-PRP is a minimally invasive treatment associated with few complications that may be appealing when more conservative therapies (e.g., oral medications, PT), are contraindicated, unavailable, or fail to provide adequate relief. Current evidence suggests limited difference in efficacy from IA-HA at up to 6 months, but that IA-PRP may associated with better outcomes at 1-year follow-up. If IA-PRP can be conclusively shown to provide benefits over IA-HA at 1 year, it has the potential to displace IA-HA. Future research should consider the role of PRP preparation protocols upon efficacy, as they vary considerably across studies. There is no standardization or consensus as to best practices, nor is there clear understanding of which steps and factors (if any) are associated with better outcomes. These factors are likely to bear upon acceptance of PRP as an alternative to IA-CS or IA-HA in the future. The annual review identified five new key RCT studies. The evidence remains unchanged. (Author Di Martino A et al. (2018) previously cited in this policy, is included in this review)

An ECRI Clinical Evidence Assessment (2020) report on platelet-rich plasma therapy (PRP) for knee osteoarthritis (KOA) was published following systematic review and meta-analysis. The report concentrated on PRP's effectiveness and safety compared with those of hyaluronic acid (HA) and corticosteroids. Pain relief, knee function, and adverse events were assessed. Pain relief: meta-analysis of data from 30 RCTs reported that PRP yielded better pain score improvements than HA, corticosteroids, and placebo at 3, 6, and 12 months. Knee function: PRP had better Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) scores than HA, corticosteroids, and placebo at 3, 6, and 12 months. No serious AEs occurred. More complications with PRP alone than with PRP plus HA were reported as well as more local AEs with leukocyte-rich PRP. The authors concluded that there was insufficient comparative data and evidence is inconclusive. Limitations included varied PRP preparation, injection methods, and number of injections. Time between injections varied (weekly to monthly). Analysis was limited to 3-, 6-, and 12-month outcomes; data were not available for longer follow-up. Other limitations within the evidence base included lack of blinding in some studies, need for long-term follow-up, primarily single-center focus, and no reporting on a treatment's ability to postpone knee replacement. (ECRI, 2020; updated 2022)

Trams et al. (2020) performed a systematic review and meta-analysis to evaluate platelet-rich plasma (PRP) efficacy in the recovery of knee disorders and during knee surgery. A total of 83 clinical studies with 5,323 patients were included in this review. Mean follow-up period was 12 months (ranging from 10 days to 3 years) and the mean number of patients included was 62 (ranging from 20 to 315). The study included patellar tendinitis (4 studies/137 patients), muscle injuries around the knee (4 studies/224 patients), high tibial osteotomy (HTO) (2 randomized controlled trials (RCTs)/80 patients), total knee arthroplasty (TKA) (6 RCTs/621 patients), arthroscopy (4 RCTs/199 patients), anterior cruciate ligament reconstruction (ACL) (16 RCTs/740 patients), meniscal repair (2 RCTs/5 non-RCTs), and osteoarthritis (38 studies/2,962 patients). In total, seven areas of meta-analysis reported a positive effect of PRP. Among them, 10 sub-analyses revealed differences in favor of PRP when compared to the control groups ($p < 0.05$). The study showed positive effects of PRP, both on the recovery of knee disorders and during knee surgery. The authors concluded that PRP improves outcomes in osteoarthritis applications, arthroscopic treatment of cartilage degeneration. meniscus healing, faster return to sport after muscle injuries, and reduces blood loss after total knee replacement. Limitations include the need for further prospective and randomized studies with a higher number of subjects with lower biases.

A randomized, double-blind, triple-parallel, placebo-controlled trial by Lin and colleagues (2019) prospectively compared the efficacy of intraarticular (IA) injections of PRP and hyaluronic acid (HA) with a sham control group (normal saline solution [NS]) for KOA. A total of 87 osteoarthritic knees (53 patients) were assigned to 1 of 3 groups receiving 3 weekly injections of either LP-PRP (31 knees), HA (29 knees), or NS (27 knees). The WOMAC Index score and International Knee Documentation Committee (IKDC) subjective score were collected at baseline and at 1, 2, 6, and 12 months after treatment. All 3 groups showed statistically significant improvements in both outcome measures at 1 month; however, only the PRP group sustained the significant improvement in both the WOMAC and IKDC scores at 12 months, showing improvement of 21% and 40%, respectively. There was no significant difference in both functional outcomes between the HA and NS groups at any time point. Only the PRP group reached the minimal clinically important difference in the WOMAC score at every evaluation. Study limitations included small sample size and that the trial did not include imaging studies for the evaluation of joint cartilage post-injection. The authors concluded that IA injections of LP PRP can provide clinically significant functional improvement for at least 1 year in patients with mild to moderate KOA. Future long-term studies of larger sample sizes encompassing all stages of degeneration with the inclusion of imaging evaluation and biomarker analysis of the knee joints are warranted to further elucidate these findings. These findings need to be reproduced in additional large high-quality studies to assess the implications for clinical care.

Delanois and colleagues (2019) conducted a systematic review and analysis of reports evaluating: (1) PRP injections; (2) bone marrow-derived mesenchymal stem cells (BMSCs); (3) adipose-derived mesenchymal stem cells (ADSCs); and (4) amnion-derived mesenchymal stem cells (AMSCs) in management of KOA. Of 1009 studies identified within the last 5 years, 123 met inclusion criteria. Although the majority of PRP reports demonstrated improvements in pain and/or function, some revealed no substantial improvements. Similar findings were noted for the other therapy. The reviewers concluded that although some promising early results for PRP, BMSC, ADSC, and AMSC therapies were identified, the majority of level I studies have multiple problems including but not limited to small sample sizes, potentially inappropriate control cohorts, and short-term follow-up. Despite the limitations, they indicate that there still appears to be evidence justifying their use for KOA management. More high-level, larger human studies utilizing standardized protocols are needed.

Annaniemi et al. (2018) conducted a retrospective study with 190 participants to compare PRP versus visco supplements in terms of symptom relief and time to arthroplasty in patients with KOA. Subjects received either IA injections of PRP (94

patients), which the authors label as “an experimental treatment in osteoarthritis”, or HA (86 patients) between January 2014 and October 2017. WOMAC, VAS, and range of motion (ROM) were measured before injection, at 15 days, 6 months, 12 months, and at final follow-up. Individuals treated with HA experienced a higher arthroplasty rate (36% vs 5.3%), lower ROM, worse VAS and WOMAC Index scores, and increased risk of any arthroplasty occurrence than those treated with PRP. Cox proportional hazards analysis revealed a tendency to decrease the risk of knee arthroplasty for the participants treated by PRP. When adjusted for propensity score in matched pairs (n = 78), the PRP group still showed significant improvement over the HA group in arthroplasty rate (12.8% vs 41%), VAS and WOMAC scores, but not in ROM during the mean follow-up of 16.7 months. Authors found that in comparison to HA, IA injections of PRP are associated with better outcomes, prolonged time to arthroplasty, and a valid therapeutic option in select KOA patients who are unresponsive to conventional treatments. A limitation of retrospective study design was cited by the authors, who concluded that further larger studies are needed to validate this promising treatment modality. Additionally, the findings are limited by lack of randomization between interventions, which could have introduced biases and multiple comparisons.

A systematic literature review and meta-analysis if possible were performed by Laudy et al. (2015) to evaluate the effectiveness of PRP injections for KOA based on decreasing pain, improving function, global assessment and changes regarding joint imaging. Ten trials were included. Most of these compared PRP to HA and were observational. The author identified only one RCT comparing PRP to placebo (Patel, et al. 2013), which is also review with newer studies in the systematic review by Delanois, et al. (2019). In the studies reviewed by Laudry, et al., IA PRP injections were more effective for pain reduction compared with placebo or HA, but the level of evidence was limited due to a high risk of bias.

Hip Osteoarthritis (HOA)

Gazendam et al. (2020) performed a systematic review and network meta-analysis of randomized controlled trials (RCTs) to compare the efficacy of various intra-articular (IA) injectable treatments in treating hip osteoarthritis at up to 6 months of follow-up. The intra-articular injectables included: corticosteroids (CCS), hyaluronic acid (HA), and platelet-rich plasma (PRP). Eleven studies which included 1,353 patients were reviewed. Treatment groups included IA placebo injection with or without local anesthetic (n = 314), HA (n = 596), CCS (n = 237), PRP (n = 155), a combined HA and PRP injection (HA+PRP, n = 31), and a control group with no injection (n = 20). There was high risk of bias due to deviations from the intended interventions and missing outcome data. Results revealed that none of the hip injections demonstrated improvement in pain or function scores compared with saline hip injection at 2-4 months, and 6 months except for HA+PRP and the control group. The authors concluded that no treatment was found to have a clinically meaningful benefit beyond placebo. Limitations included small sample size. Well designed, comparative studies with larger patient populations are needed to further describe safety and clinical outcomes.

