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Platelet Rich Plasma and Amniotic Allograft Product Interventions: The Basic Science

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Purpose Statement

This white paper provides a focused review of biologic interventions commonly described as platelet-derived and amniotic-derived orthobiologic products. It outlines their biologic composition, proposed mechanisms of action relevant to post-traumatic musculoskeletal injury, and their appropriate clinical application within evidence-based practice.

The intent is to clarify how and when these therapies may be medically reasonable in cases where conventional treatment has plateaued or failed to restore functional capacity.

Executive Summary

Platelet-Rich Plasma (PRP) and amniotic allograft (AA) products are orthobiologic therapies used to modulate inflammatory signaling and support tissue repair through delivery of concentrated growth factors and bioactive mediators.

PRP is autologous and functions primarily through enhanced platelet-derived signaling. AA products contain structural matrix components, growth factors, and may contain viable or non-viable progenitor cellular elements depending on processing methods.

These therapies are most commonly considered in cases of:

- Persistent soft tissue or ligament injury
- Degenerative spinal or facet pathology
- Post-traumatic conditions with delayed or incomplete recovery

When properly selected, PRP and AA may improve pain and functional outcomes by augmenting biologic repair mechanisms in tissues with limited vascularity or regenerative capacity.

Current literature supports potential benefit in specific spinal and facet-mediated pain syndromes, including conditions associated with whiplash-associated disorder (WAD), though continued research is ongoing to further define optimal indications and protocols.

These therapies are not positioned as experimental replacement treatments, but rather as biologically rational adjuncts within comprehensive musculoskeletal care.

Key Findings

- **Platelet-Rich Plasma (PRP)** is an autologous regenerative therapy utilizing a concentrated platelet fraction derived from the patient's own blood, injected into areas of pathology to support tissue repair, reduce pain, and improve functional outcomes.
- **Amniotic/Allograft (AA)** products are regenerative biologics derived from amniotic membrane, fluid, or umbilical cord tissue, formulated to promote healing and modulate inflammatory pathways.
- **Both PRP and AA** contain elevated concentrations of growth factors and cytokines that may enhance healing responses when native repair is limited due to trauma, reduced vascularity, or patient-specific factors.
- **Both PRP and AA t**herapies may facilitate recruitment and activation of progenitor cells, supporting tissue remodeling in ligamentous, tendinous, and facet-mediated pathology.
- **AA products** may contain viable or non-viable cellular components depending on processing methods; their primary mechanism is understood to be paracrine signaling rather than structural engraftment.

- **For both PRP and AA** current clinical literature demonstrates meaningful improvements in pain and functional outcomes in appropriately selected patients with spinal and facet-mediated conditions, including presentations consistent with whiplash-associated disorders.
- **Optimal outcomes** depend on appropriate patient selection, correlation with objective clinical findings and imaging, and adherence to established procedural protocols.

Implications

In post-traumatic musculoskeletal injury, particularly following motor vehicle accidents, persistent pain and functional limitation may result from ligamentous disruption, facet capsule injury, or degenerative acceleration.
In cases where:

- Conservative care has failed,
- Imaging correlates with clinical findings,
- Functional recovery has plateaued,

PRP and/or AA may represent biologically rational interventions aimed at enhancing tissue signaling, improving pain control, and restoring functional capacity.

When properly indicated, these therapies may reduce reliance on long-term pharmacologic management or more invasive surgical procedures, thereby supporting both patient-centered recovery and cost-conscious care strategies.

Introduction

Attorneys often serve as advocates for individuals recovering from motor vehicle accidents (MVA), helping coordinate both legal and medical pathways toward recovery. In this role, clarity regarding appropriate medical options is essential.

Orthobiologics represent a category of biologic therapies used in musculoskeletal medicine to support tissue repair and functional restoration. These interventions may be used as surgical adjuncts, graft materials, or injectable therapies delivered directly into injured tissues. [1 3]

Because orthobiologics encompass multiple product categories with differing biologic composition, regulatory status, and mechanisms of action, the terminology can be confusing, even for medical professionals.

The purpose of this paper is therefore threefold:

1. To clarify the biologic distinctions among commonly used orthobiologic products.
2. To explain their proposed mechanisms in post-traumatic pathology.
3. To provide a balanced framework for evaluating medical necessity in injury-related cases.

The following categories will be reviewed:

- Platelet-Rich Plasma (PRP)
- Platelet-Poor Plasma (PPP)
- Platelet Lysate (PL)
- Platelet-Rich Fibrin (PRF)
- Amniotic Membrane & Fluid–Derived Allografts (AA)
- Wharton's Jelly Allograft
- Exosomes

Overview of Platelet-Derived Biologic Products

Platelet-Rich Plasma (PRP) is an autologous biologic product derived from a patient's own blood and processed to concentrate platelets to supraphysiologic levels for therapeutic use. [4] [6] PRP has been studied across multiple musculoskeletal conditions, including knee osteoarthritis, carpal tunnel syndrome, lateral epicondylitis, rotator cuff pathology, whiplash-associated injuries, and lumbar spine pain. [6] [22]

PRP is produced by drawing a predetermined volume of venous blood, adding an anticoagulant, and centrifuging the sample to separate blood components by density. [5] Whole blood typically contains 150,000–450,000 platelets per microliter; PRP is generally defined as a concentration reaching approximately 3–5 times baseline platelet levels.[5] [23]
Several PRP subtypes exist, including:

- Leukocyte-rich PRP (LR-PRP)
- Leukocyte-poor PRP (LP-PRP)
- Platelet-poor plasma (PPP)
- Platelet-rich fibrin (PRF)
- Platelet lysate (PL)

Each formulation differs in cellular composition and inflammatory potential, and selection depends on tissue type, pathology, and treatment objectives. [24] [27]

Mechanism of Action

PRP supports tissue repair primarily through concentrated release of platelet-derived growth factors and signaling proteins that influence inflammation, angiogenesis, and cellular proliferation. [28]
As described by Dos Santos et al.:

"Depending on the tissue type and localization, the standard healing process may pose a great challenge, demanding a prolonged amount of time due to finite blood supply and comparably slower cell turnover. A treatment plan with PRP enables accelerated neovascularization, increasing blood supply and nourishment of nearby cells. This is essential for cellular regeneration and the restoration of damaged tissue. Additionally, PRP can also ameliorate other biological events including recruitment, proliferation and differentiation of cells, which collectively contribute towards adequate healing." [28]

Following injury, the body initiates a coordinated healing cascade involving hemostasis, inflammation, proliferation, and remodeling.[29] [30] Platelets play a central role not only in clot formation but also in regulating tissue regeneration via growth factor release. [31]

Key growth factors released from activated platelets include:

- Vascular Endothelial Growth Factor (VEGF)
- Epidermal Growth Factor (EGF)
- Hepatocyte Growth Factor (HGF)
- Platelet-Derived Growth Factor (PDGF)
- Tumor Necrosis Factor-alpha (TNF-α)
- Transforming Growth Factor-beta 1 (TGF-β1) [28] [32]

These signaling molecules influence angiogenesis, fibroblast proliferation, collagen synthesis, and extracellular matrix remodeling. Elevating platelet concentration may amplify these native biologic processes in tissues with limited vascularity or impaired healing potential.

Cellular Recruitment and Progenitor Signaling

Beyond growth factor delivery, platelet activation initiates chemotactic signaling that may recruit progenitor cells to sites of injury.[28] [31] Experimental data demonstrate increased cellular migration and differentiation toward tendon, cartilage, muscle, nerve, and bone phenotypes in PRP-treated tissues.[33] [37]

Importantly, the prevailing understanding is that PRP enhances endogenous repair mechanisms via signaling rather than direct tissue replacement. The therapeutic goal is augmentation of the body's intrinsic regenerative capacity, not structural implantation.

PRP Preparation Methods

PRP preparation typically involves one- or two-spin centrifugation protocols. During the first spin, anticoagulated blood separates into density-based layers. The upper plasma layer (supernatant) contains platelets and is isolated for therapeutic use.

A second centrifugation ("double-spin" method) may further concentrate platelets depending on the desired formulation and clinical indication. [38] Variations in spin duration and force directly influence platelet concentration and leukocyte content.

Appropriate preparation and subtype selection are critical to optimizing tissue-specific effects.

Subtypes of Platelet-Derived Products

Leukocyte-Rich PRP (LR-PRP)

LR-PRP contains concentrated leukocytes in addition to platelets. Leukocytes include lymphocytes, granulocytes (neutrophils, eosinophils, basophils), and monocytes, which are central to immune and inflammatory responses.[39] Because leukocytes may amplify inflammatory signaling, LR-PRP may be selected in chronic degenerative conditions such as knee osteoarthritis or tendinopathies, where stimulation of a stronger inflammatory cascade is theorized to restart stalled healing. [40] [42]

However, the increased inflammatory response may also result in greater short-term post-injection discomfort compared to leukocyte-poor formulations.

Leukocyte-Poor PRP (LP-PRP)

LP-PRP is prepared through selective extraction or filtration to reduce leukocyte concentration. This formulation may generate a less intense inflammatory response and is often selected for intra-articular applications such as cartilage pathology or chronic pain syndromes. [43] [44]

Selection between LR-PRP and LP-PRP depends on tissue type, inflammatory burden, and clinical judgment. [24] [45]

Platelet-Poor Plasma (PPP)

Platelet-Poor Plasma (PPP) is obtained following further centrifugation and removal of platelet-rich fractions. [46] Historically considered a byproduct of PRP preparation, PPP has demonstrated potential benefit in muscle regeneration due to a comparatively lower TGF-β1 concentration, which may favor myogenic repair. [47]

Clinically, PPP may be considered for:

- Muscle injury
- Wound healing
- Soft tissue support and closure [48] [51]

Platelet Lysate

Platelet Lysate (PL) is an autologous biologic derived from the patient's blood and processed to release intracellular platelet growth factors while minimizing intact platelet content. Following centrifugation, platelet membranes are intentionally disrupted through methods such as ultrasonication, lyophilization, or freeze–thaw cycles (–80°C/37°C), followed by filtration. [52] This process liberates soluble growth factors into the serum without maintaining high platelet counts.

Compared to standard PRP, PL has been reported to contain elevated concentrations of several growth factors, with a comparatively lower pro-inflammatory cellular profile. [52] Experimental data suggest anti-inflammatory properties, cartilage-protective effects, and support for tenocyte proliferation. [52]

Because of its reduced leukocyte and platelet content, PL may generate less post-injection inflammatory response. Clinically, this profile may be considered in scenarios where excessive inflammation could exacerbate symptoms—such as nerve-related conditions, epidural applications, or hydrodissection procedures. [52] [54]

As with all orthobiologic interventions, patient selection and anatomical targeting are critical to appropriate utilization.

Platelet-Rich Fibrin (PRF)

Platelet-Rich Fibrin (PRF) is another autologous platelet-derived product created through centrifugation of whole blood without anticoagulant, resulting in formation of a fibrin-based matrix. [55] [56]

Unlike PRP, PRF forms a structured fibrin clot that functions as a biologic scaffold. The clot mimics aspects of the natural extracellular matrix involved in wound repair and can be used either as a surgical implant (thicker matrix) or as injectable PRF depending on centrifugation parameters. [55] [57]

PRF contains growth factors including VEGF, PDGF, and TGF-β1. [57]

- **VEGF** supports angiogenesis.
- **PDGF** recruits reparative cells.
- **TGF-β1** stimulates fibroblast proliferation and extracellular matrix synthesis.

The fibrin architecture enables a slower, sustained release of growth factors compared to PRP, potentially prolonging biologic signaling within the treatment region. [56]

PRF has been used in dental, dermatologic, and orthopedic applications and may be considered in traumatic injury settings to support bone, cartilage, rotator cuff, or ligament repair (e.g., ACL augmentation). [56] [58]

The mechanism is primarily scaffold-mediated growth factor delivery rather than structural tissue replacement.

Overview of Amniotic and Fluid-Derived Allografts

Amniotic Allograft (AA) products are biologic therapies derived from donated human placental tissues, including amniotic membrane, amniotic fluid, and umbilical cord tissue and/or blood. [59] [60] Because these tissues originate from donors rather than the recipient, they are classified as allografts (distinct from autografts, which originate from the patient).

Amniotic-derived products may be processed into:

- Surgical membrane sheets
- Particulate grafts
- Injectable formulations[59]

Processing methods aim to preserve extracellular matrix components, structural proteins, growth factors, and bioactive peptides while maintaining sterility. [61]

AA products contain growth factors, cytokines, and extracellular matrix elements that support tissue repair and modulate inflammatory signaling. [59]

Some formulations may contain viable or non-viable progenitor cellular components depending on processing and storage conditions. [62] [63] However, current understanding suggests that therapeutic benefit is largely mediated through paracrine signaling rather than long-term cellular engraftment.