A 2019 Hayes Health Technology Assessment of published literature on the use of PRP for the treatment of HOA identified 4 RCTs representing 303 patients who were treated with intra-articular (IA)-PRP or IA-HA. They stated that the small body of low-quality evidence suggests that pain and function outcomes may improve after treatment with ultrasound-guided IA-PRP and remain better than pretreatment status up to 1 year. IA-PRP outcomes do not appear to be different from those obtained with IA injection with IA-HA, a common treatment alternative for which there is uncertainty regarding the clinical significance of treatment benefits. There is insufficient evidence available to draw firm conclusions about safety; the limited published evidence indicates that IA-PRP is safe and well tolerated. Long-term effects of PRP therapy beyond 1 year have not been established. The report concludes that there is potential but unproven benefit of PRP for HOA. Future studies may help determine whether IA-PRP is more efficacious than placebo or other active treatments and provide additional information regarding potential harms (Hayes, 2019). The October 19, 2020 annual review identified four new abstracts which included one randomized controlled trial and 3 systematic reviews and meta-analyses. The evidence remains unchanged. (Hayes, 2020) (Authors Dallari et al. (2016) and Battaglia et al. (2013) which were previously cited in this policy are included in this report)

Dold and colleagues (2014) conducted a systematic review of PRP for articular cartilage pathology. Literature search was conducted for studies published up to October 2012 that assessed clinical outcomes of the use of PRP for the treatment of chondral and osteochondral pathology, excluding those including concomitant management of acute fractures or ligament reconstruction. Ten studies were included in the final analysis, but only one addressed use of PRP for HOA and was only level IV evidence.

Soft Tissue (Tendon, Joint, and other Soft Tissue Areas of the Body)

In 2016, the Washington State Health Care Authority (WSHCA) conducted a technology assessment to evaluate the safety and efficacy of PRP and/or ABI for the treatment of various musculoskeletal and orthopedic conditions. As part of the technology assessment, a total of 54 RCTs and 8 cohort studies were included and reviewed. Limitations of the studies noted by the Committee generally included small sample populations, short-term follow-up, inconsistency of measured outcomes, potential for risk bias, and lack of high-quality evidence. The authors concluded there was insufficient evidence to draw strong conclusions regarding safety and efficacy. Moreover, the Committee reported despite its current use, standardization of PRP preparation is lacking, and although the technology to obtain PRP is FDA-approved, PRP is currently not indicated for direct injection.

Balasubramaniam et al. (2015) systematically reviewed the literature regarding PRP therapy in chronic tendinopathy. A total of 389 articles were reviewed from Feb 2010 to April 2014, with 9 RCTs meeting inclusion criteria. Each article was reviewed independently by 2 authors. Each article was analyzed using the Cochrane Criteria checklist. The review found that PRP was most effective in patellar and lateral epicondylar tendinopathy, with both RCTs in the patellar section of the study supporting the use of PRP in pain reduction at 3 and 12 months, whereas 2 of 4 studies in the lateral epicondylar section showed improvements in pain and disability at 6 and 12 months. There was a lack of evidence to support the use of PRP in Achilles and RC tendinopathy. The authors concluded that although the results of this review showed promise for the use of PRP in chronic tendinopathy, the analysis highlighted the need for more controlled clinical trials comparing PRP with placebo. The findings are limited by the small number of quality studies for each indication and inconsistent results of the intervention.

Moraes et al. (2014) conducted a Cochrane review to assess the effect of platelet rich therapy (PRT) for musculoskeletal soft tissue injuries . Nineteen studies were found that compared PRT with placebo, autologous whole blood, DN or no PRT (n = 1,088). The trials covered 8 types of injury, some of which were treated surgically: RC tears, shoulder impingement syndrome, tennis elbow, knee ligament reconstruction using autologous and donor grafts, PT, AT, and acute rupture of the Achilles tendon. The available evidence base comprised a diverse collection of small trials that applied PRT in various ways for treating tendinopathies or as an augmentation procedure for surgically treated soft tissue injuries. There was very low quality evidence from a subset of the trials for a marginal short-term benefit in pain from PRT; however, other very low quality evidence indicated that using PRT did not appear to have a clinically relevant effect on short-term or long-term function. Very low quality evidence showed no difference in AEs between the PRT and the various control interventions. Overall, and for the individual conditions, researchers concluded there is currently insufficient evidence to support the use of PRT for treating these injuries.

Knee

A systematic review and meta-analysis was performed by Barman et al. (2022) to assess the efficacy of autologous platelet-rich plasma (PRP) injections in the treatment of patellar tendinopathy. The PubMed, MEDLINE, EMBASE, CINAHL, and Cochrane Central Register of Controlled Trials databases were searched for clinical trials which compared PRP injection with other 'active treatment' interventions ('Non-PRP' injection and 'No-injection' treatments) or 'No-active treatment' interventions. Randomized and non-randomized clinical trials that had been published up to November 15, 2021, were included in the meta-analysis. The primary outcome, pain relief, was measured on a 'visual analog scale.' Secondary outcomes were knee functional activities and quality of life (QoL). The PRISMA guidelines were followed throughout the study. A total of 8 comparative studies were identified for inclusion in the meta-analysis. Assessment of these studies revealed that there were no differences in pain relief, functional outcomes, and QoL in the short, medium, and long term between PRP injection and Non-PRP injection interventions. Similarly, comparison of PRP injection to the No-active treatment intervention showed no differences in short- and medium-term pain relief. However, when PRP injection was compared to the No-injection treatment intervention extracorporeal shock wave therapy (ESWT), the former was found to be more effective in terms of pain relief in the medium term (mean difference [MD] − 1.50; 95% confidence interval [CI] − 2.72 to − 0.28) and long term (MD − 1.70; 95% CI, − 2.90 to − 0.50) and functional outcomes in the medium term (MD 13.0; 95% CI 3.01–22.99) and long term (MD 13.70; 95% CI 4.62–22.78). The authors concluded in terms of pain relief and functional outcomes, the PRP injection did not provide greater clinical benefit than Non-PRP injections in the treatment of patellar tendinopathy. However, in comparison with ESWT, there was a benefit in favor of PRP injection. Limitations include heterogeneous treatment modalities in the control groups, in the 8 studies included most of the findings in the sub-group analysis were based on one clinical trial only, and the total number of participants in each study was low. Further investigation is needed before clinical usefulness of this procedure is proven. (Authors Dragoo et al. (2014) which were previously cited in this policy are included in this review)

A systematic review and meta-analysis by Migliorini et al. (2022) was performed to evaluate whether platelet-rich plasma (PRP) augmentation in combination with arthroscopic meniscal repair would lead to greater patient-reported outcome measures (PROMs) and accelerate the healing process. This meta-analysis compared arthroscopic meniscal repair performed in isolation or augmented with PRP. The present study was conducted according to PRISMA 2020 guidelines. PubMed, Web of Science, Google Scholar and Embase were accessed in August 2021. All the clinical trials which compared arthroscopic meniscal repair performed in isolation or augmented with PRP were included. Eight hundred thirty-seven patients were included: 38% (318 of 837 patients) were women; the mean age of the patients was 35.6 (range, 20.8–64.3) years; the mean follow-up was 26.2 (range, 6–54) months. Similarity was found in analogue scale (VAS) ($p = 0.5$) and Lysholm ($p = 0.9$), and International Knee Documentation Committee (IKDC) scores ($p = 0.9$). Similarity was found in the rate of failure ($p = 0.4$) and rate of revision ($p = 0.07$). The authors concluded that the current published scientific evidence does not support PRP augmentation for arthroscopic meniscal repair. Limitations include the small number of studies included in the review, heterogeneity in PRP preparation and processing protocols, and timing of the PRP injection, i.e., during meniscal repair, or after the meniscal suture. Well designed, comparative studies with larger patient populations are needed to further describe safety and clinical outcomes.

Zhu et al. (2022) performed a systematic review and meta-analysis of randomized controlled trials (RCTs) to evaluate the effects of platelet-rich plasma (PRP) on patient-reported functional scores, the clinical assessments of knee function and structure, and complications following anterior cruciate ligament reconstruction (ACLR). The authors searched 9 online databases for RCTs published in English or Chinese that examined the effects of PRP on ACLR. The primary outcome measures were visual analog scale (VAS) for pain and International Knee Documentation Committee (IKDC) scores. The secondary outcomes included KT-1000 arthrometer, pivot-shift test, Lysholm and Tegner scores, tunnel widening, graft characterization, and complications. Subgroup analyses were performed according to time of assessments. Fixed- and random-effects models were selected for data analysis. A total of 14 studies were included. When PRP was injected to graft tunnels, the pooled VAS scores of the 2 groups were similar ($p = .31$), and the subgroup analysis found that VAS and IKDC only improved at 3 months postoperatively ($p = .0003$ and $p < .00001$, respectively). When PRP was used at the bone-patellar tendon-bone harvest sites, VAS was decreased in the first 6 months postoperatively ($p < .00001$), whereas IKDC score was not remarkably different ($p = .07$). After PRP injection, Lysholm scores at 3 months postoperatively was different between the 2 groups ($p < .00001$), but the Tegner scores ($p = .86$), KT-1000 measurements ($p = .12$), the positive rate of pivot-shift test ($p = .64$), the enlargement of tunnels (femoral, $p = .91$; tibial, $p = .80$), and the characterization of grafts ($p = .05$) were not different. No difference in complications was found in either group. The authors concluded that PRP applied alongside ACLR could reduce postoperative pain and improve knee function in the short and medium terms but is ineffective in the long term. PRP does not improve knee stability and the enlargement of tunnels and does not accelerate the healing of grafts. Limitations are that the volume, concentration, intensity, and number of injections of PRP varied across the different studies as well as graft types (allografts and autografts) and fixation techniques, all of which may have affected the results. Further research with randomized controlled trials is needed to validate these findings.