Experimental and clinical studies demonstrate recruitment of host progenitor cells and modulation of local immune activity following AA application, similar to signaling pathways described in PRP literature. [64] [67]

Despite being donor-derived, amniotic tissues demonstrate relatively low immunogenicity due to reduced expression of Human Leukocyte Antigens (HLA). [68] [69] This contributes to a lower likelihood of acute immune rejection, although immune modulation rather than immune invisibility is the more accurate biologic description.

Injectable AA products have been reported in musculoskeletal applications including:

- Knee osteoarthritis
- Tendinosis of ankle and foot
- Degenerative spinal and facet pathology
- Cartilage defects
- Hip osteoarthritis
- Rotator cuff disorders
- Lumbar radiculopathy [70] [78]

As with PRP, appropriate imaging correlation, clinical diagnosis, and failure of conservative management are essential considerations when evaluating medical necessity.

Amniotic Membrane and Fluid-Derived Products

Amniotic Membrane and Fluid-Derived Products (AMFDPs) are donor-derived biologic materials obtained either from amniotic fluid (typically collected during clinically indicated amniocentesis procedures) or from amniotic membrane tissue collected during cesarean delivery of term pregnancies. [62]

Cells isolated from amniotic fluid have demonstrated multipotent mesenchymal characteristics with high proliferative capacity in laboratory settings. [62] Cells derived from amniotic membrane exhibit phenotypic similarities to adult mesenchymal stromal cells with favorable expansion profiles.[62]

As allografts, AMFDPs are donor-derived rather than autologous. Similar to other amniotic allografts, they demonstrate relatively low immunogenicity compared to many transplanted tissues. [68] [70] [72]

Depending on processing and storage methods, injectable AMFDP formulations may contain:

- Viable progenitor cells
- Non-viable cellular remnants
- Extracellular matrix components
- Soluble growth factors and cytokines[79] [84]

Current scientific understanding suggests that clinical effects are primarily mediated through paracrine signaling and immune modulation rather than long-term cellular engraftment.

AMFDPs contain bioactive mediators including interleukins (IL-1, IL-10), transforming growth factor-beta (TGF-β), and tissue inhibitors of metalloproteinases (TIMPs), which may contribute to inflammatory modulation, cartilage protection, and regulation of extracellular matrix turnover. [79]

Clinically, these products may be used as injectable biologics or as membrane grafts in surgical or wound-healing applications.

Wharton's Jelly Allograft

Wharton's Jelly is a gelatinous connective tissue within the umbilical cord that functions physiologically as a protective matrix surrounding fetal vasculature. [85] [86]

It contains abundant extracellular matrix (ECM) components, including collagen, hyaluronic acid, proteoglycans, and various growth factors. [85] [87] Reported growth factors include insulin-like growth factor (IGF), fibroblast growth factor (FGF), interleukin-6 (IL-6), VEGF, and TGF-β.[85] [87]

Mesenchymal stromal cells have been identified within Wharton's Jelly tissue. [86] [88] [89] In vitro studies demonstrate differentiation potential into neural, myogenic, osteogenic, and vascular lineages.[88] [89] However, in clinical injectable formulations, therapeutic effect is generally understood to arise from extracellular signaling and matrix-mediated biologic support rather than structural tissue replacement.

Like other amniotic-derived allografts, Wharton's Jelly demonstrates relatively low immunogenicity due to reduced HLA expression, contributing to a lower likelihood of acute immune rejection. [87] [90] [2]

For injectable orthopedic applications, Wharton's Jelly tissue is processed to remove vascular structures, disinfected, and prepared through explantation or enzymatic digestion prior to formulation into injectable suspensions. [88], [93]

Emerging literature reports clinical application in:

- Knee osteoarthritis
- Carpometacarpal joint arthritis
- Rotator cuff pathology
- Labral injuries
- Lumbar and cervical spine pathology
- Plantar fascial tears[94],[98]

As with other orthobiologic interventions, patient selection and anatomical correlation are essential considerations.

Exosomes

Exosomes are nanoscale extracellular vesicles (approximately 30–200 nm) released by many cell types as part of intercellular communication. [99] [101]

Exosomes derived from mesenchymal stromal cells (MSCs) have been studied in regenerative medicine due to their ability to transfer bioactive molecules, including proteins, microRNA, mRNA, and other signaling elements, to recipient cells via paracrine pathways. [99] [101]

Experimental research suggests that some therapeutic effects previously attributed to stem cell therapies may be mediated through exosome-driven signaling rather than direct cellular engraftment. [99] [101] These signals may influence tissue repair pathways and inflammatory modulation. [102]

Exosomes may be delivered via local injection (e.g., intra-articular administration), sometimes in combination with other orthobiologics such as PRP, or through systemic administration depending on investigational protocols. [103] [104]

Preliminary research reports clinical investigation in orthopedic conditions including spinal facet pathology, rotator cuff disorders, and hip/knee osteoarthritis. [105] [111]

It should be noted that exosome-based therapies remain an area of active investigation, and regulatory frameworks continue to evolve. Careful evaluation of product sourcing and compliance is necessary prior to clinical use.

Clinical Comparison

Both PRP and amniotic-derived allografts are utilized in patients who have not achieved adequate relief with standard conservative measures such as:

- Physical therapy
- Pharmacologic management
- Activity modification
- Image-guided corticosteroid injection

Selection between PRP and AA is influenced by biologic considerations, patient preference, logistics, and clinical judgment. PRP requires venous blood draw and on-site processing, typically taking 30–60 minutes depending on formulation and equipment. [5] Preparation quality may be influenced by patient factors such as systemic inflammation, metabolic health, or platelet baseline levels. [112] [114]

AA products, by contrast, are donor-derived and pre-processed, eliminating the need for same-day centrifugation. In situations where venipuncture is contraindicated, patient tolerance is limited, or time constraints exist, AA may be considered as an alternative.

Both therapies aim to augment biologic signaling in tissues with impaired healing capacity. Neither should be viewed as a universal solution; rather, they represent potential adjuncts within a broader multimodal care strategy.

Real-World Application

In trauma-related conditions such as **Whiplash-Associated Disorder (WAD)**, patients frequently present with elevated pain, functional limitation, and inflammatory dysregulation. [115] [117]

Early pain control is critical to enable participation in active rehabilitation, which remains foundational to long-term recovery.[118] [120] Short-term corticosteroid injection may reduce acute inflammation and facilitate engagement in therapy. As Jull et al. note, "early implementation of effective pain management for those with early moderate to high pain levels is critical in attempts to lessen the transition to chronicity." [121]

However, repeated corticosteroid injections have documented negative effects on cartilage integrity and joint structures. [124] [125] Therefore, after initial stabilization, transition toward biologic therapies such as PRP or AA may be considered to support longer-term tissue recovery while minimizing cumulative steroid exposure.[123]

The existing literature suggests that both PRP and AA may improve pain and functional participation with relatively low reported adverse event rates.

Rather than replacing established standards of care, these therapies may serve as biologically rational adjuncts within a comprehensive rehabilitation model aimed at restoring strength, function, and quality of life.

Clinical Implications and Future Directions

Management of patients suffering persistent symptoms following a motor vehicle accident, particularly those with Whiplash-Associated Disorder (WAD)—remains clinically challenging. Epidemiologic data indicate that recovery is not universal under standard care. As reported:

"50% of individuals will recover from pain and disability within 3 to 6 months of injury, but the remainder will continue to report symptoms up to 1 to 2 years or longer after the motor vehicle crash. Of those who do not recover, between 30% and 40% are likely to have persistent mild to moderate levels of pain and between 10% and 20% will have moderate to severe pain syndromes." [121]

These statistics underscore the need for continued evaluation of adjunctive therapies that may improve recovery trajectories in appropriately selected patients.

Emerging literature evaluating PRP and amniotic-derived allografts demonstrates improvements in pain and functional outcomes across multiple musculoskeletal conditions, including spinal and facet-mediated pathology. [12] [14] [16] [18] [19] [126] [135] While further high-quality randomized trials are warranted, the growing body of evidence supports consideration of these biologic interventions as adjuncts within comprehensive musculoskeletal care models.

Optimal application appears to involve:

- Early appropriate pain control
- Restoration of movement through guided rehabilitation
- Targeted biologic augmentation when recovery plateaus

Rather than replacing established standards of care, orthobiologic therapies may serve as biologically rational adjuncts integrated into multimodal rehabilitation programs designed to restore strength, reduce disability, and improve quality of life.

Future directions should include:

- Prospective cohort studies
- Randomized controlled trials with standardized protocols
- Longitudinal outcome tracking
- Clear reporting of adverse events and contraindications

Such research will help define ideal patient selection criteria, dosing strategies, and long-term effectiveness.

Next Steps

For legal professionals representing clients with persistent post-traumatic musculoskeletal conditions, understanding the evolving role of orthobiologics may assist in coordinating medically appropriate care.

Referral decisions should prioritize:

- Accurate diagnosis with imaging correlation
- Failure of conservative management
- Qualified providers trained in image-guided injection techniques
- Evidence-based integration within a broader rehabilitation strategy

PRP and amniotic-derived biologic therapies may offer additional options for patients whose recovery has plateaued under conventional approaches. When applied judiciously, these interventions may support functional restoration and reduce progression toward chronic pain syndromes.

Continued collaboration between medical providers, researchers, and legal professionals is essential to ensure that patient care decisions are grounded in evolving evidence, clinical judgment, and regulatory compliance.

References

1. Moreno-Garcia A, Rodriguez-Merchan EC. Orthobiologics: current role in orthopedic surgery and traumatology. Archives of Bone and Joint Surgery 2022;10:536.
2. Costa FR, Pires L, Martins RA, et al. Orthobiologics Revisited: A Concise Perspective on Regenerative Orthopedics. Current Issues in Molecular Biology 2025;47:247.
3. Mavrogenis AF, Karampikas V, Zikopoulos A, et al. Orthobiologics: A review. International Orthopaedics 2023;47:1645-1662.
4. Middleton KK, Barro V, Muller B, et al. Evaluation of the effects of platelet-rich plasma (PRP) therapy involved in the healing of sports-related soft tissue injuries. The Iowa orthopaedic journal 2012;32:150.
5. Arnoczky SP, Shebani-Rad S. The basic science of platelet-rich plasma (PRP): what clinicians need to know. Sports medicine and arthroscopy review 2013;21:180-185.
6. Shen L, Yuan T, Chen S, et al. The temporal effect of platelet-rich plasma on pain and physical function in the treatment of knee osteoarthritis: systematic review and meta-analysis of randomized controlled trials. Journal of orthopaedic surgery and research 2017;12:16.
7. Senna MK, Shaat RM, Ali AAA. Platelet-rich plasma in treatment of patients with idiopathic carpal tunnel syndrome. Clinical rheumatology 2019;38:3643-3654.
8. Li S, Yang G, Zhang H, et al. A systematic review on the efficacy of different types of platelet-rich plasma in the management of lateral epicondylitis. Journal of Shoulder and Elbow Surgery 2022;31:1533-1544.
9. A. Hamid MS, Sazlina SG. Platelet-rich plasma for rotator cuff tendinopathy: A systematic review and meta-analysis. Plos one 2021;16:e0251111.
10. Xuan Z, Yu W, Dou Y, et al. Efficacy of platelet-rich plasma for low back pain: a systematic review and meta-analysis. Journal of Neurological Surgery Part A: Central European Neurosurgery 2020;81:529-534.
11. Wongjarupong A, Pairuchvej S, Laohapornsvan P, et al. "Platelet-Rich Plasma" epidural injection an emerging strategy in lumbar disc herniation: a Randomized Controlled Trial. BMC Musculoskeletal Disorders 2023;24:335.
12. Smith AD, Gupta AT, Stone J, et al. The Safety and Efficacy of Multimodal Physiotherapy versus Usual Care in Chronic Whiplash-Associated Disorders with Facet-Mediated Pain Undergoing Platelet Rich Plasma (PRP) Treatment: A Series of Single Case Experimental Designs (SCEDs). Interventional Pain Medicine 2023;2:100222.
13. Smith AD, Andruski B, Deng G, et al. Responders to Cervical Facet Platelet-Rich Plasma Demonstrate Synergistic Improvements in Pain and Isometric Strength in Chronic Whiplash-Associated Disorders: A Series of Mediation Analyses. Clinics and Practice 2025;15:135.
14. Allison DJ, Loh E, Burnham R, et al. Leukocyte poor platelet rich plasma vs leukocyte rich platelet rich plasma as a treatment for cervical facetogenic pain: A pooled analysis. Interventional Pain Medicine 2025;4:100566.
15. Allison DJ, Ebrahimzadeh S, Muise S, et al. Intra-articular corticosteroid injections versus platelet-rich plasma as a treatment for cervical facetogenic pain: a randomized clinical trial. Regional Anesthesia & Pain Medicine 2024.
16. THAMPI G. A PROSPECTIVE STUDY ON THE FUNCTIONAL OUTCOME OF PLATELET RICH PLASMA INJECTION IN LUMBAR FACET ARTHROPATHY: SDUAHER, 2024.