An updated 2022 Hayes comparative effectiveness review on PRP for treatment of ligament injuries and tendinopathies of the knee identified 1 good-quality systematic review and meta-analysis with findings from 4 RCTs and 2 quasi-RCTs assessing the efficacy of PRP versus no PRP in anterior cruciate ligament reconstruction (ACLR) surgery or at the patellar graft donor site. Two additional primary RCTs were identified that supplemented these data. Two primary RCTs were identified that examined the use of PRP versus no PRP in patients with PT. No studies of PRP use in medial collateral ligament (MCL) injuries were found. The use of PRP in ACLR may not yield different functional outcomes from ACLR without PRP. However, limited evidence from patients who received PRP for patellar donor site morbidity suggests that function may improve more by 12 months compared with patients who did not receive PRP treatment and that use of PRP may reduce graft donor site pain more than no PRP. With regard to PT, limited and conflicting evidence precludes conclusions regarding functional improvement and pain reduction for PRP relative to some active controls. There is a paucity of evidence regarding the use of PRP to treat other ligament injuries or tendinopathies of the knee. The overall quality rating of the evidence was low to very low due to study limitations and inconsistency in the data and the report concluded that there was no proven benefit for this indication. (Author Dragoo et al. (2014) which was previously cited in this policy, is included in this review.) The 2020 annual review identified one new key RCT study. This updated annual review identified 2 new primary RCTs, however, the evidence remains unchanged.

An ECRI Clinical Evidence Assessment (2021) on platelet-rich plasma (PRP) for patellar tendinopathy assessed 1 systematic review with randomized controlled trials (RCTs) and 2 RCTs not included in the systematic review. PRP safety and effectiveness was compared with alternative therapies. Primary outcomes were Pain, function, and adverse events. The authors reported no significant differences in PRP-treated patients compared with saline-treated patients after 1 year and with dry needling patients after 6 months. PRP-treated patients had greater pain relief than those undergoing extracorporeal shockwave therapy at 1 year

and high-volume-image-guided saline injections at 6 months. A meta-analysis of all 4 RCTs found no significant differences for pain. PRP with autologous expanded bone marrow mesenchymal stem cells revealed pain improved in both groups after 6 months, with no differences between groups. The authors reported no significant differences in function, measured using Victorian Institute of Sports Assessment-Patella (VISA-P) scores in PRP-treated patients compared with saline-treated patients after 1 year and with dry needling patients after 6 months. Two other RCTs reported PRP-treated patients had greater function improvement compared with patients undergoing extracorporeal shockwave therapy at 1 year and high-volume-image-guided saline injections at 6 months. A meta-analysis of all 4 RCTs found no significant differences in VISA-P. No adverse events were reported. The authors concluded that PRP injections may improve pain and function in individuals with patellar tendinopathy based on inconclusive evidence. Limitations include small study size, short follow-up period and potential bias risks. Larger RCTs with longer follow-up comparing PRP with other treatments treating patellar tendinopathy and reporting patient-oriented outcomes are needed. (ECRI, 2021)

Lopez-Royo et al. (2020) performed a systematic review and meta-analysis of randomized controlled trials (RCTs) to determine the effectiveness of minimally invasive techniques (MIT) in patients with patellar tendinopathy. The study included a total of 10 RCTs and 326 patients. Five RCTs were included in the meta-analysis. The primary outcome was functionality using the VISA-p questionnaire. Secondary outcome was focused on pain. The study revealed MIT including PRP, skin-derived tenocyte-like cells, and dry needling combined with exercise lasting over 6 weeks obtained better results in pain and functionality than other short-term treatments. Long term results revealed that skin-derived tenocyte-like cells, and dry needling are more effective than PRP. The authors conclude that while PRP was effective at post-treatment, the improvements were not maintained over time and may have secondary effects. In addition, the authors concluded that it will be necessary to develop RCTs analyzing not only the effect but also comparing efficacy between different MIT. Limitations include the short-term follow-up which did not allow for assessment of intermediate and long-term outcomes. Further investigation is needed before clinical usefulness of this procedure is proven.

Achilles Tendinitis (AT) and Plantar Fasciitis (PF)

A systematic review and meta-analysis of randomized controlled trials was performed by Chutumstid et al. (2022) to investigate the efficacy and safety of dextrose prolotherapy for treating chronic plantar fasciitis. Comprehensive review of randomized controlled trials investigating dextrose prolotherapy for chronic plantar fasciitis was done. Two investigators independently screened the titles, abstracts, and full texts and extracted data from eligible studies. The changes in visual analog scale (VAS) pain score, foot function index (FFI), American Orthopaedic Foot and Ankle Society (AOFAS) score, and plantar fascia thickness were analyzed. Reports of complications of the procedure were collected. Eight randomized controlled trials (RCTs) were included in the meta-analysis, analyzing 444 patients in total. The subgroup analysis showed that at short-term follow-up (< 6 months) dextrose prolotherapy was more effective in reducing VAS pain score compared to the non-active treatment control group including exercise and normal saline solution (NSS) injection. However, there was no difference in the change of VAS pain score between dextrose prolotherapy and active treatment control group, which included extracorporeal shock wave therapy (ESWT), steroid injection, and platelet-rich plasma (PRP) injection. Dextrose prolotherapy was more effective in reducing FFI, increasing AOFAS score, and reducing plantar fascia thickness at short-term (< 6 months) follow-up compared to other comparators. For long-term (≥ 6 months) follow-up, there was no significant difference in the change in VAS pain score and FFI between the dextrose prolotherapy group and other comparators. No serious complication was reported. The authors concluded that dextrose prolotherapy is an effective treatment of chronic plantar fasciitis to reduce pain, improve foot functional score, and decrease plantar fascia thickness at short-term follow-up. Further studies in larger populations are needed to identify the optimal treatment regimen including dextrose concentration, volume, injection site, injection technique, and the number of injections required. The long-term effects of these treatments also require further examination. This meta-analysis is limited by the heterogeneity of the dextrose prolotherapy treatment regimen, including the injected solution mixture, concentration, and the treatment technique use in some trials and blinded injection use in the others. In addition, the control group varied greatly among studies, including placebo injection, exercise, and multiple active treatment options.

Fei et al. (2021) performed a systematic review and meta-analysis to compare the effectiveness of platelet-rich plasma (PRP) versus steroid injection to relieve pain and improve foot and ankle function in patients with plantar fasciitis (PF). The study included a total of 12 randomized controlled trials (RCTs) involving 653 patients performed between 2012 and 2019. The primary goals were pain relief and improved function. Visual Analog Scale (VAS) of the PRP group was lower than that of the steroid group at 6 months ($p = 0.02$), 1 year ($p = 0.02$), and 1.5 years ($p < 0.00001$) follow-up. American Orthopedic Foot and Ankle Society (AOFAS) scores of the PRP group were higher than that of the steroid group at 1 year ($p = 0.005$) follow-up. The authors concluded that PRP injection is more effective in relieving pain and improving foot and ankle function compared to

steroid injection at mid-term follow-up. Limitations include small sample size and short duration of follow-up, high heterogeneity between studies, and subjective outcome measures.

In an updated 2021 Hayes comparative effectiveness review, the effectiveness of PRP for treatment of conditions of the Achilles tendon and plantar fascia was assessed based on measures of functional improvement and pain relief, along with rates of adverse events. The report concluded that while PRP is a minimally invasive treatment that is associated with very few complications, available evidence from randomized trials does not indicate better functional outcomes after AT repair (compared with no PRP), and evidence for use of PRP in AT is limited and inconclusive. For treatment of PF, PRP may lead to better functional and pain-related outcomes compared with corticosteroid injection but evidence for other comparators is limited. The authors concluded that PRP development protocols varied considerably across studies; there was no consensus regarding best practices nor was there clear understanding of which steps and factors (if any) are associated with better outcomes. The annual review identified seven new RCTs. The studies were low quality of evidence and did not change the previous conclusion. (Authors Usuelli et al. (2018), Boesen et al. (2017), Gogna et al. (2016), Jain et al. (2015) which were previously cited in this policy, are included in this Hayes report)

Shoulder

Ahmad et al. (2022) performed a systematic review of meta-analyses of rotator cuff repair using platelet-rich plasma (PRP) to identify whether PRP improves clinical function and rate of tendon retears. The authors carried out a systematic review of previous meta-analyses published on the clinical outcomes of PRP used in the treatment of rotator cuff tears. They performed a comprehensive search of PubMed, Medline, Cochrane, CINAHL (Cumulative Index to Nursing and Allied Health Literature), and Embase databases, using various combinations of the commercial names of each PRP preparation and "rotator cuff" (with its associated terms), looking specifically at human meta-analysis studies involving the repair of the rotator cuff tendon surgically in the English language. Data validity was assessed and collected on clinical outcomes. Following this, a meta-analysis was undertaken. Thirteen meta-analyses met the inclusion and exclusion criteria. All were considered of similar quality with Oxman-Guyatt index of 9 and PRISMA score of more than 24. A total of 1,800 patients with an average follow up of 12 to 36 months. Based on review, the use of PRP for arthroscopic rotator cuff tear, when compared with controls, leads to a lower number of retears, improved short-term postoperative scores, and functional outcome. The following postoperative scores were reported: Constant: 12, Simple Shoulder Test: 10, ASES (American Shoulder and Elbow Surgeons): 9, UCLA (University of California, Los Angeles) 11, SANE (Single Assessment Numeric Evaluation) 1, VAS (visual analog scale): 6, and Retears: 13. Subgroup analysis showed that leukocyte content and gel application make no difference in the effectiveness of PRP. VAS score subgroup analysis showed short-term pain relief. The authors concluded the study shows that PRP is effective in reducing retears after rotator cuff repair and improving functional outcome scores and reducing short-term pain. Limitations to this study include review of meta-analyses with low-level evidence and not individual randomized controlled trials. The findings of this review need to be validated by well-designed studies.