17. Baltzer AW, Enneper J, Baltzer LM, et al. Platelet Rich Plasma for the Therapy of the Lumbar Facet Joint Syndrome: A Prospective Study About CT-Guided Facet Joint Injections With PRP Compared to Local Anesthetics. Orthopedic Reviews 2025;17:141416.
18. Kirchner F, Anitua E. Intradiscal and intra-articular facet infiltrations with plasma rich in growth factors reduce pain in patients with chronic low back pain. Journal of Craniovertebral Junction and Spine 2016;7:250-256.
19. Kotb SY, Sherif NM, Saleh HA, et al. The role of intra-articular injection of autologous platelet-rich plasma versus corticosteroids in the treatment of synovitis in lumbar facet joint disease. Saudi Medical Journal 2022;43:1200.
20. Khosromanesh M, Alikarami S, Espahbodi E, et al. Efficacy of Ultrasound-Guided Platelet-Rich Plasma (PRP) Injection in Patients with Sacroiliac Joint Pain: A Single-Arm, Before and After, Open-Label Clinical Trial. Archives of Neuroscience 2024;12.
21. Wallace P, Wallace LB, Tamura S, et al. Effectiveness of ultrasound-guided platelet-rich plasma injections in relieving sacroiliac joint dysfunction. American journal of physical medicine & rehabilitation 2020;99:689-693.
22. Won SJ, Kim D-y, Kim JM. Effect of platelet-rich plasma injections for chronic nonspecific low back pain: a randomized controlled study. Medicine 2022;101:e28935.
23. Straum OK. The optimal platelet concentration in platelet-rich plasma for proliferation of human cells in vitro—diversity, biases, and possible basic experimental principles for further research in the field: A review. PeerJ 2020;8:e10303.
24. Kim J-H, Park Y-B, Ha C-W, et al. Adverse reactions and clinical outcomes for leukocyte-poor versus leukocyte-rich platelet-rich plasma in knee osteoarthritis: a systematic review and meta-analysis. Orthopaedic Journal of Sports Medicine 2021;9:23259671211011948.
25. Alves R, Grimalt R. A review of platelet-rich plasma: history, biology, mechanism of action, and classification. Skin appendage disorders 2018;4:18-24.
26. Collins T, Alexander D, Barkatali B. Platelet-rich plasma: a narrative review. EFORT open reviews 2021;6:225-235.
27. Ehrenfest DMD, Rasmusson L, Albrektsson T. Classification of platelet concentrates: from pure platelet-rich plasma (P-PRP) to leucocyte-and platelet-rich fibrin (L-PRF). Trends in biotechnology 2009;27:158-167.
28. Dos Santos RG, Santos GS, Alkass N, et al. The regenerative mechanisms of platelet-rich plasma: A review. Cytokine 2021;144:155560.
29. Duchesne E, Dufresne SS, Dumont NA. Impact of inflammation and anti-inflammatory modalities on skeletal muscle healing: from fundamental research to the clinic. Physical therapy 2017;97:807-817.
30. Järvinen TA, Järvinen M, Kalimo H. Regeneration of injured skeletal muscle after the injury. Muscles, ligaments and tendons journal 2014;3:337.
31. Etulain J. Platelets in wound healing and regenerative medicine. Platelets 2018;29:556-568.
32. Pineda-Cortel MR, Suarez C, Cabrera J-T, et al. Complexity of Platelet-Rich Plasma: Mechanism of Action, Growth Factor Utilization and Variation in Preparation. Plasmatology 2024;18:26348535241277625.
33. Li H, Usas A, Poddar M, et al. Platelet-rich plasma promotes the proliferation of human muscle derived progenitor cells and maintains their stemness. PloS one 2013;8:e64923.
34. Imai S, Kumagai K, Yamaguchi Y, et al. Platelet-rich plasma promotes migration, proliferation, and the gene expression of scleraxis and vascular endothelial growth factor in paratenon-derived cells in vitro. Sports Health 2019;11:142-148.
35. Xie X, Zhang C, Tuan RS. Biology of platelet-rich plasma and its clinical application in cartilage repair. Arthritis research & therapy 2014;16:204.
36. Fernandes G, Yang S. Application of platelet-rich plasma with stem cells in bone and periodontal tissue engineering. Bone Research 2016;4:1-21.
37. Dou X-Y, An M. Advances in the application of platelet-rich plasma in peripheral nerve injuries. Anesthesiology and Perioperative Science 2025;3:1-9.
38. Legiawati L, Yusharyahya SN, Bernadette I, et al. Comparing single-spin versus double-spin platelet-rich plasma (PRP) centrifugation methods on thrombocyte count and clinical improvement of androgenetic alopecia: a preliminary, randomized, double-blind clinical trial. The Journal of Clinical and Aesthetic Dermatology 2023;16:39.
39. Bellingan G. Leukocytes: friend or foe. Intensive care medicine 2000;26:S111-S118.
40. Jayaram P, Mitchell PJ, Shybut TB, et al. Leukocyte-rich platelet-rich plasma is predominantly anti-inflammatory compared with leukocyte-poor platelet-rich plasma in patients with mild-moderate knee osteoarthritis: a prospective, descriptive laboratory study. The American Journal of Sports Medicine 2023;51:2133-2140.
41. Cole BJ, Gilat R, DiFiori J, et al. The 2020 NBA orthobiologics consensus statement. Orthopaedic journal of sports medicine 2021;9:23259671211002296.
42. Lin K-Y, Chen P, Chen AC-Y, et al. Leukocyte-rich platelet-rich plasma has better stimulating effects on tenocyte proliferation compared with leukocyte-poor platelet-rich plasma. Orthopaedic Journal of Sports Medicine 2022;10:23259671221084706.
43. Su F, Tong MW, Lansdown DA, et al. Leukocyte-poor platelet-rich plasma injections improve cartilage T1ρ and T2 and patient-reported outcomes in mild-to-moderate knee osteoarthritis. Arthroscopy, sports medicine, and rehabilitation

44. Wang F, Meng F, Chan TCW, et al. Platelet-Rich Plasma for Treating Chronic Noncancer Pain: A Systematic Review and Meta-analysis of Randomized Controlled Trials. Pain and Therapy 2025:1-20.
45. Peng Y, Wu W, Li X, et al. Effects of leukocyte-rich platelet-rich plasma and leukocyte-poor platelet-rich plasma on the healing of bone-tendon interface of rotator cuff in a mice model. Platelets 2022;33:1075-1082.
46. Dhurat R, Sukesh M. Principles and methods of preparation of platelet-rich plasma: a review and author's perspective. Journal of cutaneous and aesthetic surgery 2014;7:189-197.
47. Chellini F, Tani A, Zecchi-Orlandini S, et al. Influence of platelet-rich and platelet-poor plasma on endogenous mechanisms of skeletal muscle repair/regeneration. International journal of molecular sciences 2019;20:683.
48. Moradi R, Taghizadeh B, Ghaffari R, et al. Development of nano-liposomal platelet-poor plasma (PPP) for topical application in wound healing and burn treatment. Journal of Pharmaceutical Investigation 2025:1-15.
49. Man D, Plosker H, Winland-Brown JE. The use of autologous platelet-rich plasma (platelet gel) and autologous platelet-poor plasma (fibrin glue) in cosmetic surgery. Plastic and reconstructive surgery 2001;107:229-236.
50. Fernandes GC, Rodeo SA. Platelet-Poor Plasma for Muscle Injuries: A Review of Mechanisms and Clinical Perspectives. Orthopaedic Journal of Sports Medicine 2025;13:23259671251356628.
51. Kasitinon D, Dragoo JL, Hwang CE. Use of platelet-poor plasma in acute quadriceps muscle strain in a division I football placekicker: a case report. Current sports medicine reports 2021;20:572-574.
52. da Fonseca L, Santos GS, Huber SC, et al. Human platelet lysate–A potent (and overlooked) orthobiologic. Journal of clinical orthopaedics and trauma 2021;21:101534.
53. Trescot A, Brown M. Peripheral nerve entrapment, hydrodissection, and neural regenerative strategies. Techniques in regional anesthesia and pain management 2015;19:85-93.
54. Rawson B. Platelet-rich plasma and epidural platelet lysate: novel treatment for lumbar disk herniation. Journal of Osteopathic Medicine 2020;120:201-207.
55. Dashore S, Chouhan K, Nanda S, et al. Platelet-rich fibrin, preparation and use in dermatology. Indian Dermatology Online Journal 2021;12:S55-S65.
56. Costa FR, de Souza SAL, Martins RA, et al. The Role of Injectable Platelet-Rich Fibrin in Orthopedics: Where Do We Stand? Current Issues in Molecular Biology 2025;47:239.
57. Miron RJ, Estrin NE, Ahmad P, et al. Thirty Years of Autologous Platelet Concentrates: From Platelet-Rich Plasma to Platelet-Rich Fibrin. Journal of Periodontal Research 2025.
58. Grecu AF, Reclaru L, Ardelean LC, et al. Platelet-rich fibrin and its emerging therapeutic benefits for musculoskeletal injury treatment. Medicina 2019;55:141.
59. Nakagawa H, Panero AJ, Qin X, et al. Basic science and preclinical evidence for amniotic membrane– derived allografts in orthobiologics. OrthoBiologics: Elsevier, 2025;111-120.
60. Velarde F, Castañeda V, Morales E, et al. Use of human umbilical cord and its byproducts in tissue regeneration. Frontiers in Bioengineering and Biotechnology 2020;8:117.
61. Bedewy N, Elbordiny M, Swelem M, et al. Biochemical assessment of amniotic membrane extract for optimal application in regenerative medicine. Alexandria Journal of Medicine 2024;60:215-221.
62. Roubelakis MG, Trohatou O, Anagnou NP. Amniotic fluid and amniotic membrane stem cells: marker discovery. Stem cells international 2012;2012:107836.
63. Capelli C, Gotti E, Morigi M, et al. Minimally manipulated whole human umbilical cord is a rich source of clinical-grade human mesenchymal stromal cells expanded in human platelet lysate. Cytotherapy 2011;13:786-801.
64. Maan ZN, Rennert RC, Koob TJ, et al. Cell recruitment by amnion chorion grafts promotes neovascularization. Journal of Surgical Research 2015;193:953-962.
65. Koob TJ, Rennert R, Zabek N, et al. Biological properties of dehydrated human amnion/chorion composite graft: implications for chronic wound healing. International wound journal 2013;10:493-500.
66. Massee M, Chinn K, Lei J, et al. Dehydrated human amnion/chorion membrane regulates stem cell activity in vitro. Journal of Biomedical Materials Research Part B: Applied Biomaterials 2016;104:1495-1503.
67. Moreno SE, Massee M, Koob TJ. Dehydrated human amniotic membrane inhibits myofibroblast contraction through the regulation of the tgfβ-SMAD pathway in vitro. JID Innovations 2021;1:100020.
68. Magatti M, Vertua E, Cargnoni A, et al. The immunomodulatory properties of amniotic cells: the two sides of the coin. Cell transplantation 2018;27:31-44.
69. Wassmer C-H, Berishvili E. Immunomodulatory properties of amniotic membrane derivatives and their potential in regenerative medicine. Current diabetes reports 2020;20:31.
70. Natali S, Farinelli L, Screpis D, et al. Human amniotic suspension allograft improves pain and function in knee osteoarthritis: a prospective not randomized clinical pilot study. Journal of Clinical Medicine 2022;11:3295.
71. McIntyre JA, Jones IA, Danilkovich A, et al. The placenta: applications in orthopaedic sports medicine. The American journal of sports medicine 2018;46:234-247.
72. Hou W-H, Lin P-C, Tung K-M, et al. Effectiveness of amnion allograph injections in patients with degenerative musculoskeletal diseases: a systematic review and meta-analysis. American Journal of Physical Medicine & Rehabilitation 2024:10.1097.