Hamid and Sazlina (2021) conducted a systematic review and meta-analysis to assess the clinical effect of platelet-rich plasma (PRP) injection for rotator cuff tendinopathy. A literature search was conducted using CINAHL, Medline, SCOPUS, SPORTSDiscus and Web of Science databases to retrieve articles published in peer-reviewed journals until December 2020. Randomized controlled trials (RCTs), which compared clinical effects of PRP injection to the usual care among adults diagnosed with rotator cuff conditions were reviewed. The main outcomes of interest were changes in shoulder pain symptoms and shoulder functions. All variables were analyzed using random effects meta-analyses. Eight RCTs were reviewed in this study. The risk of bias for randomization was low for 6 RCTs, one study had unclear risk and the other was a high risk. Studies vary on the PRP techniques including preparation and injections. Moreover, the control intervention also differs. Four studies compared PRP with normal saline injection while in the remaining 4 RCTs the control intervention were rehabilitation program and dry needling. The authors concluded meta-analysis of selected studies showed that PRP injection was safe and effective intervention for long-term pain control and shoulder function in patients with RC disorders. Limitations included variations in PRP intervention and preparation, and high heterogeneity was observed across studies. The optimal PRP used for shoulder tendinopathy is yet to be identified. In addition, the funnel plot showed possible publication bias that may be attributed to studies with small sample size and studies with negative results that were not published. Therefore, the outcomes reported in this meta-analysis should be interpreted with caution.

An ECRI Health Technology Assessment (2020) on platelet-rich plasma to aid healing after rotator cuff surgery included 1 systematic review (n = 781) and 2 randomized controlled trials (RCTs) (n = 87) to compare rotator cuff surgery with PRP and rotator cuff surgery without PRP. Pain and function were assessed. No studies reported on adverse events, re-treatment rates, or symptom resolution. A single study addressing PRP use after rotator cuff surgery does not support its use. Findings revealed

surgery with PRP reduced incomplete tendon healing (measured via imaging) compared with no PRP One RCT reported that patients treated with or without PRP did not differ in shoulder functional status. One RCT reported that Constant scores and pain (VAS) did not differ statistically between surgery with delayed PRP treatment (10- to 14-days post-surgery) and surgery without PRP. The authors concluded that rotator cuff surgery plus PRP yielded small incremental benefits in shoulder function and pain compared with surgery without PRP but are too small to be clinically significant. Limitations include small sample size and moderate risk of bias due to single-center focus. (ECRI, 2020)

An updated 2020 Hayes comparative effectiveness review on PRP for treatment rotator cuff (RC) repairs, tendinopathies, and related conditions identified 1 good-quality systematic review/meta-analysis with findings from 15 RCTs, along with 6 additional primary RCTs, assessing the use of PRP in arthroscopic RC repair. Two RCTs were identified that examined PRP injections for treatment of partial RC tears or RC tendinopathy, and 2 RCTs were identified that examined PRP use with arthroscopic acromioplasty (AA) or needling for calcific tendinitis. Compared with no PRP, the use of PRP in arthroscopic RC repair may provide short-term benefits for functional improvement and pain reduction, but data were conflicting for this finding and benefits did not persist long term. Taken together, these findings provide some preliminary evidence that PRP may accelerate recovery from arthroscopic RC repair in the short term, but PRP treatment does not change long-term functional or pain outcomes. Limited evidence finds no difference in functional improvement with PRP injections for non-arthroscopic treatment of partial RC tears or tendinopathy, but findings were inconsistent with regard to pain. Finally, limited evidence suggests no difference in functional improvement after AA or needling for RC tendinopathy, along with no difference in pain relief after AA. The overall quality rating of this body of evidence is considered low to very low. (Authors Ebert et al. (2017), Pandey et al. (2016), Flury et al. (2016), Verhaegen et al (2016), Carr et al. (2015) which were previously cited in this policy, are included in this review). A 2020 annual review identified two key RCTs. The evidence remains unchanged.

Lateral Epicondylitis (LE)

Masiello et al. (2023) conducted a systematic review and meta-analysis evaluating ultrasound (US)-guided injections of platelet-rich plasma (PRP) as conservative treatment of tendinopathies. A total of 33 RCT (2,025 subjects) met inclusion criteria: 8 in lateral epicondylitis, 5 in plantar fasciitis, 5 in Achilles tendinopathy, 7 in rotator cuff tendinopathy, 3 in patellar tendinopathy and 5 in carpal tunnel syndrome. PRP, given as a single injection (20 trials) or multiple injections (13 trials), was compared to US-guided injection of steroids, saline, autologous whole blood, local anesthetic, dry needling, prolotherapy, bone marrow mesenchymal stem cells, or with non-injective interventions. The outcomes more commonly reported included pain and functional measures, sub-grouped as in the short-term (< 3 months from the intervention), medium-term (3 to 6 months) or long-term (≥ 12 months). No clear between-group differences in these outcomes were observed in patients with lateral epicondylitis, plantar fasciitis, or Achilles, rotator cuff or patellar tendinopathy. In patients with carpal tunnel syndrome, visual analog scale scores for pain at 3 and 6 months and Boston Carpal Tunnel Questionnaire severity scores at 1, 3 and 6 months were lower in PRP recipients than in controls. The certainty of evidence of all these comparisons was graded as low or very low due to risk of bias, imprecision and/or inconsistency. Pain at the injection site was more common among PRP recipients than among controls receiving other US-guided injections. In patients with tendinopathies, a trend towards pain reduction and functional improvement from baseline was observed after US-guided PRP injection, but in the majority of the comparisons, the effect size was comparable to that observed in control groups. The authors concluded that there is insufficient evidence to routinely recommend US-guided PRP injections. Further well-designed, large, randomized trials are needed to better define potential indications for, long-term benefits of, and optimal treatment protocols for PRP as a conservative treatment in orthopedics.

A systematic review and meta-analysis by Niemiec et al. (2022) was performed to evaluate the effectiveness of platelet-rich plasma (PRP) in lateral epicondylitis treatment using minimal clinically important difference (MCID) values as a reference and to investigate if leukocyte content can influence the effectiveness of the therapy. Following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines, the authors searched the Medline and Scopus databases for studies on lateral epicondylitis and PRP therapy that used the following patient-reported outcome measures (PROMs): visual analog scale (VAS) for pain; Disabilities of the Arm, Shoulder and Hand (DASH); Patient-Rated Tennis Elbow Evaluation (PRTEE); and Mayo Clinic Performance Index (MAYO). The weighted arithmetic means for the PROMs were calculated at baseline (week 0) and follow-up weeks 4, 8, 12, 24, 52, and 104. The mean differences in outcomes (△VAS, △DASH, △PRTEE, and △MAYO) were compared with the MCID values at each follow-up point. In addition, the effectiveness of leukocyte-rich PRP (LR-PRP) versus leukocyte-poor PRP (LP-PRP) was also compared. The Student t test was used in all analyses. A total of 26 studies were included in the analysis. After PRP injection, all PROM scores improved with time. The scores improved significantly from baseline to each follow-up time ($p < .0001$), with the exception of the PRTEE (no significant difference at follow-up weeks 12 and 52). The mean difference in scores from baseline exceeded the respective MCIDs from weeks 4 to 104

for the VAS and DASH, from weeks 4 to 52 for the MAYO, and from weeks 8 to 52 for the PRTEE. The MCID for each of the PROMs was exceeded at almost every observation period in both the LR-PRP and the LP-PRP systems. Based on comparisons with the MCID values of commonly used outcome scores, the authors concluded that PRP seems to be an effective form of treatment for lateral epicondylitis. Both the LR- PRP and the LP- PRP systems were effective in the context of meeting the MCID. Limitations include varying parameters in the studies used for this analysis including protocol, type of PRP preparation, preparation technique and administration, post-injection management including rehabilitation, patient characteristics, and baseline clinical conditions. There is also a high risk of heterogeneity among the compared clinical studies. The available evidence is limited with overall poor-quality methodology and design, and diversity in reporting outcome measures. Therefore, no conclusions can be made regarding the relative efficacy, effectiveness or safety of treatment.

An ECRI Clinical Evidence Assessment (2021) on platelet-rich plasma therapy (PRP) for lateral epicondylitis (LE) included 2 systematic reviews that included 25 RCTs and 5 additional randomized controlled trials (n = 2,033) to compare PRP with alternative treatments (i.e., saline or corticosteroid injections) or placebo. Pain, function, and adverse events were assessed. Findings revealed that saline injection, PRP injection, and steroid injections all provided comparable pain relief and functional improvement up to 3-months post-treatment. By 3-months, however, PRP provided better pain relief than steroid injection. PRP combined with surgery revealed improved pain in both groups up to 1-year post-treatment. At 24-weeks post-treatment, however, PRP provided better pain control compared to physical therapy. Transient post-injection pain was the most reported adverse reaction and no serious adverse events. The authors concluded that evidence is inconclusive with mixed results for PRP as treatment of LE. Limitations included wide variations in how PRP is prepared and used as well as varied patient characteristics and symptoms of LE. (ECRI, 2021)

In a 2021 comparative effectiveness review by Hayes, prolotherapy using PRP is identified as a minimally invasive treatment option for patients with persistent LE that is unresponsive to other conservative measures. Current evidence suggests that PRP may yield some long-term benefits that are not apparent before 6 months, particularly when compared with corticosteroid injection. Once PRP preparations are standardized and best practices are established, trials can identify which factors are associated with better outcomes, yielding more effective PRP preparations and patient selection criteria. (Author Schöffl et al. (2017) which was previously cited in this policy, is included in this review). The 2021 annual review identified three new RCTs. The evidence remains unchanged. (Hayes, 2021)

In 2017, Merolla and colleagues conducted a prospective comparative randomized study to compare the efficacy of autologous PRP injections and arthroscopic lateral release in treating chronic LE. A total of 101 patients received arthroscopic release (n = 50) or US-guided PRP injections (n = 51). Outcomes were assessed using VAS for pain, the Patient-Rated Tennis Elbow Evaluation (PRTEE), and a calibrated hand dynamometer for grip strength. Follow up assessments intervals were at week 2, 4, 8, 12, 24, and at 1 and 2 years for the PRP group. While unable to be assessed at weeks 2 and 4 due to immobilization and rehabilitation, the arthroscopy group was evaluated at the same intervals. Both groups experienced significant improvement in all measures. The PRP group experienced significantly improved grip strength at week 8; all other significant differences were in favor of arthroscopy. Consumption of rescue pain medication was not significantly different between the groups. Authors concluded that while both procedures were safe and well accepted, arthroscopic release ensured better long-term outcomes than PRP injection. The findings are limited by lack of comparison to a placebo injection and active intervention in the non-PRP group.

Foot Injuries

Görmeli and colleagues (2015) conducted a prospective, blinded RCT to compare the effects of HA and PRP as adjunct therapies after arthroscopic microfracture in osteochondral lesions (OCLs) of the talus. Patients with talar OCLs in their ankle joints (n = 40) were treated with arthroscopic debridement and a microfracture technique. Thirteen randomly selected patients received PRP, 14 patients received HA, and the remaining 13 patients received saline as a control group. The participants were assessed using AOFAS and VAS scores after a 15 month follow-up. Postoperatively, all the groups exhibited significantly increased AOFAS scores and decreased VAS scores compared with their preoperative results. The AOFAS scores were significantly increased in the PRP group versus the HA and control groups, although the increased AOFAS scores in the HA group versus the control group were also significant. Similar to the AOFAS scores, the decrease in the VAS scores was significantly lower in the PRP group versus the HA and control groups. The HA group had significantly lower VAS scores than the control group. The authors concluded that both PRP and HA injections improved the clinical outcomes of patients who underwent surgery for talar OCLs in the midterm period and can be used as adjunct therapies for these patients. Because a single dose of PRP provided better results, they recommended PRP as the primary adjunct treatment option in the talar OCL

postoperative period. Limitations to this study include small sample size, short follow up period, and no masking of the participants to the intervention, which could have introduced biases.

Low Back Pain (LBP)

Singh et al. (2023) conducted a double-blinded, randomized controlled trial (RCT) aimed to evaluate the effect of autologous platelet-rich (PRP) on low back pain in patients with low back pain due to prolapsed intervertebral disc (IVDP). A total of 42 patients with IVDP were randomized either to the autologous PRP (n = 21) group or control (epidural local anesthetics with steroids; n = 21) group. Change in pain was assessed using the Numeric Rating Scale (NRS). Impact of treatment was assessed using the Global Perceived Effect (GPE) scale. All of the patients were followed up for six months. Data was compared using Chi-square, independent sample t, and Mann–Whitney U tests. The two groups were similar in their demographic and clinical profile. The baseline mean NRS ±standard deviation (SD) was 6.91 ±0.94 in the PRP group and 7.38 ±1.16 in the control group ($p = 0.099$). At six months, the mean NRS ±SD was 1.43 ±0.75 in the PRP group compared to 5.43 ±0.75 in the control group ($p < 0.001$). The GPE score was also found to be significantly higher in the PRP group, compared to the control group in the final assessment ($p < 0.001$). During the course of the study, the PRP group showed a consistent decline in NRS, whereas the control group showed an initial decline followed by consistent increase in NRS. The authors concluded that PRP provided sustained relief from low back pain due to IVDP and can be recommended as a safe and promising alternative to epidural local anesthetics and steroids. A small sample size makes it difficult to decide whether these conclusions can be generalized to a larger population. In addition, the short-term follow-up did not allow for assessment of intermediate and long-term outcomes. Further investigation is needed before clinical usefulness of this procedure is proven.

Singjie et al. (2023) conducted a systematic review and meta-analysis to determine the efficacy of platelet-rich plasma (PRP) treatment for patients with chronic low back pain. Comprehensive database searches were performed in four databases. This study was conducted and reported based on the Preferred Reporting Items for Systematic Reviews and Meta-analyses Guideline and registered to PROSPERO. The authors included and examined randomized controlled trials that looked into research employing PRP for patients with chronic low back pain. Outcomes of interest included clinical enhancement of pain, which is demonstrated in pain scores. Following initial screening, 3 studies were included comprising 138 patients with chronic low back pain. After 1, 3, and 6 months after injection, there was a substantial reduction in the pain score difference between the PRP and control groups, demonstrating PRP's superiority over the control group in the treatment of chronic low back pain. The authors concluded that PRP injection enhances chronic low back pain in the first, third, and sixth months after injection compared to controls. A limitation of this analysis is the small number of samples among the included studies. Further research with randomized controlled trials is needed to validate these findings.

A prospective, double-blind, randomized controlled trial (RCT) was conducted by Won et al. (2022) to evaluate the efficacy of platelet-rich plasma (PRP) injection and prolotherapy in patients with chronic low back pain. This RCT was conducted over a period of 3 years for patient enrollment and follow-up. Thirty-four patients with chronic, nonspecific low back pain (duration of at least 3 months) refectory to conventional management were randomized to platelet-rich plasma injection and lidocaine injection. Patients were treated with weekly platelet-rich plasma or lidocaine injections at the lumbopelvic ligaments for 2 weeks and then weekly prolotherapy with 15% glucose for 2 weeks and followed up 6 months. Visual analog scale, Oswestry Disability Index, and Roland–Morris Disability Questionnaire were evaluated at initial, 4 weeks, 3 months, and 6 months 0.2 (95% CI −1.15 to 0.74), 0.0 (95% CI −1.41 to 1.46), and 0.7 (95% CI −0.54 to 1.97). Four patients did not complete this trial. Three were in the platelet-rich plasma injection and 1 was in the lidocaine injection. Results of the study revealed that the pain intensity was decreased in platelet-rich plasma injections at 6 months compared to lidocaine injections; between-group differences were 0.9 (95% confidence interval 0.10–1.75 [$p = .027$]). All participants were with decreased pain and disability index at 4weeks, 3months, and 6months but there were no differences between groups except for visual analog scale at 6months. The baseline parameters revealed no differences in both groups. The authors concluded in chronic nonspecific low back pain, the PRP injection in combination with prolotherapy is an effective intervention and either lidocaine or PRP injection reduced disability. In addition, the authors stated that injection at the lumbopelvic ligaments using the PRP and prolotherapy is also an effective treatment for pain. Limitations include small sample size (34 patients) and short duration of follow-up (6 months).

Zhang et al. (2022) conducted a prospective clinical study aimed at evaluating the effectiveness of autologous PRP on discogenic low back pain (DLBP) at 48 weeks post-injection in patients who received a single intradiscal injection. All patients received a single intradiscal injection of PRP in a prospective trial. The pain scores, lumbar function, and adverse events were assessed at 1 week, 4 weeks, 8 weeks, 12 weeks, 24 weeks, and 48 weeks post-injection and compared to the pre-injection values (0 weeks). Data were analyzed from 31 patients with a 94% follow-up rate. Compared to pre-injection, pain and lumbar function were improved, and there were differences ($p < 0.05$) over the 48-week follow-up. Twenty-two (71%) patients were

classified as successes after the intradiscal injection of PRP. One patient received surgery at two weeks post-injection due to intervertebral discitis. The authors concluded that intradiscal injection of PRP can relieve pain sensation and improve lumbar function in patients with DLBP over a 48-week follow-up period. This study has several limitations. First, the sample size was relatively small, and a control group was not used. Second, there is a lack of composition data of PRP on cell count, including platelets, red cells, and white blood cells, as well as biological analysis of various growth factors. Finally, there is no routine radiological assessment of the morphologic changes of the disc treated with PRP during follow-up, preferably with MRI analysis. Further randomized controlled clinical trials are needed to assess the effects of this injection therapy.