73. Aratikatla A, Maffulli N, Rodriguez HC, et al. Allogenic perinatal tissue for musculoskeletal regenerative medicine applications: a systematic review. Biomedicines 2022;10:3173.
74. Ackley JF, Kolosky M, Gurin D, et al. Cryopreserved amniotic membrane and umbilical cord particulate matrix for partial rotator cuff tears: A case series. Medicine 2019;98:e16569.
75. Bennett DS. Cryopreserved amniotic membrane and umbilical cord particulate for managing pain caused by facet joint syndrome: a case series. Medicine 2019;98:e14745.
76. Castellanos R. Injectable amniotic membrane/umbilical cord particulate for facet joint syndrome: A retrospective, single-center study. Journal of Back and Musculoskeletal Rehabilitation 2022;35:559-564.
77. Miedema M, Anderson A. Outcomes of transforaminal epidural injection of amniotic membrane/umbilical cord particulate for lumbar radiculopathy: a case series. Frontiers in Pain Research 2024;5:1322848.
78. Gomoll AH, Farr J, Cole BJ, et al. Safety and efficacy of an amniotic suspension allograft injection over 12 months in a single-blinded, randomized controlled trial for symptomatic osteoarthritis of the knee. Arthroscopy: The Journal of Arthroscopic & Related Surgery 2021;37:2246-2257.
79. Huddleston HP, Cohn MR, Haunschild ED, et al. Amniotic product treatments: clinical and basic science evidence. Current Reviews in Musculoskeletal Medicine 2020;13:148-154.
80. Cooke M, Tan E, Mandrycky C, et al. Comparison of cryopreserved amniotic membrane and umbilical cord tissue with dehydrated amniotic membrane/chorion tissue. Journal of wound care 2014;23:465-476.
81. Duan-Arnold Y, Gyurdieva A, Johnson A, et al. Retention of endogenous viable cells enhances the anti-inflammatory activity of cryopreserved amnion. Advances in wound care 2015;4:523-533.
82. Davis KE, Killeen AL, Farrar D, et al. Lyopreserved amniotic membrane is cellularly and clinically similar to cryopreserved construct for treating foot ulcers. International Wound Journal 2020;17:1893-1901.
83. Gaudet C, Solecki L, Mathéaud B, et al. Questions about residual cell viability in cryopreserved human amniotic membrane and its impact on clinical applications. Biomedicines 2022;10:2456.
84. Hofmann N, Rennekampff H-O, Salz AK, et al. Preparation of human amniotic membrane for transplantation in different application areas. Frontiers in Transplantation 2023;2:1152068.
85. Sobolewski K, Małkowski A, Bańkowski E, et al. Wharton's jelly as a reservoir of peptide growth factors. Placenta 2005;26:747-752.
86. Davies JE, Walker JT, Keating A. Concise review: Wharton's jelly: the rich, but enigmatic, source of mesenchymal stromal cells. Stem cells translational medicine 2017;6:1620-1630.
87. Weiss ML, Anderson C, Medicetty S, et al. Immune properties of human umbilical cord Wharton's jelly-derived cells. Stem cells 2008;26:2865-2874.
88. Guenther R, Dreschers S, Maassen J, et al. The treasury of Wharton's Jelly. Stem cell reviews and reports 2022;18:1627-1638.
89. Troyer DL, Weiss ML. Concise review: Wharton's jelly-derived cells are a primitive stromal cell population. Stem cells 2008;26:591-599.
90. Dubus M, Scomazzon L, Chevrier J, et al. Decellularization of Wharton's jelly increases its bioactivity and antibacterial properties. Frontiers in Bioengineering and Biotechnology 2022;10:828424.
91. Dubus M, Scomazzon L, Chevrier J, et al. Antibacterial and immunomodulatory properties of acellular wharton's jelly matrix. Biomedicines 2022;10:227.
92. La Rocca G, Lo Iacono M, Corsello T, et al. Human Wharton's jelly mesenchymal stem cells maintain the expression of key immunomodulatory molecules when subjected to osteogenic, adipogenic and chondrogenic differentiation in vitro: new perspectives for cellular therapy. Current Stem Cell Research & Therapy 2013;8:100-113.
93. Salehinejad P, Alitheen NB, Ali AM, et al. Comparison of different methods for the isolation of mesenchymal stem cells from human umbilical cord Wharton's jelly. In Vitro Cellular & Developmental Biology-Animal 2012;48:75-83.
94. Matas J, Orrego M, Amenabar D, et al. Umbilical cord-derived mesenchymal stromal cells (MSCs) for knee osteoarthritis: repeated MSC dosing is superior to a single MSC dose and to hyaluronic acid in a controlled randomized phase I/II trial. Stem cells translational medicine 2019;8:215-224.
95. Lofink S, Trumble T. The effectiveness of Wharton's jelly versus steroid injection for the treatment of thumb carpometacarpal joint arthritis for pain relief and the increase of function. Medical Research Archives 2024;11.
96. Lai A, Tamea C, Shou J, et al. Safety and efficacy of Wharton's Jelly connective tissue allograft for rotator cuff tears: findings from a retrospective observational study. Biomedicines 2024;12:710.
97. Baravarian B, Kwon G, Tamea C, et al. Wharton's Jelly Tissue Allografts for Tearing in the Plantar Fascia: A Case Series. Biomedicines 2025;13:2328.
98. Sharan J, Barmada A, Prodromos C, et al. First human report of relief of lumbar and cervical discogenic and arthritic back pain after epidural and facet joint mesenchymal stem cell injection: a case report. Current stem cell research & therapy 2023;18:1013-1015.
99. Jing H, He X, Zheng J. Exosomes and regenerative medicine: state of the art and perspectives. Translational Research 2018;196:1-16.