Zielinksi et al. (2022) performed a prospective, multi-center, randomized, double-blind, placebo-controlled study to evaluate the efficacy of platelet-rich plasma (PRP) for treatment of lumbar discogenic pain. Twenty-six (12 men, 14 women) human patients, ages 25 to 71 with a diagnosis of chronic lumbar discogenic pain, were randomly assigned to active (PRP) or control (saline) groups in a ratio of 2 active to 1 control. Baseline and follow-up Oswestry Disability Index and Numeric Pain Rating Scale questionnaires were obtained to track patient outcomes at 8 weeks postoperatively. Within group assessment showed clinically significant improvement in 17% of PRP patients and clinical decline in 5% (1 patient) of the active group. Clinical improvement was seen in 13% of placebo group patients and no placebo patients had clinical decline secondary to the procedure. The authors conclude that this study posits necessary caution for researchers who wish to administer PRP for therapeutic benefit and may ultimately point to necessary redirection of interventional research for discogenic pain populations. Limitations include small sample size (26 patients) and short duration of follow-up (8 weeks). Additional limitations include a range of factors including differences in patient demographics, outcome-measure sensitivity, or misalignment of statistical analyses. Further investigation is needed before clinical usefulness of this procedure is proven.

A randomized study by Wu et al. (2017) compared efficacy and safety between autologous PRP and local anesthetic (LA)/corticosteroid IA injection for the treatment of lumbar facet joint syndrome. Forty-six patients were randomized into group A (IA injection with PRP) and group B (IA injection with LA/corticosteroid). Outcomes were assessed via the VAS, the Roland-Morris Disability Questionnaire (RMQ), Oswestry Disability Index (ODI), and modified MacNab criteria for pain relief and applications of post-treatment drugs, and were performed prior to injection, at 1 week, and at 1, 2, 3, and 6 months post-injection. No significant difference between groups was observed at baseline. Compared with pretreatment, both group A and group B demonstrated statistical improvements in the pain VAS score at rest or during flexion, the RMQ, and the ODI. For group B, subjective satisfaction based on the modified MacNab criteria and objective success rate were highest (80% and 85%) after 1 month, but only 50% and 20%, respectively after 6 months. However, for group A, they increased over time. No treatment-related complications were reported by either group. The authors concluded that both autologous PRP and LA/corticosteroid for IA injection are effective, easy, and safe enough in the treatment of lumbar facet joint syndrome. However, autologous PRP was considered superior due to longer duration of efficacy. Limitations to this study include short follow up period and small sample size.

Singla and colleagues (2017) conducted a prospective randomized open blinded end point (PROBE) study to assess the efficacy and safety of PRP compared with methylprednisolone in US-guided sacroiliac joint (SIJ) injection for LBP. Patients (n = 40) with chronic LBP and SIJ pathology were randomly allocated into 2 groups. Group S received 1.5 mL of methylprednisolone (40 mg/mL) and 1.5 mL of 2% lidocaine with 0.5 mL of saline, while Group P received 3 mL of leukocyte-free PRP with 0.5 mL of calcium chloride into US-guided SIJ injection. VAS scores, Modified Oswestry Disability Questionnaire (MODQ) scores, Short Form (SF-12) Health Survey scores, and complications (if any) were evaluated at 2, 4, 6, and 12 weeks. Intensity of pain was significantly lower in Group P at 6 and 12 weeks as compared to Group S. The efficacy of steroid injection was reduced to only 25% at 3 months in Group S, while it was 90% in Group P. Patients receiving PRP also showed a reduction of VAS ≥ 50% from baseline when other factors were controlled. The MODQ and SF-12 scores were improved initially for up to 4 weeks but deteriorated further at 3 months in Group S, while both the scores improved gradually in Group P for the entire follow up period. Authors concluded that PRP injection is an effective treatment modality in LBP involving the SIJ. Limitations included small study group size and short follow up period.

A prospective, double-blind, RCT was conducted by Tuakli-Wosornu et al. (2016) to determine whether single injections of autologous PRP into symptomatic degenerative intervertebral disks will improve participant-reported pain and function. Adults (n = 46) with chronic (≥ 6 months), moderate-to-severe lumbar discogenic pain that was unresponsive to conservative treatment were randomized to receive intradiskal PRP (n = 29) or contrast agent (n = 18). Main outcome measures included the Functional Rating Index, Numeric Rating Scale for pain, the pain and physical function domains of the SF-36 Health Survey, and the modified North American Spine Society Outcome Questionnaire. Data on pain, physical function, and participant satisfaction were collected at 1 week, 4 weeks, 8 weeks, 6 months, and 1 year. Participants in the control group who did not

improve at 8 weeks were offered the option to receive PRP and subsequently followed. Over 8 weeks of follow-up, there were statistically significant improvements in participants who received intradiskal PRP with regards to pain, function, and patient satisfaction compared with controls. No AEs of disk space infection, neurologic injury, or progressive herniation were reported following the injection of PRP. The authors concluded that intradiskal PRP injection resulted in significant improvements in function, pain, and patient satisfaction scores over 8 weeks compared with controls. Those who received PRP maintained significant improvements functional scores through at least 1 year of follow-up. Study limitation cited was the very limited follow up time of only 8 weeks for the randomized portion of the study and differential exclusion of participants after randomization. The authors concluded that although these results are promising, further studies are needed to define the subset of candidates most likely to respond to biologic intradiskal treatment and the ideal cellular characteristics of the intradiskal PRP injectate.

Wounds

A 2022 Hayes Technology Assessment report on platelet-rich plasma for wound treatment in diabetic foot ulcers was performed. For use of autologous platelet-rich plasma (PRP) as an adjunct to conventional wound therapy (CWT) to treat adults who have hard-to-heal diabetic foot ulcers (DFUs) that have not responded to prolonged standalone CWT, a C rating was assigned. An overall low-quality body of evidence comprises 12 RCTs and 2 prospective cohort studies and suggests that PRP is safe and has the potential to improve wound healing compared with standalone CWT in patients with DFUs that have not healed adequately with CWT. Despite the abundance of well-designed studies, conclusions of statistical analyses were inconsistent across the evidence base and pooled interstudy ranges of key efficacy outcomes varied widely. Furthermore, 13 of the 14 studies utilized different PRP preparation protocols and 3 methods of PRP application were investigated. Three of the reviewed studies included patients with concomitant peripheral artery disease (PAD) and evaluated how concurrent disease impacted the efficacy and safety of PRP compared with patients who had DFUs and no PAD, suggesting that the existence of PAD impedes healing. The heterogeneity across studies leaves substantial uncertainty regarding which PRP protocols are most effective and which patient populations are most likely to benefit from PRP therapy. (Hayes, 2022)

Deng et al. (2022) conducted a preliminary clinical study to assess the therapeutic potentials of platelet-rich plasma (PRP) in refractory wounds with exposed tendons, as well as corresponding efficacy and safety. A total of 12 patients (5 males and 7 females) with refractory wounds and exposed tendons who were admitted to Jiangxi Provincial People's Hospital from June 2018 to December 2020 were included in this study. After the preparation of PRP, the included patients underwent the PRP injection after the debridement of wounds, and the efficacy and prognosis were assessed by the same group of senior surgeons. The average age of included patients was 42.7 ±12.9 years, and the causes of injury included traffic accidents (3 cases), contusion (2 cases), burns (2 cases), diabetes complications (4 cases), and melanoma complications (1 cases). The average healing time was 23.0 ±5.0 days, and the mean size of the wound was 3.1 × 5.1 cm2. During the whole treatment process, Vancouver Scar Scale (VSS) decreased from 7.4 ±1.6 before PRP treatment to 3.6 ±0.9 after treatment ($p < 0.001$), Manchester Scar Scale (MSS) decreased from 12.3 ±4.5 before PRP treatment to 5.4 ±1.2 after treatment ($p < 0.001$), and no redness and swelling were observed around wounds, the size and degree of wounds gradually reduced, the coverage rate of granulation tissue was acceptable, overall quality of scar was relatively good, skin sensitivity around wounds was normal, there was no local wounds secretion, and postoperative patient's satisfaction was relatively good during follow-up. The authors concluded that their study has preliminarily indicated that PRP can promote the wounds healing, reduce the inflammation around wounds, and improve the granulation tissue and angiogenesis, thereby effectively polishing up the safety and efficacy. This was a nonrandomized study design without a control group and a small sample size (n = 12) makes it difficult to decide whether these conclusions can be generalized to a larger population. Further research with randomized controlled trials is needed to validate these findings.

Boztug et al. (2021) conducted a prospective, randomized controlled trial (RCT) to evaluate the effect of platelet-rich plasma (PRP) in patients' pain scores, wound healing and quality-of-life in the process of treatment for pilonidal sinus (PS) disease. Patients who were over 18 years old and had chronic PS disease between March 2018 and January 2019 were enrolled and randomly divided into three groups. Open surgery and moist dressings were applied to patients in group A (n = 18). Open surgery followed by PRP application was performed on patients in group B (n = 22). Group C (n = 9) underwent curettage of the sinus cavity followed by application of PRP. In this prospective randomized controlled study, patients completed questionnaires (including the Nottingham Health Profile (NHP), Short Form-36 (SF-36) and clinical information) before and after surgery. Demographics, pre-operative characteristics, healing parameters, and quality-of-life scores were evaluated and calculated before and after surgery. The cavity volume and wound-healing time were compared among the groups on post-operative days 0, 2, 3, 4, and 21. Each patient was followed up throughout the process of wound healing, and follow-up was continued afterward to monitor the patients for recurrence. Due to the nature of the treatment that group C received, this group achieved shorter healing times and smaller cavity volume than the other groups. In contrast, the recovery time per unit of cavity volume

was faster in group B than in the other groups. Overall post-operative pain scores were lower for both PRP groups (open surgery, group B; minimally invasive surgery, group C) than for group A ($p < 0.001$) and showed different time courses among the groups. The authors concluded that in the treatment of PS disease, PRP application improves post-operative recovery in that it speeds patients' return to daily activities, reduces their pain scores and increases their quality-of-life. This study has limitations including a small sample size. Group C had fewer patients than either of the other groups as the authors stopped allocating patients to group C due to the high rate of post-operative abscess formation. The absence of a minimally invasive non-PRP treated control for group C is another limitation. Also, patient follow-up times varied between 6 and 18 months. These limitations make it difficult to decide whether these conclusions can be generalized to a larger population.

A randomized controlled trial (RCT) was performed by Nolan et al. (2021) to determine if the local administration of fat grafts with platelet-rich plasma (PRP) increases wound healing in diabetic foot ulcers at a histological level compared with standard care. A three-armed RCT was undertaken of 18 diabetic foot ulcer patients: fat grafting; fat grafting with PRP; and routine podiatry care. Biopsies were obtained at week 0, 1, and 4, and underwent quantitative histology/immunohistochemistry (H&E, CD31, and Ki67). Treatment with fat and PRP increased mean micro vessel density at 1 week to 1645 (SD 96) micro vessels/mm2 (+32%-45% to other arms, $p = .035$). PRP appeared to increase vascularity surrounding fat grafts, and histology suggested PRP may enhance fat graft survival. There was no clinical difference between arms. The authors concluded that this study demonstrates PRP with fat grafts increased neovascularization and graft survival in diabetic foot ulcers. The histology was not, however, correlated with wound healing time. Future studies should consider using apoptosis markers and fluorescent labelling to ascertain if enhanced fat graft survival is due to proliferation or reduced apoptosis. Trial registration NCT03085550. The approach used to measure fat graft survival (visual comparison of the density of adipocytes) had limitations compared with other approaches, such as apoptosis markers or fluorescent labeling. In addition, another limitation is that increased micro vessel density was observed at week 1, however, it is not clear which cell type is responsible for this. Additional limitations include small sample size (18 patients) and short duration of follow-up (4 weeks).

A 2021 Hayes Health Technology Assessment report focused on the efficacy and safety of platelet-rich plasma (PRP) for treatment of venous leg ulcers (VLUs). Individuals enrolled in the reviewed studies were adult men and women who had VLUs that had not responded adequately to conventional treatment with an average VLU duration range from 3 months to 6 years. The studies included were 8 randomized controlled trials (RCTs) and 1 comparative cohort study that evaluated PRP for treatment of VLUs. PRP was administered as either a gel, topical liquid, or injected liquid in conjunction with standard wound care, and compared with standard wound care alone. Findings from 7 studies suggested that PRP may significantly improve healing of VLUs, 1 study found no benefit and the other study did not perform between-group statistical analyses. Six studies reported that no complications occurred. Two studies reported the following complications: cellulitis prompting antibiotic treatment (8%), superficial minute ulceration (4%), and pain (unidentified number of patients). No deaths related to PRP treatment were identified. There was variation in protocols for preparation and administration of PRP, small treatment groups, heterogenous study populations, and variability in number of PRP treatment sessions. The authors concluded that the results of the reviewed studies suggested that PRP is reasonably safe for treatment of VLUs. Additional RCTs with large study populations and appropriate controls to avoid potential bias of results are needed to confirm that PRP improves VLU healing and to determine the optimal method for administration of PRP (Hayes, 2021). (Authors Escamilla Cardenosa et al. (2017) and Moneib et al.(2018) which were previously cited in this policy are included in this review)

An ECRI Clinical Evidence Assessment (Nov. 17, 2021) on platelet-rich plasma (PRP) for diabetic foot ulcers (DFUs) reporting on 1,323 patients. ECRI documented that PRP for DFUs, reveals "evidence is somewhat favorable", however, given the inclusive evidence, routine use of these products is not recommended. This report focuses on how the safety and effectiveness of wound care that includes PRP therapy compares with those of standard wound care without PRP for treating diabetic foot ulcers (DFUs). Moderate-strength evidence from a systematic review (SR) with meta-analysis of randomized controlled trials (RCTs) found that PRP therapy added to wound care for DFUs increased complete wound closure; low-strength evidence found PRP shortened time to complete wound closure and reduced wound area and wound depth compared with wound care with no PRP therapy. For outcomes of hospitalization rates, amputation, pain reduction, wound infection, recurrence, serious adverse events (AEs), and deaths, no significant differences were found between groups treated with or without PRP. Three additional RCTs (not in the SR) reported either improved outcomes with PRP or no difference in outcomes. Thirteen RCTs and one observational study were meta-analyzed, and despite numerous limitations to individual included studies, the strength of evidence was low to moderate for DFU and patient outcomes, enabling conclusions, albeit with some level of uncertainty. Results of three additional RCTs were generally consistent with SR findings for the outcomes assessed. Several factors limit the strength of these findings: lack of standard reporting of PRP preparation and application and patient selection and follow-up differences. About 40% of RCTs did not report on AEs; reporting was inconsistent among those that did. Results may not be

generalizable because studies were primarily single-center and conducted in several different countries. Additional RCTs (preferably multicenter) are needed that use standard PRP protocols and standard reporting on key outcomes.

An ECRI clinical evidence assessment (Nov. 30, 2021) on platelet-rich plasma (PRP) therapy for chronic venous leg ulcers indicates “evidence is inconclusive: too few data on outcomes of interest”. This report focuses on whether standard wound care that includes PRP therapy is safe and more effective than standard wound care without PRP for chronic venous leg ulcers (VLUs). Wound care that includes PRP therapy appears to be safe; however, evidence from a systematic review (SR) with meta-analysis and two additional single center randomized controlled trials (RCTs) is insufficient to determine PRP therapy's effects on VLU wound healing. Results from the SR and two additional small RCTs regarding the potential benefits of adding PRP therapy to standard care are mixed. Findings from studies in the SR and additional RCTs were limited by lack of blinding, lack of a standard procedure for producing PRP, and differences in platelet concentrations, frequency of PRP application, and follow-up times. Also, results may not be generalizable, because studies were primarily single-center and conducted in several different countries. Additional RCTs (preferably multicenter) are needed that employ standard PRP protocols and standard reporting on key outcomes. The authors did not identify any guidelines that discuss PRP therapy for chronic VLUs.

Qu et al. (2020) completed a systematic review and meta-analysis to evaluate the efficacy of autologous platelet-rich plasma (PRP) in individuals with lower extremity diabetic ulcers (DUs), lower extremity venous ulcers (VUs), and pressure ulcers (PUs). A total of 27 (22 randomized and 5 comparative observational) studies with 1,796 patients were included in the review: DUs = 15; VUs = 11; and PUs = 2. Follow-up post-treatment ranged from no follow-up to 11 months. PRP therapy increased healing and complete wound closure in lower extremity DUs compared to treatment without PRP (Relative Risk (RR): 1.20; 97% CI: 1.09 to 1.32, moderate strength of evidence (SOE)). PRP therapy also shortened the time to complete wound closure and reduced wound area and depth (low SOE). There were no significant changes found in terms of wound infection, amputation, wound recurrence, or hospitalization. Evidence related to VUs and PUs was insufficient to estimate effect on critical outcomes. There was no statistically significant difference in death, total adverse events, or serious adverse events between PRP and management without PRP. The authors concluded that autologous PRP based on moderate SOE increases complete wound closure/healing, and low SOE shortens healing time and reduces wound size in patients with lower extremity DUs. The evidence is insufficient regarding VUs and PUs. Limitations included a lack of standard reporting of PRP formulation techniques, PRP concentration, formulation and volume used, lower extremity DU off-loading procedures and periprocedural restrictions, and patient recruiting methods. In addition, the available data are relatively weak and inconclusive and derived primarily from uncontrolled or poorly controlled studies with significant methodological flaws.