100. Doyle LM, Wang MZ. Overview of extracellular vesicles, their origin, composition, purpose, and methods for exosome isolation and analysis. Cells 2019;8:727.
101. Hade MD, Suire CN, Suo Z. Mesenchymal stem cell-derived exosomes: applications in regenerative medicine. Cells 2021;10:1959.
102. Norouzi F, Aghajani S, Vosoughi N, et al. Exosomes derived stem cells as a modern therapeutic approach for skin rejuvenation and hair regrowth. Regenerative Therapy 2024;26:1124-1137.
103. Lu J, Zhang Y, Yang X, et al. Harnessing exosomes as cutting-edge drug delivery systems for revolutionary osteoarthritis therapy. Biomedicine & Pharmacotherapy 2023;165:115135.
104. Ogéus T. Amniotic-Derived Exosomes in Clinical Practice: Safety and Outcomes in 608 Patients. Journal of Orthopedics and Sports Medicine 2025;7:412-421.
105. Zhao J, Sun Y, Sheng X, et al. Hypoxia-treated adipose mesenchymal stem cell-derived exosomes attenuate lumbar facet joint osteoarthritis. Molecular Medicine 2023;29:120.
106. Gupta A. Exosomes for the management of low back pain: a review of current clinical evidence. Cureus 2024;16.
107. Phillips A, Wong A, Chen G, et al. One month safety study of ExoFlo injection for the treatment of lumbar or cervical radiculopathy in the epidural space. IJSRA 2021;4:119-124.
108. Aratikatla A, Arcot S, Gupta M, et al. Exosomes for the Management of Rotator Cuff Injuries: A Systematic Review. Indian Journal of Orthopaedics 2025;59:710-719.
109. Connor DE, Paulus JA, Dabestani PJ, et al. Therapeutic potential of exosomes in rotator cuff tendon healing. Journal of bone and mineral metabolism 2019;37:759-767.
110. Wang Y, Kong Y, Du J, et al. Injection of human umbilical cord mesenchymal stem cells exosomes for the treatment of knee osteoarthritis: from preclinical to clinical research. Journal of Translational Medicine 2025;23:641.
111. Ogéus T. Amniotic Derived Exosomes with Platelet Rich Fibrin Combined in the Treatment of Hip and Knee Osteoarthritis: A Retrospective 1-Year Follow-Up Study. Journal of Orthopedics and Sports Medicine 2025;7:122-130.
112. Argut SK, Celik D, Ergin ON, et al. Factors affecting the features of platelet-rich plasma in patients with knee osteoarthritis. Acta Orthopaedica et Traumatologica Turcica 2023;57:148.
113. Rossi L, Ranalletta M, Pasqualini I, et al. Substantial variability in platelet-rich plasma composition is based on patient age and baseline platelet count. Arthroscopy, Sports Medicine, and Rehabilitation 2023;5:e853-e858.
114. Chowdhary K, Sahu A, Iijima H, et al. Aging affects the efficacy of platelet-rich plasma treatment for osteoarthritis. American journal of physical medicine & rehabilitation 2023;102:597-604.
115. Stenneberg MS, Scholten-Peeters GG, den Uil CS, et al. Clinical characteristics differ between patients with non-traumatic neck pain, patients with whiplash-associated disorders, and pain-free individuals. Physiotherapy theory and practice 2022;38:2592-2602.
116. Stenneberg MS, Rood M, de Bie R, et al. To what degree does active cervical range of motion differ between patients with neck pain, patients with whiplash, and those without neck pain? A systematic review and meta-analysis. Archives of physical medicine and rehabilitation 2017;98:1407-1434.
117. Anstey R, Kongsted A, Kamper S, et al. Are people with whiplash-associated neck pain different from people with nonspecific neck pain? journal of orthopaedic & sports physical therapy 2016;46:894-901.
118. Vassiliou T, Kaluza G, Putzke C, et al. Physical therapy and active exercises–an adequate treatment for prevention of late whiplash syndrome?: Randomized controlled trial in 200 patients. Pain 2006;124:69-76.
119. Scholten-Peeters GG, Bekkering GE, Verhagen AP, et al. Clinical practice guideline for the physiotherapy of patients with whiplash-associated disorders. Spine 2002;27:412-422.
120. Blanpied PR, Gross AR, Elliott JM, et al. Neck pain: revision 2017: clinical practice guidelines linked to the international classification of functioning, disability and health from the orthopaedic section of the American Physical Therapy Association. Journal of Orthopaedic & Sports Physical Therapy 2017;47:A1-A83.
121. Jull GA, Söderlund A, Stemper BD, et al. Toward Optimal Early Management After Whiplash Injury to Lessen the Rate of Transition to Chronicity. Spine 2011;36:S335-S342.
122. Park D. The Pathophysiology and Mechanism of Acute and Chronic Whiplash Injury: A Narrative Review. International journal of Pain 2022;13:20-24.
123. Dickson RR, Reid JM, Nicholson WT, et al. Corticosteroid and cortisol serum levels following intra-articular triamcinolone acetonide lumbar facet joint injections. Pain Practice 2018;18:864-870.
124. Bharadwaj UU, Lynch JA, Joseph GB, et al. Intra-articular Knee Injections and Progression of Knee Osteoarthritis: Data from the Osteoarthritis Initiative. Radiology 2025;315:e233081.
125. Ayub S, Kaur J, Hui M, et al. Efficacy and safety of multiple intra-articular corticosteroid injections for osteoarthritis—a systematic review and meta-analysis of randomized controlled trials and observational studies. Rheumatology 2021;60:1629-1639.
126. Smith AD, Andruski B, Deng G, et al. Cervical Spine Platelet-Rich Plasma and Physiotherapy Increases Cervical Mobility and Isometric Strength in Chronic Whiplash Associated Disorder. Interventional Pain Medicine 2023;2:100362.
127. Smith A, Andruski B, Deng G, et al. Cervical facet joint platelet-rich plasma in people with chronic whiplash-associated disorders: A prospective case series of short-term outcomes. Interventional pain medicine 2022;1:100078.

128. Smith A, Andruski B, Deng G, et al. Cervical facet joint platelet-rich plasma in people with chronic whiplash-associated disorders: A prospective case series of longer term 6-and 12-month outcomes. Interventional Pain Medicine 2023;2:100237.
129. Aufiero D, Vincent H, Sampson S, et al. Regenerative injection treatment in the spine: review and case series with platelet rich plasma. J Stem Cells Res. Rev & Rep 2015;2:1019.
130. Ross A, Gambrill V, Main C. Clinical outcomes of amniotic membrane/umbilical cord particulate in spinal disorders: A retrospective study. Journal of Pain Research 2022:3971-3979.
131. Wu J, Du Z, Yang L, et al. A new technique for the treatment of lumbar facet joint syndrome using intra-articular injection with autologous platelet rich plasma. Pain physician 2016;19:617.
132. Wu J, Zhou J, Liu C, et al. A prospective study comparing platelet-rich plasma and local anesthetic (LA)/corticosteroid in intra-articular injection for the treatment of lumbar facet joint syndrome. Pain Practice 2017;17:914-924.
133. Singh C, Yadav S, Loha S, et al. Comparison of intra-articular lumbar facet joint injection of platelet-rich plasma and steroid in the treatment of chronic low back pain: a prospective study. Journal of Orthopaedics, Trauma and Rehabilitation 2023;30:180-187.
134. Gellhorn AC, Han A. The use of dehydrated human amnion/chorion membrane allograft injection for the treatment of tendinopathy or arthritis: a case series involving 40 patients. PM&R 2017;9:1236-1243.
135. Gupta A, Maffulli N. Amniotic membrane and/or umbilical cord tissue for treatment of facet joint syndrome: a narrative review. Journal of Orthopaedic Surgery and Research 2023;18:744.