A systematic review was performed by Miron et al. (2017) to analyze studies utilizing platelet-rich fibrin (PRF) for soft tissue regeneration, augmentation, and/or wound healing. Thirty one clinical studies were included; a total of 8 reported the effects of PRF in a RCT, with 5 additional studies (13 total) reporting appropriate controls. Fifty-eight percent of clinical studies reported positive wound healing events associated with the use of PRF. Twenty-seven of the 31 studies (87%) supported the use of PRF for soft tissue regeneration and wound healing for a variety of procedures in medicine and dentistry. The findings of the RCT were conflicting with a number of studies showing no benefit of PRP. While the authors concluded that the currently available literature supports soft tissue regeneration after soft tissue regenerative procedures utilizing PRF, they stated there is a lack of appropriate controls with which to conduct comparative analyses. The authors note that it is imperative that the next wave of research utilizing PRF as an adjunct to soft tissue regenerative therapies designs appropriate studies with necessary controls to further evaluate the regenerative potential of PRF for soft tissue wound healing.

The primary objective of a case series performed by Suthar et al. (2017) was to assess the efficacy of PRP in wound/ulcer healing by evaluating the percentage reduction in wound/ulcer size over the 24 weeks follow-up period by visual inspection. The secondary objectives included safety and feasibility of autologous PRP injections, time to wound/ulcer healing, improvement in pain or discomfort, and QOL. Twenty-four patients with non-healing ulcers of different etiologies were treated with a single dose of a combination of autologous PRP gel and subcutaneous injections of PRP in and around the wound periphery. All the patients showed signs of wound healing with reduction in wound size, and the mean time duration to ulcer healing was 8.2 weeks. Reduction in pain was observed in all the patients post-treatment and the patients’ QOL significantly improved. The authors concluded that PRP is a safe and effective treatment modality for chronic non-healing ulcers and recommended that further research with prospective RCTs on larger patient population are necessary to validate the results. Limitations include study design with no comparison group, small sample size, and short follow up.

In a meta-analysis, Martinez-Zapata et al. (2016) examined whether autologous PRP promotes the healing of chronic wounds. Ten RCTs that compared autologous PRP with placebo or alternative treatments for any type of chronic wound in adults were

included (n = 442). Four RCTs recruited people with a range of chronic wounds; three RCTs recruited people with VLUs and three RCTs studied foot ulcers in people with diabetes. The median length of treatment was 12 weeks. The authors concluded that the results were non-conclusive as to whether autologous PRP improves the healing of chronic wounds generally compared with standard treatment. Autologous PRP may increase the healing of foot ulcers in people with diabetes compared with standard care, but it is unclear if autologous PRP has an effect on other types of chronic wounds. Three studies reported wound complications such as infection or dermatitis, but results showed no difference in the risk of AEs in people treated with PRP or standard care. These findings are based on low quality evidence due to the small number of studies and patients included, and their poor methodological quality.

Clinical Practice Guidelines

American Academy of Orthopaedics (AAOS)

A 2022 AAOS clinical practice guideline on management of osteoarthritis of the knee states that platelet-rich plasma (PRP) may reduce pain and improve function in patients with symptomatic osteoarthritis of the knee. This recommendation is based on evidence from one or more low quality studies with consistent findings or evidence from a single moderate quality study recommending for or against the intervention. AAOS recommends that future research in this area should include detailed osteoarthritis characterization including sub-group analyses and osteoarthrosis severity stratification. (AAOS, 2021; Brophy, 2022)

A 2020 AAOS clinical practice guideline on management of glenohumeral joint osteoarthritis is based on a systematic review of published studies. There is lack of evidence of the utilization of platelet rich plasma in the treatment of osteoarthritis of the glenohumeral joint and it cannot be recommended. AAOS concluded that better standardization and high-quality evidence from clinical trials is needed to provide definitive evidence on the efficacy of biologics in glenohumeral OA. (AAOS, 2020)

A 2019 AAOS clinical practice guideline on the management of rotator cuff injuries makes the following recommendations:

- Limited evidence does not support the routine use of platelet rich plasma for the treatment of rotator cuff tendinopathy or partial tears
- Strong evidence does not support biological augmentation of rotator cuff repair with platelet-derived products on improving patient reported outcomes; however, limited evidence supports the use of liquid platelet rich plasma in the context of decreasing re-tear rates
- Lack of supporting evidence does not support the routine use of platelet rich plasma in the non-operative management of full-thickness rotator cuff tears (AAOS, 2019)

American Academy of Physical Medicine and Rehabilitation (AAPM&R)

Oh-Park et al. (2023) with the AAPM&R state that while dextrose prolotherapy injections are a promising alternative treatment for long-standing clinical problems unsolvable by current standards of treatment, the current body of research is limited by small effect sizes and inability to generalize results due to highly varied injection schedules, injection sites, dextrose concentrations, controls and comparators studied. Results are promising but there is not yet enough data to determine the benefits of prolotherapy at this time.

American Association of Hip and Knee Surgeons

The American Association of Hip and Knee Surgeons 2019 position statement on biologics for advanced hip and knee arthritis stated “It is our position that biologic therapies, including stem cell and PRP injections, cannot currently be recommended for the treatment of advanced hip or knee arthritis. With unproven benefits, high out-of-pocket costs for patients, and clear safety concerns, we do not support the routine clinical use of these therapies. While we do recognize the potential benefit of biologic therapies, we encourage rigorous, well-designed clinical trials to establish the safety, efficacy, and cost-effectiveness of these potential treatments prior to widespread adoption”. (Browne et al., 2019)

American College of Physicians (ACP)

ACP published 2015 guidelines on the treatment of pressure ulcers. The guidelines noted that “although low quality evidence suggests that dressings containing Platelet derived growth factors (PDGF) promote healing, ACP supports the use of other dressings such as hydrocolloid and foam dressings, which are effective at promoting healing and cost less than PDGF dressings.”

American College of Rheumatology

A 2019 American College of Rheumatology/Arthritis Foundation Guideline for the management of osteoarthritis of the hand, hip, and knee made the following recommendations:

- Prolotherapy is conditionally recommended against in patients with knee and/or hip OA
- Platelet-rich plasma treatment is strongly recommended against in patients with knee and/or hip OA

(Kolasinski et al., 2019)

American Society of Interventional Pain Physicians (ASIPP)

A 2019 ASIPP guideline on the management of low back pain stated that after review of evidence there is Level III evidence for intradiscal injections of PRP, whereas the evidence is considered Level IV for lumbar facet joint, lumbar epidural, and sacroiliac joint injections of PRP, (on a scale of Level I through V). (Navani et al., 2019)

National Institute for Health and Care Excellence (NICE)

NICE's 2019 interventional procedures guidance on PRP injections for KOA states that the technology raises no major safety concerns however, the evidence on efficacy is limited in quality. Therefore, this procedure should only be used with special arrangements for clinical governance, consent, and audit or research. Further research should be in the form of RCTs with medium- to long-term follow-up, including validated measures of knee function and patient-reported outcomes.

In a diabetic inpatient clinical guideline, NICE recommends that autologous PRP gel should not be offered as treatment for diabetic foot problems unless part of a clinical trial. (2016, updated 2019)

Veterans Affairs/Department of Defense (VA/DoD)

The VA/DoD 2020 clinical practice guideline for the non-surgical management of hip and knee osteoarthritis made the following statement:
There is insufficient evidence to recommend for or against platelet-rich plasma injections for the treatment of osteoarthritis of the hip or knee. The quality of evidence reviewed was very low given the serious inconsistency and imprecision with study designs, lack of standardization (e.g., dose, frequency, preparation technique), and outcome measures.

Wound Healing Society

In guidelines for the treatment of venous ulcers, the Wound Healing Society states that cytokine growth factors [includes platelet-derived growth factor] have yet to be shown to demonstrate sufficient statistically significant results of effectiveness to recommend any of them for treatment of venous ulcers, although isolated reports suggest their potential usefulness (Level I). (Marston et al., 2016)

U.S. Food and Drug Administration (FDA)

This section is to be used for informational purposes only. FDA approval alone is not a basis for coverage.

Prolotherapy and platelet rich plasma therapy are procedures and, therefore, not subject to FDA regulation. However, any medical devices, drugs, biologics, or tests used as a part of these procedures may be subject to FDA regulation.

For additional information, search product codes KSS, ORG, or JQC at the following website: 510(k) Premarket Notification (fda.gov). (Accessed July 20, 2023)

The agents used in the reviewed studies, such as dextrose and lidocaine, are approved for injection by the FDA but are not specifically approved for prolotherapy for joint and ligamentous injections, making such use off-label.

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Guideline History/Revision Information

Date	Summary of Changes
11/01/2023	**Supporting Information** • Updated *Clinical Evidence* and *References* sections to reflect the most current information • Archived previous policy version MMG111.P

Instructions for Use

This Medical Management Guideline provides assistance in interpreting UnitedHealthcare standard benefit plans. When deciding coverage, the member specific benefit plan document must be referenced as the terms of the member specific benefit plan may differ from the standard plan. In the event of a conflict, the member specific benefit plan document governs. Before using this guideline, please check the member specific benefit plan document and any applicable federal or state mandates. UnitedHealthcare reserves the right to modify its Policies and Guidelines as necessary. This Medical Management Guideline is provided for informational purposes. It does not constitute medical advice.

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